ÓBUDA UNIVERSITY
REJTŐ SÁNDOR FACULTY OF LIGHT INDUSTRY AND ENVIRONMENTAL ENGINEERING

VIth International Symposium-2022

"Biosphere & Environmental Safety"

Proceedings Book

May 5th – 6th, 2022

Óbuda University
Budapest, Hungary

Proceedings Book

Biosphere and Environmental Safety
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Biosphere and Environmental Safety
VI.th International Symposium-2022

2-DAY EVENT Online

VI[th] International Symposium-2022 on

"Biosphere & Environmental Safety"

PROCEEDINGS BOOK

(PROGRAM, ABSTRACT & Full Papers)

Venue:
Óbuda University
Budapest, Hungary

Date:
May 05 - 06, 2022

Editor-in-Chief
Prof. Dr. Hosam BAYOUMI HAMUDA

VIth International Symposium-2022 on

“Biosphere & Environmental Safety”

In light of the unprecedented circumstances, and the uncertainty due to the travel restrictions imposed by different countries, the Organizing Committee has made the decision to hold the VIth Symposium virtually.

Online

May 05th – 06th, 2022
RKK – Óbuda University
Budapest, Hungary

Content

INTRODUCTION

Dear Distinguish Friends, Guests & Colleagues

According to World Health Organization (2016), around 24% of global deaths are caused by violations of environmental protocols. People required fresh water to drink, clean air to breathe, and places to live free of toxic substances and hazards through sustainable environmental practices to secure future growth potentials and help build prosperous communities.

Currently, we are witnessing global climatic, biological & geological transformations taking place on the Planet & having a significant impact on all aspects of modern human life. Biosphere changes affect all countries & continents, their negative consequences are felt not only by underdeveloped states, but also by states that are usually referred to as "post-industrial", i.e. states with a high level of economic development & advanced technologies.

On the basis of environmental monitoring data, the current state of the environment is characterized, especially in areas of intensive industrial production, negative anthropogenic factors are identified that violate the ecological balance in the territories of active resource extraction, & the environmental threats arising in this connection. It is noted that in the context of increasing economic activity & global climate change, compliance with environmental safety requirements becomes a factor capable of ensuring sustainable economic development.

In the context of large-scale environmental degradation, ensuring sustainable socio-economic development is impossible without achieving the required level of environmental safety, which allows carrying out production activities without going beyond the capacity of the biosphere. The main approaches of the Symposium-2022 are mentioned below.

– Discusses a new environmental strategy based on the biosphere approach & taking into account the regularities of biosphere development & includes supplementary material on the influence of technologies on global climate change, the development of natural disasters & biosphere degradation.
– Highlights the contradictions between the market economy & ecology as well as the Symposium-2022 provide new facts about the global environmental crisis to be expected in the following 10 years.
– Ensuring environmental security is among the global strategic tasks. This problem is related to the rapidly aggravating threats caused by increasing population growth on the Earth, diminishing life-supporting resources, technologies, global climate change, & escalating natural disasters.
– Environmental safety becomes the most important factor controlling human survival on the Planet.

The VIth International Symposium-2022 examines the state of natural environment & the causes of its degradation using the biospheric approach. The increasing human population has resulted in people being more involved in research & innovation to find means of dealing with the increasing demands for food. The 21st century has witnessed numerous challenges affecting human life. One of these challenges is problems encountered in achieving food security by many nations across the globe, resulting in many people being unable to meet their basic human need of access & affordable food. The innovation of human beings is in increasing food production & ensuring food security through biotechnology. As such biotechnology plays a part in food security which refers to the secure, adequate supply of food for everyone.

The COVID-19 pandemic disease now affects the entire world & has many major effects on the global economy, environment, health, & society. Focusing on the harm COVID-19 poses for human health & society. The world is unsure about the possible determining factors of the COVID-19 pandemic, which need to be known through conducting nonlinearity relationships, which caused the pandemic crisis. The study should examine the nonlinear relationship between COVID-19 cases & carbon damages, managing financial development, renewable energy consumption & innovative capability in a cross section of most global countries.

Advances in sector of vaccinology & immunology dependency on innovations in biotechnology, especially genomics, signature tagged mutagenesis, proteomics, immune modulation, computational simulations & complicated system analysis. These fields gain experience quickly growing or developing knowledge which increased realizations of the human immune system & pathogens.

Artificial intelligence (AI) is an important field of computer science & engineering to make machine capable to show intelligence like human. The idea of artificial intelligence is discovered upon the concept which human think & reasoning procedures is conventionally expressed, collected & conventionally embedded into machines. Artificial intelligence includes intelligent agents (e.g., systems which recognize their environment & make decisions & take actions) to execute operation like reasoning, planning, knowledge extraction, learning, perception, communication, moving & also handling & operating objects.

The field of AI is flourishing thanks to large investments & big companies with heavy ecological footprints can use it to make their activity more sustainable. This field focuses on multiple areas where AI can be helpful in achieving such goals. Thanks to the use of artificial intelligence – specifically relationships between both people & computers (for example, different elevation or land cover datasets, or hydrologic models, are consistently labelled with clear, uniform & unambiguous descriptors).
Artificial intelligence plays an important role in achieving not only environmental but all other Sustainable Development Goals- from ending hunger & poverty to achieving sustainable energy & gender equality to protecting & preserving biodiversity.
Artificial intelligence has the potential to accelerate global efforts to protect the environment & conserve resources by detecting energy emission reductions, CO_2 removal, helping develop greener transportation networks, monitoring deforestation, & predicting extreme weather conditions. Artificial intelligence provides means to tackle the most pressing environmental challenges such as climate change, biodiversity & conservation, ocean health, water issues, healthy air, weather forecast & disaster resiliency.

Several studies have demonstrated the negative impacts of environmental pollution on population health; in general, few studies have examined the potential differential effects on the physical health of middle-aged & older populations. It is widely recognized that non-communicable chronic diseases have become more prevalent than infectious diseases in the world. Environmental pollution is associated with a range of chronic conditions & represents a major public health burden.

Environmentally, problems of air pollution are occurred in many of worldwide. Recent studies demonstrated that environmental pollution significantly increased the number of chronic diseases as well as the risk of being sick, thereby highlighting the corrosive effect of pollution on physical health status. This negative effect was stronger as pollution intensity grew. The growing prevalence of chronic conditions over the last 20 years has become a serious health problem & the main cause of premature mortality.
Pollution problems are severe in Worldwide. Presently, air pollution is a burning problem for every part of the globe. More than 100 pollutants which pollute air have been identified. They may be in the form of solids, liquids or gases. They differ significantly from place to place depending upon the particular complex of contaminant source & atmospheric conditions. The air pollutants emitted from both natural as well as anthropogenic sources. Air pollution has become a severe environmental stress to crop plants due to increasing industrialization & urbanization during last few decades.
One way to reduce pollution is through green innovation which is defined as the implementation of new, or significantly improved, products, processes, marketing methods, organizational structures & institutional arrangements which, with or without intent, lead to environmental improvements compared to relevant alternatives. It is one of the most important choices that firms make to deal with environmental issues & build sustainable development. Green investment refers to the investment necessary to reduce greenhouse gas & air pollutant emissions, so green investment is also called environmental protection investment, ecological investment, etc.
In global, groundwater not only provides valuable freshwater resources but also supports agricultural cultivation & industrial production activities, playing an increasingly important role in human life,

ecosystems, & sustainable development. However, many countries in the world are facing the pressure of water resources & environmental problems, such as water shortage, water pollution, & frequent occurrence of extreme hydrological events under the influence of climate change & anthropogenic activities. Understanding the quality & associated hydrogeochemical evolution process of groundwater are urgently required for managing & utilizing groundwater resources in the world.

Drainage of treated wastewater to surface water is a severe threat to the health of aquatic organisms. A major human activity or natural event may cause changes to the surface attributes immediately or after a period of time. Water is the source of life. Facing the increasingly serious shortage of fresh water & pollution of the water, remote sensing-based monitoring of water has received widespread attention. Urban rivers are closely related to the lives of urban residents & remote sensing data has also been widely used to monitor changes in water quality of urban river.

Environmental pollution from petroleum compounds has become a major problem, both biologically & economically. Oil spills in aquatic ecosystems are among the worst catastrophic events that can affect & compromise aquatic life. The contamination of aquatic ecosystems with oil may be caused by accidental oil leakage from petroleum reservoirs & oil deposits, damage to pipelines, oil extraction platforms, & discharge of effluents from refineries, etc. Crude oil is a toxic compound mixture with a high potential for bioaccumulation in the body of aquatic organisms.

Plastics continue to have a critical & essential role in human society such as food packing, product packages & building materials. Plastic waste spreading around our planet has become one of the biggest concerns of this century. Massive production & use of plastic products bring convenience to people while leading to the accumulation of plastic pollutants in the environment. In total, 80% of plastic wastes can accumulate in landfills or be released into natural environments. Every year, open oceans are dumped with an estimated 4.8 to 12.7 million tons of plastics due to improper waste management strategies. The recycling is much less than the generated plastic waste & accounts for only 9% of the total plastic waste discarded. In the meantime, it has been recognized as a global sustainability priority to study &mitigate pollution of plastics & the associated unknown impacts from ultrafine plastic particles. Microplastics particles, for instance, have been detected in the aquatic environment globally & have raised scientific interests & environmental concerns. The larger plastics in turn are fragmented by chemical reactions, UV radiations, wave action & biodegradation to form small plastic pieces, termed microplastics. Microplastic pollution has gradually become a global problem & attracted much attention from scientists. Plastic particles have invaded almost every ecosystem of the earth & their significance can be marked by the fact that they are even seen in drinking water.

The pollution of soils & plants & their location in different climatic, physiographic & geochemical conditions require not only constant monitoring of the soil condition, but also the development of differentiated approaches to assess & prevent the risk of pollution. The development of technologies for the rehabilitation of soil properties, including its fertility is also a challenge. The problem of soil monitoring & rehabilitation is becoming increasingly topical due to population expansion to abandoned mining areas & other industrial areas. It was especially important evaluate the variation & spatial distribution of natural & man-made associations of macro & microelements as a key to understanding the dynamics of sustainability of natural & anthropogenic substances and their spatial structures formed in soils that we need to know to return to safe operation of polluted land.

The socio-environmental crisis & the complexity of urban problems highlight the importance of better understanding the emergence & configuration of social innovation ecosystems & their impact on cities. The globalization index is composed of economic, social, & political factors. Economic globalization is generally the combination of financial factors as well as trade dimensions. Many empirical studies investigated the effects of globalization on the ecological footprint. In 2018, global energy utilization increased by 2.9% & this rate of increase was almost doubled compared with the average rate of 1.5% per annum in the preceding 10 years. In addition, the overall resource consumption has already surpassed the resource generating capacity of the earth causing an ecological deficit that can have detrimental effects on global population.

Despite the economic development, the majority of world nations could not develop their industrial sector to the desired extent. Therefore, the financial sector has an undeniable role in the structural transformation & energy transition of these nations. This structural transformation helps in the reduction of environmental pressure since the service sector produces less ecological damages.
The ecological footprint is a strategy advanced by the Global Footprint Network (2020) to quantify human requirements on natural capital—the number of natural resources required for an individual or an economy.
The Earth has undergone warming & cooling numerous times since its formation over billions of years ago. These changes have emanated from several atmospheric & land use systems leading to natural disasters which are the biggest global, regional & local challenges in recent years.
Climate adaptation & low-carbon investment in areas such as climate change, renewable energy, & clean technology in green investment. Considering pollution control within environmental protection investment is green investment in a narrow sense, while a broader definition of green investment should consider multiple aspects of the environment, the economy, & society. Climate change has a large impact on tourism activities in terms of the change of spatial & temporal distribution of temperatures, the availability of beaches for recreation, & the quality of the coastal environment. Climate change will have far-reaching effects on many aspects of human activity, including agricultural & industrial productivity, real estate markets, human health, & even recreational opportunities. Crafting efficient climate policy requires a comprehensive understanding of these many consequences.

Today, climate change primarily takes the form of an increase in temperature which induces a global rise in sea level. The low-lying coastal areas, including but not limited to coastal tourism, will be at risk depending on the preparedness & the resilience of different societies. Coastal tourism is a climate-dependent industry & is closely linked to natural resources such as climate, beaches & sea.
Global climate has undergone unprecedented changes due to several natural- & human induced factors. Residents undertake temporal evacuations with financial assistance from local financial institutions.
Global warming has resulted in the formation of several large-scale climate events in the twenty-first century. Sea level rise has resulted in the submersion of coastal lands (1 km–2 km l& residual inland). Notable among these is sea level rise which is an adverse impact of global warming. This has eventually amplified submersion & occasional flooding tide in low-lying coastal environments.

The coasts of sub-Saharan Africa & those along the Pacific particularly have not been spared from the harsh effects of climate hazards. For instance, the WHO in 2002 estimated an annual death rate of about 150,000 caused by climate hazards in the sub-Saharan region every year. Concurrently, urbanization is a sensitive indicator that has exacerbated climate hazards in cities due to poor planning & the changes done to land cover. In growing coastal cities, sea level rise, inundation & submersion among other climate hazards have claimed lives & destroyed properties worthy. This phenomenon is again driven by human activities such as deforestation of mangroves & coconut trees that play primary roles in carbon sequestration & serve as coastal defence systems. A consistency ratio of 10% based on pairwise comparisons of risks along with associated impacts show the judgements from respondents are pragmatic.
Crop productions are highly vulnerable to climatic changes associated with the increase in annual temperature & changing patterns of rainfall. The increasing average annual temperature change has the potential to distort the productivity growth of major agricultural crops & aggravate food security conditions in world.

As biotechnology, phytoremediation uses the potential of plants to remove pollutants & contaminants from the environment, which occurs through different processes. Most phytoremediation studies for water purification focus on the use of aquatic macrophytes. These plants species have different levels of contaminant tolerance & when used in combination in a decontamination system, they provide an environmentally sustainable & economically viable technology. Moreover, ornamental plants can be used to compose buffer strips mitigating contamination of rural areas in the vicinity of contaminant sources & the resulted biomass used for bioenergy production. However, more studies also need to assess the ornamental quality of plants produced in contaminated environments as well as the accumulation of contaminants in the marketable organs of ornamental plants, such as flowers & foliage, aiming to evaluate the feasibility & safety of their commercialization. Ornamental plants can be used for Phytostabilization, promoting the beautification of contaminated sites, tourism & environmental education.

Impacts of Eco-Innovation on the Environmental Safety are become modern technology to increase the development & more biosphere security. The concept of eco-innovation has begun to be considered as a solution to preventing environmental damage, especially since the 1990s. Eco-innovation is expected to reduce amounts of waste, air pollution, & material resource usage. However, the effect of eco-innovation on environmental & financial performance has received limited attention. While factors such as global agreements, market conditions, technologies & regulations have important implications for the environment, eco-friendly investment can still be considered an additional charge for companies. New technologies have significantly changed production concepts. It has been a matter of curiosity to us how this situation will change financial & environmental performance.

The use of pesticides, insecticides, & fertilizers has become indispensable in agricultural production for higher yield of crops in order to meet the growing demands for food on a global level. Out of the total consumption of 6 million tons worldwide of these chemicals, only 1% reaches the target pest & the rest ends up in different environmental segments posing a potential risk to non-target organisms.

There is growing recognition of the potential environmental & socio-economic benefits of applying a circular approach to urban organic waste management through resource recovery. Decisions around planning & implementing circular urban waste systems require estimates of the quantity of resources available in waste streams & their potential market value. However, studies assessing circular economy potential have so-far been conducted mostly in high-income countries, yet cities in low- & middle-income countries have different challenges when developing a circular economy.
Global environmental investment, as an effective means of world investment, provides financial & human support for globe's green technology innovations that require a large amount of capital investment. The proportion of global environmental investment reflects the importance that the global attaches to green technology innovation. Environmental investment & the application of green technologies is bound to influence global energy efficiency.

Subsequently, energy value & environmental concerns rise to imperil the sustainability of the developing economy. Oppositely, renewable energy is shaped after topped off natural resources to upgrade energy security & obliging the issues of environmental change & a worldwide temperature alteration. Renewable energy implies a fundamental component for achieving continuous economic advancement. The energy significantly boosts the level of economic growth according to the energy-led growth hypothesis & energy reduction policies effectively depressed the level of economic growth. This relationship is also called unidirectional association between energy & growth; therefore, the energy acts as the complement of the other inputs & imperative ingredient of the production process.

The VI.th Symposium-2022 will provides the newest innovate approaches & methods to prevent the environment & secure the environmental elements (Air, Soil, Water, Biodiversity, Food, Health, etc.) based on researches on life sciences, engineering, modern biotechnology & also provide the platform for all experts from academia, industry & research laboratory to discuss the latest hot researches & achievements.

Based on the huge success of last events, I am strongly confident that the VI.th Symposium-2022 will be a great success & meet our expectations. Moreover, the VI.th Symposium-2022 offers a valuable platform to create new contacts in the field of Traditional & Alternative technologies, by providing valuable networking time for you to meet great personnel in the field.

The above facts indicate that improving environmental quality can significantly reduce health risks & increase social welfare. Based on the above, it can be seen that the bilateral relationship between these five factors Environmental Health, Quality, Regulations, Safety, Security level should be considered in the future of the scientific basic research all over the World.

The International Council of Environmental Engineering Education (ICEEE) & the Óbuda University, Rejtő Sándor Faculty of Light Industry & Environmental Engineering (RKK) & Institute of Environmental Engineering & Natural Sciences have the great pleasure & cordially thank you to participate in the program of the VIth. International Symposium on Biosphere & Environmental Safety **ONLINE** event during 5th and 6th of May, 2022 at Óbuda University RKK, Budapest (Hungary).

Publication of the abstracts & full papers are published in the **ISBN Proceedings book** with the code: **978-963-449-285-6 or in other journals.**

For more information, please visit the following websites:

- https://www.iceee.hu
- https://www.kti.rkk.uni-obuda.hu

I sincerely look forward to meet you & your colleagues in next event.

Yours Sincerely,

Prof. Dr. Hosam E.A.F. Bayoumi Hamuda
President of ICEEE
Chair, VIth International Symposium-2022
Institute of Environmental Engineering & Natural Sciences
Óbuda University
E-mail: bayoumi.hosam@uni-obuda.hu
WhatsApp/viber/messenger: +36-30-390-0813

BIBLIOGRAPHIC INFORMATION

Editor and affiliation	Prof. Dr. Hosam E.A.F. Bayoumi Hamuda President of ICEEE Institute of Environmental Engineering & Natural Sciences Óbuda University
Organizations	International Council of Environmental Engineering Education (ICEEE)
Country of Origin	Hungary
Publication Date	30th of July 2022
Product Type	**Proceedings Book of VIth International VIth Symposium-2022**
Proceedings Book Title	***Biosphere & Environmental Safety***
ISBN	**978-963-449-285-6**
Number of Pages	668 pages
Language	English
Publisher	ICEEE, KTI, RKK, Óbuda University H-1034 Budapest, Doberdó Str. 6. Hungary
Contact us	Prof. Dr. Hosam E.A.F. Bayoumi Hamuda President of ICEEE Institute of Environmental Engineering & Natural Sciences Óbuda University E-mail: bayoumi.hosam@uni-obuda.hu WhatsApp/viber/messenger: +36-30-390-0813

Biosphere and Environmental Safety
VI.th International Symposium-2022

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- International Council of Environmental Engineering Education (ICEEE)
- Institute of Environmental Engineering & Natural Sciences (KTI)
- Rejtő Sándor Faculty of Light Industry & Environmental Engineering (RKK)
- Óbuda University (ÓU/ÓE)

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Biosphere and Environmental Safety
VI.th International Symposium-2022

VI^th International Symposium on

"Biosphere & Environmental Safety"

with the following keywords:

Air, Biosphere, Environment, Food, Health, IT, Pollution, Quality, Safety, Security, Soil, Waste, Water,

is carrying out under the auspices of:

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- Dr. Veronika MAJOR (Hungarian Water & Wastewater Technology Association, Hungary)

VIth International Symposium Principal Publishing Partners:

- Tájökológiai Lapok: Hungarian Journal of Landscape Ecology (SCOPUS)
- Euro-Mediterranean Journal for Environmental Integration (https://www.springer.com/journal/41207)
- ISBN Proceedings book (978-963-449-285-6)

SYMPOSIUM'S HIGHLIGHT TOPICS

Form the above mentioned reasons, the special VIth. International Symposium-2022 on Biosphere & Environmental Safety aims to provide a comprehensive perspective on changes in environmental quality affecting ecosystem & human health adopting global perspective concepts of climate change, modelling, & ecosystem services. For this purpose, valuable studies were gathered together for the special Symposium-2022. The majority of the selected papers will be focused on the quality of environmental elements (air, landscape, soil, water, food, health & waste) as well as treatment & systems of management.

The VI.th Symposium-2022 provides leading forum for the presentation (plenary, keynote, oral & poster) of new advances & research results in the fields of on Biosphere & Environmental Safety. Accordingly, Topics of interest for paper submission include, but are not limited to:

Session (A): Atmosphere Quality
- Air Pollutants & Crop Yields
- Air Pollution & Its Association with Acute Respiratory Infections
- Air Quality & Environmental Safety
- Exogenous Pollution & Green Innovation

Session (B): Hydrosphere Quality
- Assessment of Groundwater Hydrogeochemistry & Quality
- Assessment of Running & Potable Water Quality Parameters
- Biological & Microbiological Assessment of Surface & Groundwater
- Environmental Factors & Phytoplankton in Surface Water
- Heavy Metals in Surface Water & Their Ecotoxicological Implications
- Hydrogeological Engineering & Physicochemical Parameters in Surface Water
- Macro- & Microplastics in Running Water
- Membrane Technology, Process & System Design
- Water Desalination
- Water Pollution & Treatment Technology
- Water Resources Planning & Management

Session (C): Lithosphere Quality
- Application of GIS for Soil Suitability & Crop Productivity
- Application of Pesticides & Other Agrochemicals
- Dynamics Nutrient Cycling in Agroecosystems
- Environmental Impact Assessment on Soil Pollution
- Erosion & Sediment Control & Soil Microbes
- Microbial Communities & Bioremediation of Oil-Contaminated Agricultural Soils
- Organic & Inorganic Pollutants in Soil
- Remediation of Radioactive Soil
- Soil Biological & Physical Properties & Ecosystem Processes
- Soil Biota, Ecosystem Services & Land Productivity
- Soil Carbon & Nitrogen Stocks & Storage of Soil Microbiome
- Soil Quality, Biocontrol & Productivity

Session (D): Biodiversity & Landscape Security
- Biodiverse of Plant & Vegetation Communities
- Biodiversity Benefits of Ecological Intensification
- Biodiversity & Conservation
- Biodiversity & Ecosystem Functioning in Soil
- Biodiversity in Global Above- & Below-Ground Linking

- Biodiversity in Life Cycle Assessment
- Biodiversity Management
- Ecological Role of Biodiversity in Agroecosystems
- Future of Global Birds
- Grassland Biodiversity
- Honey Bees
- Landscape & Nature Protection
- Linking Agricultural Practice to Insect & Bird Populations
- Landscape Composition, Biodiversity & Natural Pest Control
- Landscape-Moderated Biodiversity Effects of Agri-Environmental Management
- Ornamental Plants
- Restoration & Landscape
- Sustainable Regulation in Agricultural Landscapes

Session (E): Food Quality

- Antimicrobial-Resistant Foodborne Pathogens
- Antioxidants
- Bioprocess & Biosystems Engineering
- Biosecurity Strategy for Agricultural & Food Industry
- Drought-Resistant Soil & Sustained Food Production
- Fermentation & Food Technology
- Food Safety & Environmental Sustainability
- Food Supply Chain More Eco-Friendly
- Global Food Security & Biodiversity
- Global Trends in Agriculture & Food Systems
- Microbial Pigments: Alternative to Synthetic Dyes & Food Additives
- Organic Agriculture & Global Food Supply
- Phytotoxic Effects of Antibiotics on Crop Plants
- Quality Control & Marketing of Food Products
- Pesticides & Decrease Pest Damage in Crop Production
- Use of Biotechnology in Solving Food Security Problem

Session (F): Health Insurance

- Artificial Intelligence & Health
- Biomechanics & Modelling in Mechanobiology
- COVID-19 Pandemic on Socio-Economic & Sustainability
- Diet & Mental Illness
- Drugs from Natural Sources
- Ecotoxicological Aspects
- Emergency Preparedness & Response
- Environmental Pollution & Physical Health
- Global Map of COVID-19 Vaccine Acceptance
- Health & Safety Management
- Healthy Eating
- Management & Healthcare
- Molecular Pharmacology
- Nutrition Therapy
- Plants & Essential Oils
- Probiotics & Prebiotics: Health Benefits & Therapeutic Potentials
- Probiotics & Human Health
- Probiotics & COVID-19, HIV infection, Anti-carcinogenic Diseases
- Prevalence, Knowledge & Potential Determinants of COVID-19

Session (G): Integration of Education, Science & Business in Modern Environment

- Artificial Intelligence in Environment: Technology & Data science Trends
- Biomass Conversion & Biorefinery
- Civil, Electrical & Mechanical Engineering in Environmental Quality
- Eco-Design & Environmental Safety
- Eco-Innovation & Environmental Safety
- Ecological Footprints of Environmental Resources
- Education Strategy in Natural & Engineering Sciences
- Environmental Investment & Resource Economics
- Environmental Modelling & Assessment
- Environmental Planning Education
- Environmental Technology & Innovation
- Financial Globalization, Economic Growth & Environmental Sustainability
- Humanities & Social Science in Environment
- Socio-Economics & Ecology
- Social Innovation Ecosystems
- Technological Innovation & Energy-Environmental Efficiency

Session (H) Environmental Science, Pollution & Technology

- Agroecology: New Research & Development
- Application of Bio(Phyto)remediation Technique
- Biotechnology & Bioengineering in Environment
- Bio- & Genetic Engineering in Environment
- Deforestation
- Green Nanotechnology in Environment
- Ecosystems for Water & Food Security
- Environmental Contamination
- Environmental Degradation
- Environmental Monitoring & Assessment
- Environmental Sustainability Assurance & Future Research
- Health, Quality & Security of Environment
- Hygienic Engineering & Environmental Design
- Microplastic & Nanoplastic Pollution in Environment
- Phytonanotechnology: Challenges & Future Perspectives
- Phytoremediation & Ornamental Plants
- Prevent, Control & Remediate Environmental Hazards
- Rehabilitation of Ecosystem
- Rhizosphere Microbiome
- Strategies of Cold-Adapted Microorganisms
- Toxicity & Genotoxicity of Domestic Sewage Sludge in Ecosystem

Session (I): Carbon Emission & Renewable Energy

- Biomass, Bioenergy & Renewable Energy Technologies
- Biomass Energy Consumption & Ecological Footprint
- Carbon Footprint
- Energy & Environmental Issues
- Energy-Saving Technology Investment
- Environmental Regulations & Carbon Emission
- Greenhouse Gas Emissions
- Energy Investment & Environmental Sustainability
- Renewable Energy: Sources & Environmental Economic Growth
- Solar Radiation, Saving Time, Water & Energy

Session (J): Climatic Changes & Biosphere

- Climate Change & Adaptation in Agro-Ecosystems

- Climate Change & Crop Production
- Climate Change & Environmental Sustainability
- Climate Change & Future of Agricultural Land
- Climate Change & Global Environmental Change
- Climate Change & Human Security & Next Generation
- Climate Change & Socio-Economic Scenario & Tourism
- Climate Change & Spreading of Diseases
- Climate Change &Water Pollution
- Climate Insecurities & Global Food Security

Session (K): Waste Management

- Biogenic Municipal Waste & Biofuel Production
- Bioremediation & Management of Hazardous & Radioactive Waste
- Circular Economy Potential of Urban Organic Waste
- Ecotoxicological Evaluation & Treatment of wastewater
- Microbial Systems & Technology for Pollutant Removal
- Municipal Wastewater Treatment Plants & Environmental Management
- Socio-Environmental Conflict: Mining & Industrial Wastes
- Sustainable Use & Waste Management of Plastics
- Waste Management (Air, Water, Soil, Industrial, etc.)

AWARDS of the BEST PRESENTATION, POSTER & MUNSCRIPTS

This award recognizes individuals from poster presenters who have display their outstanding research & findings for an innovative future. Recipients of the award are considered to be the Best Poster Presenter of the VIth International Symposium-2022.

Criteria:

- All presented abstracts will automatically be considered for the Award.
- All the presentation will be evaluated in the conference venue
- All the awards will be selected by the judges of the award category
- The winners will be formally announced during the closing ceremony.
- The winners will receive award certificate.
- The awards will be assessed as far as plan & format, intelligence, argumentation & approach, familiarity with work, engaging quality, message & primary concerns, parity of content visuals & by & large impression.

VIth International Symposium-2022 Excellence Awards for best papers & presentation was instituted sine the year 2010 & have been given to the researchers for significant papers, to municipalities, temples, industries for their significant achievement in environmental health, quality, safety, etc. as well as the protection of the environment from pollution. The awards of the VIth International Symposium-2022 were given to the most outstanding researchers of the symposium under below three categories.

SELECTION PROCESS

1. CRITERIA FOR THE SESSION'S BEST PRESENTATION AWARD

Each & every presentation was evaluated by two evaluators & the average mark of both evaluators was taken as the final mark. The best presentation from sessions was selected based on the final mark received from the evaluators & the final decision was given by the Symposium's Chair. Below criteria were taken into consideration for this award & marks are given out of 100.

1. **Value of the Content (30%)**
2. **Clarity of Presentation (20%)**
3. **Appropriate Audio Visual Aids (20%)**
4. **Ability to Connect with the Audience (10%)**
5. **Proper Timing (20%)**

2. CRITERIA FOR THE BEST POSTER PRESENTATION AWARD

Every poster presentation is evaluated by a special evaluator based on below criteria & the presentation with the highest mark was selected as the best poster presentation award. The final mark is given out of 100.

1. **Depth of Content (40%)**
2. **Introduction** & **Abstract (15%)**
3. **Content knowledge** & **organization (20%)**
4. **Poster Design** & **Overall Visual Appeal (10%)**
5. **Verbal Interaction (15%)**

3. CRITERIA FOR THE OVERALL BEST PRESENTATION AWARD & **BEST STUDENT PRESENTATION AWARD**

Presentations of each technical session with the highest marks were recommended for these two awards. They were evaluated by a special committee headed by the Symposium’s Chair according to the below criteria.

1. **Total Marks gained in the presentation (100%)**
2. **Significance of the paper to the field (30%)**
3. **Theoretical contribution (15%)**
4. **The ability of practical implementation (20%)**
5. **Use of appropriate methodological rigor (20%)**
6. **Originality (15%)**

The organizing committee is waiting for your join the atmosphere of the VIth. International Symposium-2022 in Budapest & contribute to these exciting debates on the Biosphere & Environmental Safety in order to shape the future of our biotic & abiotic factors in our planet!

Based on the huge success of last events, I am strongly confident that the VI.th Symposium-2022 will be a great success & meet our expectations. Moreover, the VI.th Symposium-2022 offers a valuable platform to create new contacts in the field of Traditional & Alternative technologies, by providing valuable networking time for you to meet great personnel in the field.

In case you might have any queries or requirements please do not hesitate to contact me by replying to this e-mail.

I sincerely look forward to meet you & your colleagues in this event.

Yours Sincerely,

Best regards,

Prof. Dr. Hosam Bayoumi Hamuda
President of ICEEE, Symposium Chairman

AWARDS CEREMONY

List of the Best participation in VIth International Symposium-2022
Biosphere and Environmental Safety

Congratulations to all our participants and the
Awards winners in VIth International Symposium-2022

A. PROFESSIONAL RESEARCHERS

1. **Edit CSANÁK**

Arts and Nature: The Contribution of Artists to Understanding of the World and the Development of Natural Sciences

2. **Tünde TAKÁCS *, Anna FÜZY:**

Promoting Phytoremediation by Arbuscular Mycorrhizal Fungi

3. **Tibor SZILI-KOVÁCS, Tünde TAKÁCS:**

Impact of Floods on Soil Microbial Biomass and Activity at a Floodplain Contaminated by Former Metal Mining

4. **Csaba CENTERI, Viktória VONA, Márton VONA, Zsolt BIRÓ:**

Impacts of Mole Activities on Soil Properties

5. **Csaba MÉSZÁROS, István Róbert NIKOLÉNYI, Ágnes BÁLINT:**

New Methods for Applying the Symmetry Theory of Stereoregular Polymers for Quantum-Mechanical Modelling of Photovoltaic Type Materials

6. **Csaba ÁGOSTON**

Odour Problem of Animal Keeping in Hungary

7. **Viraja BHAT, Prakash RAO, Shubham BARJIBHE:**

An Analytical Study of E-Waste Awareness and Disposal Behaviour Amongst Rural, Semi-Urban and Urban Consumers of Maharashtra

8. **Nawal HICHAMI, Mohamed ZNARI**

Management Plan for a Declining Population of the Souss Valley Tortoise in an Arid Steppe-Land of West-Central Morocco

9. **Smaine CHELLAT, L. BOUDRAA, R. ZATOUT, A. BOUREFIS, M. HACINI:**

Superficial Pollution of Quaternary Soils of the City of Ali Mendjeli, Constantine, Northeast of Algeria

10. **Karim SBIHI, Sara EL HAMJI, Siham LGHOUL, Khalid AZIZ, Noureddine EL BARAKA, Faissal AZIZ:**

Potential of Local Freshwater Microalgae Craticula Subminuscula for Hexavalent Chromium Removals: Tolerance, Ptimization, Kinetics and Isotherm Studies

B. PhD STUDENTS

The most outstanding presentations presented by a participant who has registered under the Ph.D. student. The winner Ph.D. students were:

11. **Sara El HAMJI, Karim SBIHI, Jihen ELLEUCH, Naaila OUAZZANI2, Imen FENDRI, Slim ABDELKAFI, Brahim OUDRA, Faissal AZIZ:**

Toxicity and Removal of Phenolic Compounds by the Freshwater Diatom Craticula Subminuscula

12. **Nidal ZRIKAM, Lahcen OUAHMANE, Faissal AZIZ**

Mycorrhization of Aleppo Pine (*Pinus Halepensis*) Seedlings by Inoculation with Three Different Ectomycorrhizae Species

13. **Ali Dawood SALMAN, Tatjána JUZSAKOVA, Moayyed G. JALHOOM, Phuoc-Cuong LE, Mohammad A. AL-MAYYAHI, Thamer Adnan ABDULLAH, Domokos ENDRE:**

Synthesis and Surface Modification of Magnetic Fe_3O_4/SiO_2/Opcs Nanoparticles and Its Application in Uptake of Scandium (III) Ions from Acidic Media

14. **Amina HAFSI, Ahsene BOUREFIS, Farès KESSASRA, Abdellah BOUSHABA:**

Assessment of Soil Pollution by Heavy Metal in Industrial Area of Skikda City North Algeria

C. YOIUNG RESEARCHERS

15. **Viktória TÖRÖK, Rebeka SZALÓKI, Ádám MEDVECZKI, Hosam E.A.F. BAYOUMI HAMUDA:**

Analysis of Lichen Biodiversity in Different Areas of Hungary

16. **Yasmin HAMUDA, Hosam E. A. F. BAYOUMI HAMUDA:**

Budapest, 6th of May 2022.

Prof. Dr. Hosam E.A.F. Bayoumi Hamuda
President of ICEEE
Chair, VIth International Symposium-2022
Institute of Environmental Engineering & Natural Sciences
Óbuda University
E-mail: bayoumi.hosam@uni-obuda.hu
WhatsApp/viber/messenger: +36-30-390-0813

The certificates will be sent to all the awardees in e-mail by September 2021. In case of non-receipt of the certificate, please write to us with your contact details to: bayoumi.hosam@uni-obuda.hu

ACKNOWLEDGMENT

Dear Guests and Colleagues

Thank you very much for your attendance in the VIth International Symposium-2022 which was in Budapest during May 5-6, 2022 online in Budapest at Óbuda University, Hungary.

The VIth International Symposium-2022 is a meeting where researchers, environmentalists, scientists, scholars and students, share their ideas, experiences, advancements, and research results. There were a plenty of opportunities for organisations, projects and consortia hold side events (meetings, seminars and workshops) on the Symposium site to draw insights and encourage collaboration from many topics, disciplines, and backgrounds, promoting research and education to build a fair global community and more sustainable societies.

The purpose of the VIth International Symposium-2022 was to deals with „Environmental Safety and Biospheret”. Environmental Sustainability is projected to harm human health through adverse changes in security of the life-style.

The VIth International Symposium-2022 bring together plenary, keynote, invited speakers and international researchers from academia, authorities and industry, to communicate and share a wide range of highlighting potential issues and paths towards the environmental health and the sustainable due to climate change at present and future. The themes reflect an integrated approach to identifying solutions to the complex global challenge of environmental quality.

The main goals of the symposium-2022 were: to promote research and developmental activities in Environmental Protection and different fields of Natural Science; and to promote scientific information interchange between researchers, developers, engineers, students, and practitioners working in and around the world.

Here, the organizing committee of the VIth International Symposium-2022 identify opportunities for thanks the international participants from civil society, global partners, and researchers who contribute to a high quality of global effort towards environmental health systems.

The organizing committee of the VIth International Symposium-2022 has the opportunity to thanks the contributors and the reviewers for their activities and their work to review the manuscripts of the participants.

At the end, the organizing committee of the VIth International Symposium-2022 wish all the best for all the participants and thank their attendance.

Organizing Committee
of the Conference

IMPRESSUM

For the Program, Abstracts and the Proceedings Book of the papers of the VIth International Symposium-2022

– The official language was English.
– The Program, Abstracts and Full papers of the VIth International Symposium-2022 is provided to all registered participants in online (electronic) form.
– All the received papers were reviewed by two of the members of the International Committee of the Symposium.
– All reviewed papers for the VIth International Symposium-2022 are published in the Conference Proceedings Book with the ISBN **978-963-449-256-6**. in CD-ROM format and online (electronic) in the website of ICEEE: www.iceee.hu
– The selected high quality manuscripts will be also published in the online journal.
– The scientific information and quality of the manuscript is due to the corresponding author of the paper.
– Individual authors at their manuscripts shell be responsible for any possible errors
– The Publisher of the Program, Abstracts and the Proceedings Book of the VIth International Symposium-2022, Institute of Environmental Engineering and Natural Sciences, Sándor Rejtő Faculty of Light Industry and Environmental Engineering, Óbuda University, Budapest, Hungary.
– Publication year of the Proceedings is 2022.
– Important Website: www.iceee.hu

May, 2022.

Prof. Dr. Hosam Bayoumi Hamuda
President of ICEEE, Conference Chairman
Óbuda University
Budapest-Hungary
E-mail: bayoumi.hosam@uni-obuda.hu
Mobile: +36(30)390-0813

Scientific Program of the VIth International Symposium-2022

Biosphere and Environmental Safety
VI.th International Symposium-2022

May 5th – 6th, 2022

Óbuda University
Budapest, Hungary

5^{th} of May 2022 (Thursday)

09:00 a.m. – 09:30 a.m.   Opening Ceremony

Prof. Dr. Hosam BAYOUMI HAMUDA
President, International Council of Environmental Engineering Education
Symposium Chair

Dr. Rita BODÁNÉ-KENDROVICS
Director, Institute of Environmental Engineering & Natural Sciences

Dr. Koltai László
Dean, Rejtő Sándor Faculty of Light Industry & Environmental Engineering

Prof. Dr. László Gulácsi
Vice-Rector, Óbuda University

Prof. Dr. Sadhan Kumar Ghosh
Honour guest of the Symposium

09:30 – 10:20 **Plenary Session**

Chair of the Session: **Rita BODÁNÉ-KENDROVICS**

PL1 09:30 – 09:55

Sadhan Kumar GHOSH[1,2]
[1]Department of Mechanical Engineering, Jadavpur University, Kolkata India, 2School of Energy Studies, Jadavpur University, Kolkata, India, [2]International Society of Waste Management, Air and Water (ISWMAW)

Environmental & health safety by adopting circular economy

PL2 09:55 – 10:20

Borbala BIRÓ
Department of Soil Environmental Studies, University of Agriculture and Life Sciences, Budapest, Hungary

Symbiosis as a tool to soil-, plant- and environmental health

10:20 – 10:30 Break

10:30 – 12:30 **Keynote Session**

Chair of the Session: ***Borbala BIRÓ***

KL1 10:30 – 10:50

Léocadie ODOULAMI, Grégoire A. BEWA
Laboratoire Pierre PAGNEY, Climat, Eau, Ecosystème et Développement Laceede/Dgat/Fashs/ [1]université D'abomey-Calavi (Uac), Cotonou [2]dgat/Flash/Université De Parakou (Up), République Du Bénin (Afrique De L'ouest):

Hygiene and sanitation problematic in primary school of Allada commune in Benin Republic (West Africa)

KL2 10:50 – 11:10

Edit CSANÁK
Product Design Institute, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Budapest, Hungary

Arts and nature: the contribution of artists to understanding of the world and the development of natural sciences

KL3 11:10 – 11:30

Faissal AZIZ[1,2]
[1]Laboratory of Water, Biodiversity, and Climate Change, Faculty of Sciences Semlalia, Cadi Ayyad University, Marrakech, Morocco, [2]National Center for Research and Studies on Water and Energy, Cadi Ayyad University, Marrakech, Morocco

Promotion of smart irrigation systems in the Mena region using superabsorbent biopolymers

KL4 11:30 – 11:50

Sándor J. ZSARNÓCZAI
National University of Public Service, Faculty of State Scientific and International Studies, Kálmán Széll State Finance Research Workshop, Óbuda University, Rejtő Sándor Faculty of Light Industry and Environmental Engineering Institute of Environmental Engineering and Natural Sciences, Budapest, Hungary

The agricultural production concerning subsidies in Hungary in period of 2008-2020

KL5 11:50 – 12:10

Thamer Adnan ABDULLAH1, Tatjána JUZSAKOVA1, Ali Dawood SALMAN1, Viktor SEBESTYÉN1, Domokos ENDRE1
[1]*Sustainability Solutions Research Lab, Bio-, Environmental and Chemical Engineering Research and Development Center, University of Pannonia, Veszprem 8201, Hungary*

MWCNTs Based Nanocomposites for the Removal of Hydrocarbons from Water

KL6 12:10 – 12:30

Hosam E.A.F. BAYOUMI HAMUDA
Environmental Engineering and Natural Science Department, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Hungary

Environmental pollution and public health

12:30 – 13:30 *Lunch Break*

13:30 – 14:30 **Technical Session 1**

Chair of the Session: ***Hosam BAYOUMI HAMUDA***

Ajinkya MAHALE, Vrishaali VYAS, Prakash RAO
Symbiosis Institute of International Business, Symbiosis International (Deemed University), Hinjewadi, Pune, Maharashtra, India

A review of sustainability reporting practices in selected Indian consumer packaged goods sector

Abdelmalek GOUMIH[1], Mariam EL ADNANI[2], Rachid HAKKOU[3], Mostafa BENZAAZOUA[4], Salah OUHAMDOUCH[5,6]
[1]*Laboratoire GéoSciences Semlalia, Département de géologie, Faculté des Sciences Semlalia, Université Cadi Ayyad, Marrakech, Morocco,* [2]*Ecole Nationale Supérieure des Mines de Rabat, Avenue Hadj Ahmed Cherkaoui, Agdal, Rabat, Morocco,* [3]*Laboratoire de Chimie des Matériaux et de l'Environnement, Faculté des Sciences et Techniques, Université Cadi Ayyad, Marrakech, Morocco,* [4]*Université du Québec en Abitibi Témiscamingue, Boul. de l'Université, Rouyn-Noranda. QC J9X 5E4, Canada,* [5]*Faculté des Sciences Semlalia, Université Cadi Ayyad, Marrakech, Morocco,* [6]*Applied Sciences Laboratory, Water and Environment Management Team, National School of Applied Sciences, Abdelmalek Essaadi University, Al Hoceima Morocco*

Integrated management of mining rejects: Case of the abandoned mine of Sidi Bou-Othmane mine (Central Morocco)

Emőke IMRE[1], Zsombor ILLÉS[2], Ágnes BÁLINT[3,9] , Henry GONZALES[3], Levente RÉPÁSSY[3], Dang Thi Quynh HUONG[3], Lamas Lopez LIZETH[3], Daniel BARRETO[4], Giulia GUIDA[5], Maria DATCHEVA[6], Wiebke BAILLE[7], Vijay P. SHINGH[8]
[1]*Óbuda University, Bánki Donát Faculty, and Hydro-Bio-Mechanical Systems Research Center, Budapest, Hungary,* [2]*Department of Engineering Geology and Geotechnics, Budapest University of Technology and Economics, Budapest, Hungary,* [3]*Institute of Environmental Engineering and Natural Sciences, Óbuda University, Budapest, Hungary,,* [4]*Edinburgh Napier University, U.K,* [8]*Università di Roma Tor Vergata,* [6]*Institute of Information and Communication Technologies, Bulgarian Academy of Sciences, Bulgaria,* [7]*Ruhr University Bochum, Germany, Depart. of Biological and Agricultural Engineering, Texas A&M University, USA.* [9]*Hydro-Bio-Mechanical Systems Research Center, Budapest Hungary*

The permeability variables of granular matter

Amina HAFSI[1], Ahsene BOUREFIS[1] , Farès KESSASRA[2], Abdellah BOUSHABA[3]
[1]Affiliation Department of Geology and Environment, University les Fréres Mentouri, Constantine 1, [2]Laboratory of Geological Engineering, Team 3 "Geology", University of Jijel, Algeria, Department of Earth and Universe Sciences, University of Jijel, Central Campus, Algeria, [3]Department of Geology, Sidi Mohamed Benabdellah University, Fes, Morocco

Assessment of soil pollution by heavy metal in industrial area of Skikda city North Algeria

Amina BOUSSELIOU[1], I. BOUDRAA[2,3], S. CHELLAT[1], H. BELAIDI[1]
[1]Geology and Environmental Laboratory, University of Constantine-1, Constantine, Algeria, [2]Constantine-1 University, Department of Chemistry, Pollution and Water Treatment Laboratory, Constantine-1, Algeria. [3]Environmental Molecular and Structural Chemistry Research, University of Constantine-1, Constantine, Algeria

Study and evaluation of the pollution in ETM in the valley of Oued Saf-Saf and Oued Zeramna, Skikda, North-East of Algeria

Asmaa RHAZOUANI[1,2,3], Halima GAMRANI[2], Khalid AZIZ[4], Mustapha My BOUYATAS[2], Lhoucine GEBRATI[5], Faissal AZIZ[1,3]
[1]Laboratory of Water, Biodiversity and Climate Change, Faculty of Sciences Semlalia, Cadi Ayyad University, Marrakech, Morocco, [2]Team of Neurosciences, Pharmacology and Environment, Faculty of Sciences Semlalia, Cadi Ayyad University, Marrakech, Morocco. [3]National Centre for Studies and Research on Water and Energy, Faculty of Technical Sciences, Cadi Ayyad University, Marrakech, Morocco, [4]Laboratory of Materials, Biotechnology, and Valorization of Natural Resources, Department of Chemistry, Faculty of Sciences, University Ibn Zohr, Agadir, Morocco, [5]Laboratory of Materials, Processes, Environment and Quality, Cadi Ayyad University, Safi, Morocco

Graphene oxide induces a modification of the peroxidase and MDA levels in male mice

Ali Dawood SALMAN[1,2], Tatjána JUZSAKOVA[1], Moayyed G. JALHOOM[3], Phuoc-Cuong LE[4,5], Mohammad A. AL-MAYYAHI[2], Thamer Adnan ABDULLAH[1], Endre DOMOKOS[1]
[1]Sustainability Solutions Research Lab, University of Pannonia, Veszprém, Hungary, [2]Department of Chemical and Petroleum Refining Engineering /College of Oil and Gas Engineering, Basra University, [3]Department of Production Engineering and Minerals, University of Technology Baghdad-Iraq, [4]Institute of Research and Development, Duy Tan University, Danang, Vietnam, [5]Faculty of Environmental and Chemical Engineering, Duy Tan University, Danang, Vietnam

Synthesis and surface modification of magnetic Fe_3O_4/SiO^2/OPCS nanoparticles and its application in uptake of scandium (III) ions from acidic media

14:30 – 15:30 **Technical Session 2**

Chair of the Session: ***Emőke IMRE***

Hassni BELAIDI[1], A. BOUSSELIOU[1], S. KITONI[2], S. CHELLAT[1]
[1]Geology and Environment Laboratory, University of Constantine 1, Road Ain El Bey Zouaghi Slimane Constantine Algeria, [2]Department of Process Engineering, Faculty of Process Engineering. University Salah Boubnider Constantine 3, Algeria

Feldspar's role in providing soil with macronutrients K and Ca (Example: Wadi El-Annab Northeast of Algeria

Halima BOUDRA[1], FBOUAICHA[1], W. MELOUAH [2], M. BOUKHATEM[1]
[1]Geology and Environment Laboratory, University of Constantine 1, Road Ain El Bey Zouaghi Slimane Constantine, Algeria, [2]Faculty of Hydrocarbons, Renewable Energies and Earth and Universe Sciences Kasdi Merbah University, Ouargla, Algeria

Hydrogeochemical assessment of thermal waters from Souk Ahras geothermal system, North East of Algeria

Ghizlane AKHOUY[1,2], Lhoucine Gebrati[1,2], Khalid AZIZ[3], Faissal AZIZ[2,4]
[1]Laboratory of Materials, Processes and Environmental Quality, Cadi Ayyad University Safi, Morocco, [2]National Center for Research and Studies on Water and Energy, Cadi Ayyad University, Marrakech, Morocco. [3]Laboratory of Materials, Biotechnology, and Valorization of Natural Resources, Department of Chemistry, Faculty of Sciences, University Ibn Zohr, Agadir, Morocco, [4]Laboratory of Water, Biodiversity, and Climate Change, Faculty of Sciences Semlalia, Cadi Ayyad University, Marrakech, Morocco

Bio-based and biodegradable plastics derived from olive pomace

Imane HAYDARI[1,2], Laila MANDI[1,2], Amina LISSANEDDINE[1,2], Khalid AZIZ[3], Naaila OUAZZANI[1,2], Faissal AZIZ[1,2]
[1]Laboratory of Water, Biodiversity, and Climate Change, Faculty of Sciences Semlalia, Cadi Ayyad University, Marrakech, Morocco, [2]National Center for Research and Studies on Water and Energy, Cadi Ayyad University, Marrakech, Morocco, [3]Laboratory of Materials, Biotechnology, and Valorization of Natural Resources, Department of Chemistry, Faculty of Sciences, University Ibn Zohr, Agadir, Morocco

Novel low-cost bio-sorbent from olive pomace to adsorption of phenolic compounds from olive oil mill wastewater

Selma HADEF, Faouzi ZAHI, Taha Hocine DEBIECHE, Abdelmalek DROUICHE
Geological Engineering Laboratory (LGG), University of Mohamed Seddik Benyahia - Jijel, Algeria

Evaluation of surface water quality for drinking purposes: A case of Guenitra Dam (North-East Algeria)

Jihane BAGHOR[1], Faissal AZIZ[2], Jamal MABROUKI[1], Souad EL HAJJAJI[1]
[1]Laboratory of Spectroscopy, Molecular Modeling, Materials, Nanomaterial, Water and Environment, CERNE2D, Mohammed V University in Rabat, Faculty of Science, Avenue Ibn Battouta, BP1014, Agdal, Rabat, Morocco, [2]Laboratory of Water, Biodiversity, and climate change, Faculty of sciences Semlalia, Cadi Ayyad University, Marrakech, Morocco

The toxicological effects of microplastics on the environment and human health

15:30 – 16:30 **Technical Session 3**

Chair of the Session: ***Zoltán JUVANCZ***

Rudolf SZABÓ1, Lóránt SZABÓ2
[1]Rejtő Sándor Fundation, Budapest, Hungary, [2]Institute of Environmental Protection Engeneering, Óbuda University, Budapest, Hungary

Carbon fiber, the black wonder

Jovito L. OPEÑA[1,2], Gábor Endre HALASZ[2], Jószef Tibor ÁRGYELÁN[3], Mark Kalman HORVATH[2]
[1]Marinduque State College, [1]Marinduque State College, Boac, Mariduque Philippines, [2] Department of Chemistry, Institute of Environmental Sciences, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary, [3]Nitrokémia PLC, Balatonfüzfö, Hungary): [3]Nitrokémia PLC, Balatonfüzfö, Hungary

Phytoremediation of potential toxic elements by native tree species in mined- spoiled soils in mátraszentimre, Hungary

Khalid AZIZ[1], Rachid MAMOUNI[1], Nabil SAFFAJ[1], Faissal AZIZ[2]
[1]Laboratory of Biotechnology, Materials and Environment, Faculty of Sciences, Ibn Zohr University, Agadir, Morocco, [2]Laboratory of Water, Biodiversity & Climate Changes, Faculty of Science Semlalia, Cadi Ayyad University, Marrakech, Morocco

A novel hydrogel beads based copper-doped Cerastoderma edule shells for highly fungicide sorption from groundwater

Karim SBIHI[1,2], Sara EL HAMJI[2,3], Siham LGHOUL[4], Khalid AZIZ[5], Noureddine EL BARAKA[5], Faissal AZIZ[2,3]
[1]Laboratory of Biotechnology, Materials and Environment, Natural Substances and Environment Team, Polydisciplinaire Faculty of Taroudant, University Ibn Zohr, Morocco, [2]National Centre for Research and Study on Water and Energy, University Cadi Ayyad, Marrakech, Morocco. [3]Laboratory of Water, Biodiversity & Climate Changes, Semlalia Faculty of Sciences, Marrakech, Morocco, [4]Department of Biology, Faculty of Sciences Semlalia, University of Cadi-Ayyad, Marrakech, Morocco, [5]Laboratory of Materials and Environment, Faculty of Sciences, Ibn Zohr University, Agadir, Morocco

Potential of local freshwater microalgae Craticula subminuscula for hexavalent chromium removals: Tolerance, optimization, kinetics and isotherm studies

Meriem BOUKHATEM, N. CHABOUR, F. BOUAICHA, R. KOURICHE, H. BOUDRA
Geology and Environment Laboratory, University des Frères mentouri Constantine 1, Road Ain El Bey Zouaghi Slimane Constantine, Algeria

Environmental impact of barite wastes from the Ain Mimoun mine, Khenchela, North-East Algeria

Mohammad MOHAMMAD
Institute of Marketing and Management, Faculty of Economics/ Hungarian University of Agriculture and Life Sciences (MATE) Kaposvár Campus, Kaposvár, Hungary

The role of social media blogs in influencing dairy functional foods and healthy lifestyle in Hungary

16:30 – 17:30 **Technical Session 4**

Chair of the Session: ***Sándor J. ZSARNÓCZAI***

Mohammad MOHAMMAD
Institute of Marketing and Management, Faculty of Economics/ Hungarian University of Agriculture and Life Sciences, Kaposvár Campus, Kaposvár, Hungary)

Impact of healthy behaviour on consumer attitude toward dairy functional foods

Nawal HICHAMI[1], Mohamed ZNARI[2]
[1]Laboratory of Biotechnology & Sustainable Development of Natural Resources, Polydisciplinary Faculty of Beni Mellal, Sultan Mulay Slimane University, Mghila, Beni Mellal, Morocco, [2]Natural History Museum of Marrakech, Cadi Ayyad University, Ave Allal El Fassi, Marrakech, Morocco

Management plan for a declining population of the Souss valley tortoise in an arid steppe-land of West-Central Morocco

Sadhan Kumar GHOSH[1,3], Somnath PODDAR[2]
[1]Department of Mechanical Engineering, Jadavpur University, Kolkata, India, [2]School of Environmental Studies, Jadavpur University, Kolkata, India, [3]International Society of Waste Management, Air and Water (ISWMAW), India

Impact of using refuse-derived fuel in co-processing towards the quality of clinker and cement

Bitrus Eniyekenimi DAUKERE[1], Olatunde Isaac OLANIYI[2]
[1]Department of Geography, Nigerian Army College of Education, Ilorin, Nigeria, [2]Department of Political Science, Nigerian Army College of Education, Ilorin, Nigeria

National security: Interplay of environmental, human and food (in)securities in Nigeria

Mythili MADHUSUDHAN[1], N.K.AMBUJAM[2]
[1]School of Architecture, Meenakshi College of Engineering, Tamilnadu, India, [2]Centre for Water Resources, Anna University, Chennai, India

An assessment of the present condition of a wetland in a developing city: the case of Pallikaranai marsh, Chennai, India

Rima KIFOUCHE, H. BOUSBAA, F. BOUAICHA, H. SHOUT
Laboratoire de géologie et environnement, Université Constantine 1, Route Ain El Bey Zouaghi Slimane Constantine, Algeria

Prospects and geothermal potential of Mila

17:30 – 18:30 **Technical Session 5**

Chair of the Session: ***Lóránt SZABÓ***

Mythili MADHUSUDHAN[1], N. K. AMBUJAM[2]
[1]School of Architecture, Meenakshi College of Engineering, Tamilnadu, India, [2]Centre for Water Resources, Anna University, Chennai, India

The case of the shrinking Palliikaranai marsh, Chennai, India: Environmental economics to the rescue?

Sándor J. ZSARNÓCZAI
National University of Public Service, Faculty of State Scientific and International Studies, Kálmán Széll State Finance Research Workshop, Óbuda University, Rejtő Sándor Faculty of Light Industry and Environmental Engineering Institute of Environmental Engineering and Natural Sciences, Budapest, Hungary

Innovation by subsidies in agricultural production in Hungary in 2010-2020s

Nidal Zrikam[1], Lahcen Ouahmane[1] and Faissal Aziz[2,3]
[1]Laboratory of Microbial Biotechnologies, Agro-Sciences and Environment, Labeled Research Unit-CNRST N° 4., Cadi Ayyad University, Marrakesh, Morocco, [2]National Centre for Research and Study on Water and Energy, University Cadi Ayyad, Marrakech, Morocco, [3]Laboratory of Water, Biodiversity & Climate Changes, Semlalia Faculty of Sciences, Marrakech, Morocco

Mycorrhization of aleppo pine (Pinus halepensis) seedlings by inoculation with three different ectomycorrhizae species

Sara El HAMJI[1,2], Karim SBIHI[2,3], Jihen ELLEUCH[4], Naaila OUAZZANI[1,2], Imen FENDRI[4], Slim ABDELKAFI[4], Brahim OUDRA[1], Faissal AZIZ[1,2]
[1]Laboratory of Water, Biodiversity & Climate Changes, Faculty of Science Semlalia, Cadi Ayyad University, Marrakech, Morocco, [2]National Center for Research and Studies on Water and Energy, Cadi Ayyad University, Marrakech, Morocco, [3]Laboratory of Biotechnology, Materials and Environment, Natural Substances and Environment Team, Polydisciplinaire Faculty of Taroudant, University Ibn Zohr, Morocco, [4]Unité de Biotechnologie des Algues, Ecole Nationale d'ingénieurs de Sfax, Université de Sfax, Tunisie

Toxicity and removal of phenolic compounds by the freshwater diatom Craticula subminuscula

Yanina L. ROMERO[1], J. BESSEMBINDER[2], N.C. van de GIESEN[3], F.H.M. van de VEN[3]
[1]Beuningen, the Netherlands, [2]Climate Services, Royal Netherlands Meteorological Institute, De Bilt, the Netherlands, [3]Water Management, Delft University of Technology, Delft, the Netherlands

A relation between extreme daily precipitation and extreme short term precipitation

Smaine CHELLAT[1], L. BOUDRAA[1], R. ZATOUT[1], A. BOUREFIS[1], M. HACINI[2]
[1]Geology and Environment Laboratory, University of Constantine 1, Road Ain El Bey Zouaghi Slimane Constantine, Algeria, [2]Geology of Saharan laboratory, Department of earth sciences, Faculty of Hydrocarbon. University Kasdi Merbah Ouargla, Algeria

Superficial pollution of quaternary soils of the city of Ali Mendjeli, Constantine, northeast of Algeria

6th of May 2022 (Friday)

09:00 – 10:00 **Technical Session 6**

Chair of the Session: ***Ágnes BÁLINT***

Viraja BHAT[1], Prakash RAO[2], Shubham BARJIBHE[3]
[1]Department, Symbiosis Institute of International Business, Pune, India

An analytical study of e-waste awareness and disposal behaviour amongst rural, semi-urban and urban consumers of Maharashtra

Zoltán JUVANCZ, Rita BODÁNÉ-KENDROVICS, Zita LACZKÓ
Óbuda University, Faculty of Light Industry and Environmental Engineering, Institute of Environmental Engineering and Nature Science, Budapest, Hungary

Chiral separations of phyretroic acids using cyclodextrin selectors

Eman R. B. OJALEY[1], Hussein B. B. JENJEN[1], Osama R. SHALTAMI[2], Ahmed M. MUFTAH[2]
[1]Department of Zoology, Faculty of Science, University of Benghazi, Benghazi-Libya, [2]Department of Earth Sciences, Faculty of Science, University of Benghazi, Benghazi-Libya

Molluskan tissues as an accumulation sites for heavy metals from Libyan coast in North-East Libya

Dina MALGAZHDAROVA
Management and Organization Sciences/Hungarian University of Agricultures and Life Sciences, Kaposvar, Hungary

Nexus between economic growth, availability of fossil fuels and opportunities for achieving environmental sustainability in countries of CIS: the case of oil and gas exporting countries

P. SENTHILVALAVAN[1], M.V. SRIRAMACHANDRASEKHARAN[1], R. MANIVANNAN[1], C. RAVIKUMAR[2], U. SURENDRAN[3], Pritpal SINGH[4], K. P. RAGUNATH[5]
[1]Department of Soil Science and Agricultural Chemistry, Faculty of Agriculture, Annamalai University, Tamilnadu, India, [2]Department of Agronomy, Faculty of Agriculture, Annamalai University, Tamilnadu, India, [3]Centre for Water Resources Development and Management, Kozhikode, Kerala, India, 4Punjab Agricultural University, Ludhiana, Punjab, India

Carbon accumulation in low land paddy soils moderated by certain management practices

Lóránt SZABÓ
Environmental Engineering and Natural Science Department, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Hungary

Wind energy application in Hungary

10:00 – 11:00 **Technical Session 7**

Chair of the Session: ***Hosam BAYOUMI HAMUDA***

Csaba ÁGOSTON
Óbuda University, Institute of Environmental Engineering and Natural Sciences, Budapest, Hungary

Odour problem of animal keeping in Hungary

Csaba MÉSZÁROS[1], István Róbert NIKOLÉNYI[1], Ágnes BÁLINT[2,3]
[1]Department of Mathematics and Basic Natural Sciences, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary, [2]Institute of Environmental and Natural Sciences, Óbuda University, Budapest, Hungary, [3]Hydro-Bio-Mechanical Systems Research Center, Budapest Hungary

New methods for applying the symmetry theory of stereoregular polymers for quantum-mechanical modelling of photovoltaic type materials

Hadjer BOUSBA[1], Ramdane MARMI[1], Kamel BOUFAA[2], Fouad BOUAICHA[1], Rima KIFOUCHE[1]
[1]Geology and Environment Laboratory, University of Constantine 1, Route Ain El Bey Zouaghi Slimane Constantine, Algeria, [2]Geological Engineering Laboratory, University of Jijel, Cité Ouled Aissa, Algeria

Soil quality in the Sebkhas environment (South-Eastern Constantine), Algeria

Krisztina DEMÉNY
Óbuda University, Faculty of Light Industry and Environmental Engineering, Institute of Environmental Engineering and Nature Science, Budapest, Hungary

Changes in land use and stability survey in Gödöllő Hillside

Ágnes BÁLINT[1,4], Erika LÁSZLÓ[2], Csaba MÉSZÁROS[3]
[1]Institute of Environmental Engineering and Natural Sciences, Óbuda University, Budapest, Hungary, [2]Doctoral School of Public Administration Sciences, National University of Public Service, Budapest Hungary, [3]Institute of Mathematics and Basics of Natural Sciences, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary, Gödöllő, Hungary,-[4]Hydro-Bio-Mechanical Systems Research Center, Budapest Hungary

Heavy metal concentrations in the hair samples

11:00 – 12:10 **Poster Session**

Chair of the Session: ***Hosam Bayoumi Hamuda***

Amina HAFSI[1], Ahsene BOUREFIS[1], Farès KESSASRA[2], Abdellah BOUSHABA[3]
[1]Affiliation Department of Geology and Environment, University les Fréres Mentouri, Constantine 1., [2]Laboratory of Geological Engineering, Team 3 "Geology", University of Jijel, Algeria, Department of Earth and Universe Sciences, University of Jijel, Central Campus, Algeria, [3]Department of Geology, Sidi Mohamed Benabdellah University, Fes, Morocco

Assessment of groundwater pollution by heavy metals in the industrial zone of Skikda

Ádám FEHÉR[1], Csaba CENTERI[2], Pari ALKHASOVA[2], Krisztián KATONA[2]
[1]Independent Researcher, Apc, Hungary, [2]Institute for Wildlife Management and Nature Conservation, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary

Comparison of deep rooting of wild boar on soil properties in the Mátra Mountain and the Gödöllő hillside

Ákos MALATINSZKY
Department of Nature Conservation and Landscape Management, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary

Forgotten preservers of protected plants: orchard grasslands in Hungarian hilly areas

Reghais AZZEDDINE, Drouiche ABDELMALEK, Zahi FAOUZI, Debeiche TAHA-HOCINE
Geological Engineering Laboratory (LGG), University of Mohamed Seddik Benyahia - Jijel, Algeria

Risk assessment of heavy metals in the complex terminal aquifer data from Biskra, South-est Algeria

Csaba CENTERI[1], Viktória VONA[2], Márton VONA[2], Zsolt BIRÓ[3]
[1]Department of Nature Conservation and Landscape Management, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary, [2]Csernozjom Ltd., Nagykörű, Hungary, [3]Department of Wildlife Biology and Management, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary

Impacts of mole activities on soil properties

F. HIZIR[1], A. KRIKA[2], F. KESSASRA[1]
[1]Geological Engineering Laboratory, University of Mohamed Seddik Benyahia, Jijel, Algeria, [2]Laboratory of Biotechnology, Environment and Health, University of Mohamed Seddik Benyahia, Jijel, Algeria

Assessment of surface water quality of the Kebir-Rhumel Wadi (North-East, Algeria)

Ildikó TURCSÁNYI-JÁRDI, Eszter S.-FALUSI, Atilla FŰRÉSZ, Gergely PÁPAY, Péter Gergő KOVÁCS, Károly PENKSZA
Institute of Crop Production, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary

Changes in wet and dry habitats in the Ipoly Valley

Malihe MASOUDI[1], Csaba CENTERI[1], Gergely JAKAB[2,3], Zsolt BIRÓ[1], Lyndre NEL[1], Eszter KOVÁCS[1], Viola PROHASZKA[4]
[1]Institute for Wildlife Management and Nature Conservation, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary, [2]Geographical Institute, Research Centre for Astronomy and Earth Sciences, Budapest, Hungary, [3]Institute of Geography and Earth Sciences, ELTE Eötvös Loránd University, Budapest, Hungary, [4]Doctoral School of Landscape Architecture and Landscape Ecology, Hungarian University of Agricultural and Life Sciences, Gödöllő, Hungary

The effect of different land-uses on soil organic matter content in the zselic region, Hungary

Drakulovic Vesna, Marko Jovanov, Una Marceta, Bogdana Vujic
Technical faculty "Mihajlo Pupin", University of Novi Sad, Zrenjanin, Serbia

Modelling an atmospheric dispersion of methane and hydrogen sulfide originating from landfills

Dina MALGAZHDAROVA
Management and Organization Sciences/Hungarian University of Agricultures and Life Sciences, Kaposvar, Hungary

Nexus between foreign direct investment and economic growth in oil exporting countries of CIS

P. SENTHILVALAVAN[1]., M.V. SRIRAMACHANDRASEKHARAN[1], R. MANIVANNAN[1], C. RAVIKUMAR[2]
[1]Department of Soil Science and Agricultural Chemistry, [2]Department of Agronom, Faculty of Agriculture, Annamalai University, Tamilnadu, India, [2]Agricultural Research Station, Bhavanisagar, Tamilnadu Agricultural University, Tamilnadu, India

Life cycle assessment of rice-pulse production system in Cauvery Deltaic region of Tamil Nadu, India

Sundoss KABALAN, Katalin JUHOS, Nándor PRETTL, Priyo Adi NUGROHO, Borbála BIRÓ
Doctor's School of Horticulture, Hungarian University of Agriculture and Life Sciences (MATE), Budapest, Hungary

Soil-dependent importance of symbiotic interactions with three cover crops

Tibor Szili-KOVÁCS, Tünde TAKÁCS
Department of Soil Biology, Institute for Soil Sciences, Centre for Agricultural Research, Budapest, Hungary

Impact of floods on soil microbial biomass and activity at a floodplain contaminated by former metal mining

Tünde TAKÁCS, Anna FÜZY
Department of Soil Biology, Institute for Soil Sciences, Centre for Agricultural Research, Budapest, Hungary

Promoting phytoremediation by arbuscular mycorrhizal fungi

12:10 – 13:40 **Technical Session 8**

Chair of the Session: ***Hosam Bayoumi Hamuda***

Sadhan Kumar GHOSH[1,2], Abhishek KUMAR[1]
[1]Department of Mechanical Engineering, Jadavpur University, Kolkata, India, [2]International Society of Waste Management, Air and Water, India

Potential use of ELV Waste Re-circulation in co-processing

Tsend-Ayush ERDENEJARGAL, Hosam E.A.F. BAYOUMI HAMUDA
Environmental Engineering and Natural Science Department, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Hungary

Effects of land application of municipal solid sewage sludge and waste plant compost on wheat growth and soil enzymatic activities

Yasmin HAMUDA[1], Hosam E.A.F. BAYOUMI HAMUDA[2]
[1]Tomori Pál College, Budapest, Hungary, [2]Institute of Environmental Engineering and Natural Science Department, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Hungary

Eco-innovation and environmental and economic management

Ariunkhishig MUNKHSUKH, Hosam E.A.F. BAYOUMI HAMUDA
Environmental Engineering and Natural Science Department, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Hungary

Frequency distribution of heavy metal contents in natural, urban and mining locations in Mongolia

Viktória TÖRÖK, Rebeka SZALÓKI, Ádám MEDVECZKI, Hosam E.A.F. BAYOUMI HAMUDA
Environmental Engineering and Natural Science Department, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Hungary

Analysis of lichen biodiversity in different areas of Hungary

Hosam E.A.F. BAYOUMI HAMUDA[1], Fatma H. EL-FALLAH[2], Márta BERECZ[1], András SZEDER[1], András MÉNESI[1], Júlia KASZÁS[1]
[1]Environmental Engineering and Natural Science Department, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Hungary, [2]University of Ajdabiya, Benghazi, Libya

Efficacy of the different organic wastes as "clean" fertilizers

Ádám GYARMATI, Hosam E.A.F. BAYOUMI HAMUDA
Environmental Engineering and Natural Science Department, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Hungary

Effects of different pesticides on the activity of some enzymes in the rhizosphere of brown forest soil

Adebayo Raimot ADEJUMOKE
Department of Biology Education, School of Science Education, Federal College of Education (Technical) Akoka- Yaba, Lagos State, Nigeria

Biodivesrsity and conservation

Hosam E.A.F. BAYOUMI HAMUDA[1], Katalin Emese RAB GÁBORNÉ SERESS[2]
[1]Institute of Environmental Engineering and Natural Sciences, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Budapest, Hungary, [2]CEE Web for Biodiversity, Green Project, Budapest, Hungary

Role of Soil Biology in Life: Achievements and Challenges

13:40 **Closing the Symposium**

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ABSTRACTS

Plenary Session

ENVIRONMENTAL AND HEALTH SAFETY BY ADOPTING CIRCULAR ECONOMY

Sadhan Kumar GHOSH[1,2]

[1]*Department of Mechanical Engineering, Jadavpur University, Kolkata India*
[2]*International Society of Waste Management, Air and Water (ISWMAW), E-mail: sadhankghosh9@gmail.com*

The current trends in population advancement, industrialization, and modernization created a demanding ecosystem that ultimately resulted in the trading of natural resources profusely for an elegant lifestyle and has brought a catastrophic effect on our existing natural ecosystem in the form of global warming, pollution, and resource scarcity. On average, human generates 0.74kg of municipal solid waste (MSW) per day, varying wildly from 0.11kg to 4.54kg, approximating 2.01 billion tons per annum and expecting to reach 3.4 billion tons by 2050, as stated in the world bank report. It contaminates the surrounding ecosystem, namely water, soil, marine environment, vegetation etc. Improper management of these wastes whose turn out in landfill and uncontrolled incineration (40% of trash is incinerated) sites are the most reported factors plaguing nature through spreading many hazardous diseases such as, asthma, cancer, skin infection, cardiovascular and other related diseases. As per the UN records as in 2020, 2 billion people live without safely managed drinking water services which includes collection from lakes, streams, water bodies etc. Those are contaminated through the uncontrolled littered wastes impacting on health issues. On the whole, the current scenario of our modern society demands a paradigm shift in the consumption and utilization of resources towards a circular ecosystem by managing the consuming resources to be reused or reutilized by incorporating some of the methodologies through circulation of used materials and water rather throwing these into the open in the atmosphere. These circular economy approaches will help recovering the maximum possible resources, making a successive regenerative close loop processes in which the recovered material would be converted into differed valuable products promoting positive environmental impact and improving the health, environment and the reclamation of natural resources—ultimately supporting the humans and their wellbeings.

***Keywords**:* Ecosystem, Infection, Regenerative, valuable products, Contamination

Biography

Prof. Sadhan Kumar Ghosh, President, ISWMAW & IPLA Global Secretariat, chairman and editor-in-chief, IconSWM-CE, project leader, Global status of implementation of circular economy, Associate Editor, Waste Management, Journal, Elsevier, and International Journal of Materials Cycles and Waste Management. Professor & Chief-Coordinator, Centre for Sustainable Development & Resource Efficiency Management (CSD&REM) in Mechanical Engineering, Ex-Dean, Faculty council of Engineering and Technology at Jadavpur University, Kolkata. He acts as experts in many governments committee. He is international Expert in UNCRD/NN DESA and APO, Japan.

ISBN: 978-963-449-285-6

SYMBIOSIS AS A TOOL TO SOIL-, PLANT- AND ENVIRONMENTAL HEALTH

Borbála BIRÓ

Department of Soil Environmental Studies, University of Agriculture and Life Sciences, Budapest, Hungary, e-mail: biro.borbala@gmail.com

The symbiosis as mutual interrelation between the micro-symbiont bacteria and/or fungi and the macro-symbiont host plants. It is more than 500 million years of functioning among the two partners. The symbiosis might be a key-issue in plant nutrition and in plant protection. It is an appropriate tool if we want to reduce the fertilizer and agrochemical inputs in the agriculture. The European Community suggested reducing those agrochemicals by 20-50% within a 10-year-of period. The solution can be the applying of the symbiosis in more efficiency. The symbiosis however is well-working only if the beneficial mutual interrelation is existing among the plants and the microbes. The P-mobilizing mycorrhiza fungi and the biological N_2-fixing bacteria could be used for the better plant growth and development. Such application is known with industrial microbial inoculums, as products in the market. If a single and tripartite symbiosis develops, then the plant growth could be synergistically improved. The Rhizobium bacteria and the arbuscular mycorrhiza (AM) fungi are supplying the plant with fertilizer replacing N, P, K and other mezo-, micronutrients. In case of stress conditions, the symbionts are able to tolerate them in a high intensity and also, they are able to confer of their tolerances to the crop-plants. This system might offer a good practice in the agriculture and serve as a very efficient soil-health indicator. The use of cover crops with symbiotic interrelation can be improving the soil-characteristics, and soil-quality, as well. In agricultural advisory systems for farmers, it can be a potential to involve the symbiotic systems. The lecture will show the importance of symbiosis in soil-plant systems among the severe abiotic environmental stress-conditions.

***Keywords**: Symbiosis, soil-health, soil quality indicators, beneficial microbes, environmental health*

Biography

Borbála Biró is a professor emerita at the University of Agriculture and Life Sciences, Gödöllő, Hungary. She is the Doctor of Hungarian Academy of Sciences (D.Sc.) and teaching soil biology, soil ecology subjects. She is the leader of Soil-Biological Session of Hungarian Soil Science Society. She has got 4 PhD students and supervisor also for other MSc students. She has founded the course of "Biological Soil Power Management" in the University and teaching Rhizo-biology, Rhizo-ecology, Rhizo-technology subject for PhD students. B. Biró has published more than 500 papers, among them about 200 peer-reviewed, refereed articles in high quality journals. She is the member of Editorial Board for 3 International Journals, including the MDP "Agriculture" one. She was invited from Hungary as an expert of "Soil Health and Food" mission of the European Union, Horizon 2020 programs. Research interest is the use of beneficial interrelations in plant-cultivation and also the application of microbial inoculums, biofertilizers in the Agri-, Horti- and Viticultural practices. Since 2021 august, she has retired and become a prof. emerita in the University.

Keynote Session

ISBN: 978-963-449-285-6

HYGIEN AND SANITATION PROBLEMATIC IN PRIMARY SCHOOL OF ALLADA COMMUNE IN BENIN REPUBLIC (WEST AFRICA)

Léocadie ODOULAMI*, Grégoire A. BEWA

Pierre PAGNEY Laboratory, Climate, Water, Ecosystem and Development LACEEDE/DGAT/FASHS/ University of Abomey-Calavi (UAC), 03BP:1122 Cotonou 2DGAT/FLASH/University of Parakou (UP), Republic of Benin (East Africa West); leocadieo@yahoo.com

The insufficiency of hygiene and sanitation in the Allada commune particularly influence the health of schoolchildren. This research analyzed the effects of the precariousness of the basic hygiene and sanitation practices on the health of schoolchildren in this commune. For this research, 600 schoolchildren were selected by random cluster survey to observe their hygiene practices and especially to measure the prevalence of helminthiasis. Data were collected through documentary research, questionnaire surveys, observation and microbiological analyzes of stool collected from schoolchildren. Statistical analyses were performed using Epi Info version 7 software. The analysis shows that diseases linked to poor hygiene and sanitation are acted severely in the Allada commune and affect the health of schoolchildren. In fact, cases of gastrointestinal disorders were found in 51.80% of these schoolchildren. The parasites identified are mainly protozoa, responsible for gastroenteritis diseases. Faced with this result, which gives rise to concerns, it is important for the communal and government authorities to provide the commune's schools with adequate sanitary infrastructure, to train educators in good hygiene and sanitation practices and to implement place school clubs for the promotion of hygiene and sanitation in order to reduce the vulnerability of the population of Allada commune.

Keywords*: Allada commune, Benin Republic (West Africa), Hygiene, sanitation, schoolchildren health*

Biography

Léocadie ODOULAMI, Doctor, full professor of physic Geography and management at Université d'Abomey-Calavi (Republic of Bénin), is specialised in drinking water, hygiene, environmental sanitation and human health. She has conducted personally and in teams many researches on water resources, hygiene, sanitation and environmental sanitation researches in connection with the implications of climate change. She has published more than 50 papers in many reputed journals and has been serving as an editorial board member of repute.

ISBN: 978-963-449-285-6

ARTS AND NATURE: THE CONTRIBUTION OF ARTISTS TO UNDERSTANDING OF THE WORLD AND THE DEVELOPMENT OF NATURAL SCIENCES

Edit CSANÁK

Product Design Institute, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Budapest, Hungary, csanak.edit@rkk.uni-obuda.hu, +36 30 667 3639

*This paper summarises the results of the theoretical research based on the hypothesis that art had real and tangible merit in shaping man’s more profound relationship with nature and a better understanding of the natural environment. The writing summarises the key facts gathered in the early stages of the research. It examines the creative career of selected artists and presents outstanding artworks that justify this assumption. **Method**: Key method of the investigation was gathering information from the available literature. **Results**: The paper’s main result is a unique topic. The facts carefully collected from the available sources are organised chronologically. The report summarises the basic facts gathered in the early stages of the research. **Conclusion**: The objective of this study was to review the available literature on the contribution of art to a better understanding of the world and its unique biosphere, to accurately map the extensive scientific interest in art and the lasting and irreplaceable work added to its development. Contrary to expectations, significantly less scientific research and writing were discovered in the study’s first phase. However, the results so far also seem to support the hypothesis that there are verifiable facts and sources with which artists have contributed to scientific discoveries and a better understanding of the world. The author intends to continue the research.*

***Keywords**: art history, scientific discoveries, environmental art, botanic art, human anatomy, medicine*

Biography

Dr Edit Csanák DLA is a fashion designer and recognised theorist for Sustainable Fashion. She completed her DLA in the year 2009 from MOME Doctoral School. She works as an associate professor at Óbuda University in Budapest. She is the Vice Dean of the Rejtő Sándor Faculty and Head of the Product Design Institute. Her research interests are Sustainable Textiles and Fashion, Eco-design, and the Theory of art and design. In addition to participating in more than 300 collections, 16 solo and 6-group fashion shows, and more than 30 exhibitions, her artistic career is recorded in 42 scientific publications.

PROMOTION OF SMART IRRIGATION SYSTEMS IN THE MENA REGION USING SUPERABSORBENT BIOPOLYMERS

Faissal AZIZ [1,2*]

[1]*Laboratory of Water, Biodiversity, and Climate Change, Faculty of Sciences Semlalia, Cadi Ayyad University, Marrakech,* Morocco. *f.aziz@uca.ma*, [2]*National Center for Research and Studies on Water and Energy (CNEREE), Cadi Ayyad University, Marrakech, Morocco.*

The MENA region has a duty to set an example in the construction of a new way of managing water resources, the search for alternative sources of supply and the development of agricultural practices to optimize the use of soil water by plants and reduce the use of vegetative fertilizers. To improve the management of water resources for irrigation, soil quality, and the economic yield of agriculture, this project will propose the possible integration of water-retaining agents (synthetic and/or marketed) in the vegetable crops to alleviate the drought socioeconomic problems of the countries. These super water-absorbent polymers have several climatic and environmental benefits. They save at least 50% water and can act as fertilizers and soil decontamination. Through their ability to reduce the harmful effects of salinity or unsanitary conditions of treated wastewater (TW) used for irrigation, this project proposes to study the ecological and socioeconomic contributions of the use of combined water-retaining agents and treated wastewater (TW). Advanced research on improving the performance of these polymers as well as the production of new nature-friendly superabsorbent (SAP) molecules will be carried out during this work. In addition, microcosms will be created within the laboratories involved in the project to better identify the environmental and socioeconomic contributions of the polymers in question and the possible intoxication of cultures associated with them.

Keywords*: Reuse, Smart irrigation, Superabsorbent, Treated wastewater*

Biography

Professor AZIZ Faissal is currently an Associate Professor at Cadi Ayyad University, Morocco. Prof. AZIZ is a Young researcher at MENA NWC (Middle East and North Africa Network of Water Centers of Excellence) in Nanotechnology for the water treatment field. He supervises six thesis subjects on wastewater treatment and reuses; he has published over 70 papers and co-edited one book. In addition, he coordinates many research projects on wastewater treatment and biomaterial engineering in collaboration with national and international partners.

May 5-6, 2022
Óbuda University,
Budapest, Hungary
ISBN: 978-963-449-285-6

THE AGRICULTURAL PRODUCTION CONCERNING SUBSIDIES IN HUNGARY IN PERIOD OF 2008-2020

Sándor J. ZSARNÓCZAI

National University of Public Service, Faculty of State Scientific and International Studies, Kálmán Széll State Finance Research Workshop, H-1083 Budapest, Ludovika tér 2.
Óbuda University, Rejtő Sándor Faculty of Light Industry and Environmental Engineering Institute of Environmental Engineering and Natural Sciences, Doberdó u. 6, H-1034 Budapest, Hungary, e-mail: zsarnoczai@yahoo.co.uk

Study focuses on influences of subsidies on agricultural production, as plant production, animal husbandry, output growing trend, and input growing trend and agricultural gross value added. Price conditions for input and producing price, as output price from agricultural producers paid by purchasers, manufacturing industries, whole traders, retailer traders or possible farmers sell their products directly on local markets – can create considerable influences on economic and marketing background for agricultural production including output growing, agricultural gross value added, gross fixed asset accumulation all. Subsidies accompanying with self-financial capacity of agricultural producers and credits financed by banks create basic financial issues for the agricultural basic material production conditions of producers. Plan production has share as 59-60% of all agricultural production and animal husbandry has share as 33-35%. The case-study uses statistical analyses as Special Program for Social Sciences. There is an import role of gross fixed asset accumulation all without recoverable value added taxes for agricultural production, because this has very strong correlations with gross value added by 0.941 and output growth by 0.934 and input growth by 0.803, also this one has strong correlation with producing price by 0.732. Subsidies should be provided for agricultural producers in order to obtain enough incomes to realize continuous basic agricultural production process, to develop advanced technology for their competitiveness on the markets and finally not to escape from the agricultural sector in order to ensure the supplying food for domestic consumers. Naturally subsidies cannot substitute self-financing capital force of producers

***Keywords**: Gross fixed asset, gross value added, innovation, input, output, producing price*

Biography

CSc, economic sciences, Hungarian Academy of Sciences, Scientific Qualified Committee, Budapest in 1991 and Dr. of University, World Economics, Budapest Corvinus University of Economics in 1991. Habilitate Doctor, in social sciences, in Management and Business Administration, Kaposvár University, in Kaposvár in 2017. Between 1987-2017 work at University of Agricultural Sciences, then at Szent István University in Gödöllő. From 2017 work at Óbuda University. Participation at Doctoral School of Economics and Regional Sciences at Hungarian University of Agriculture and Life Sciences in Gödöllő. The research areas: Economics, Business and Management, International Regional Economic Integration, EU Study, Regional economics, Rural Development, Environmental economics. He published 207 publications with 257 independent citation count, of which 189 foreign language citations. His publications were published in Arab, English, Spanish and Russian foreign languages. International scientific conferences in Turkey, Canada, Moldavia, Czech Republic, Slovakia, Lithuania, Romania and Russia. Research project in Finland, Sweden, Denmark, Italy, Spain, France.

ISBN: 978-963-449-285-6

MWCNTS BASED NANOCOMPOSITES FOR THE REMOVAL OF HYDROCARBONS FROM WATER

Thamer Adnan ABDULLAH, Tatjána JUZSAKOVA, Ali Dawood SALMAN, Viktor SEBESTYÉN, Domokos ENDRE

Sustainability Solutions Research Lab, Bio-, Environmental and Chemical Engineering Research and Development Center, University of Pannonia, Veszprem, Hungary

The application of solid adsorbents for the removal of hydrocarbons and dyes from water has gained attention in recent years. This is due to the potential of this technology to minimize the detrimental impact of water pollution. However, this requires the development of novel solid adsorbent materials that can achieve significant selectivity, have a large adsorption capacity as well as offer fast adsorption coupled with excellent mechanical strength and the ability to regenerate. Thermal pre-treatment was used to produce V_2O_5 nanoparticle adsorbents by increasing the temperature to between 90 and 750°C. Functionalized MWCNTs were obtained by chemical oxidation using concentrated sulfuric and nitric acids. TiO_2, V_2O_5, CeO_2, V_2O_5:CeO_2 and V_2O_5:CeO_2:TiO_2 nanocomposites were prepared using hydrothermal synthesis method followed by the deposition of these oxides over MWCNTs. The polymer-modified (polyethylene (PE), polystyrene (PS) or poly-n-isopropylacrylamide-co-butylacrylate (PNIPAM)) magnetite/MWCNTs were prepared using a solution mixing method. different analytical techniques were characterized. XRD, TEM, SEM-EDX, AFM, FTIR, Raman, TG/DTA and BET techniques were used to determine the structure as well as chemical and morphological properties of the newly prepared adsorbents. The results illustrated that the modification of MWCNTs with V_2O_5:CeO_2 and polymers enhanced the adsorption properties of carbon nanotubes. Polyethylene modified magnetic MWCNTs achieved highest adsorption capacity for removal of kerosene from water, while polystyrene modified magnetic MWCNTs achieved highest removal capacity of toluene from water. The results shows that the adding of polymers to MWCNTs have greatly increased their efficiency for kerosene/toluene removal from water.

Keywords: *solid adsorbents application, hydrocarbons removal, water pollution, carbon nanotubes*

Biography

Thamer Adnan Abdullah completed his Master of Chemical Engineering from Guru Gobined Singh Indraprastha University New Delhi., since 2008 he is working as assistant lecturer in the University of Technology, Baghdad, in Applied Science Department, Chemistry Branch Group. Currently he is doing his PhD and he is researcher in Sustainability Solutions Research Lab, Faculty of Engineering, University of Pannonia, Veszprem, Hungary. He has several articles published in sciencediret reputed journals and has participated in many international conferences in the field of environmental chemistry and nano-research.

Abstract of the VIth.
International Symposium–2022
Theme: "Biosphere & Environmental Safety"

May 5-6, 2022
Óbuda University,
Budapest, Hungary
ISBN: 978-963-449-285-6

HEAVY METAL CONCENTRATIONS IN THE HAIR SAMPLES

Ágnes BÁLINT[1,4]*, Erika LÁSZLÓ[2], Csaba MÉSZÁROS[3]

[1]Institute of Environmental Engineering and Natural Sciences, Óbuda University, Budapest, Hungary, e-mail: balint.agnes@uni-obuda.hu, [2]Doctoral School of Public Administration Sciences, National University of Public Service, Budapest Hungary, e-mail: laszlo.erika@uni-nke.hu, [3]Institute of Mathematics and Basics of Natural Sciences, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary, Gödöllő, Hungary, [4]Hydro-Bio-Mechanical Systems Research Center, Budapest Hungar, y e-mail: Meszaros.Csaba@uni-mate.hu

Since the industrial revolution, human activity has continued to cause significant pollution. Some of the various pollutants released into the environment take the form of heavy metals. These substances present a major threat to the biosphere by entering the food chain and causing toxic effects on living organisms. Our interest has been turned to the heavy metal exposure of Csepel residents in Budapest. Csepel is the site of the Weiss Manfred Steel and Metal Works, which has had various pollution problems over the years. In the present work, it was chosen human hair as a tool to detect the above-mentioned heavy metal pollution. It was measured the concentrations of some heavy metals (copper, selenium, iron, zinc, cadmium, manganese) in the hair of Csepel residents and compared them with the results of a control group, namely people living in Erzsébet. It is a known fact that hair testing is a good indicator of heavy metal pollution; it is simple to perform without internal intervention and does not exposure the person being tested. The collected hair samples were cut into 2-3 mm pieces. The samples were washed, dried, digested and finally the heavy metal content was measured using a Unicam 923 QZ AA spectrometer. Statistical analysis of the results was analysed using SPSS 14.0. The results showed that the heavy metal concentrations of the Csepel hair samples were on average higher than the control samples for copper, iron, manganese, cadmium and selenium.

Keywords: *biological indicator, environmental pollution, GFAAS, hair samples, heavy metals, SPSS*

Biography

Dr. Ágnes Dr. habil. Mészáros-Bálint (Ágnes Bálint is the author's name)
Highest educational degree: *MSc, Chemistry and Physics, ELTE, Budapest, Hungary*
Scientific degree: *PhD; habilitation, in the field: Environmental Sciences, SZIE, Gödöllő, Hungary*
Institution: *Óbuda University, Rejtő Sándor Faculty of Light Industry and Environmental Engineering,* ***Department:*** *Institute of Environmental Engineering and Natural Sciences and HBM*
Phone: *+36303721342; E-mail: balint.agnes@uni-obuda.hu*
Position: *Associate Professor*
Specialties: *Inorganic chemistry, environmental analytics, colloid chemistry; Development and application of chromatographic methods for soil/plant, polymer, amino acids and food analysis; Nitrogen transformation in soil/plant/atmosphere system, application of stable isotope tracers, as fertilizer; Experimental and theoretical modelling of transport processes*

ISBN: 978-963-449-285-6

ENVIRONMENTAL POLLUTION AND PUBLIC HEALTH

Hosam E.A.F. BAYOUMI HAMUDA

Institute of Environmental Engineering and Natural Sciences, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Budapest, Hungary. *E-mail:* Bayoumi.hosam@uni-obuda.hu

Pollution is one of the major problems persisting in our environment causing an increase in the morbidity and mortality, which ultimately affects the economic growth of a world. Therefore, environment quality sensing tools have become inevitable in everyday life. Environmental health concerns are a critical issue nowadays that needs joint efforts from multiple sectors to achieve better public health outcomes. The holistic approach, relevant to food safety and control of diseases (e.g. Covid-19) through usage of green technologies should be considered. The application of cleaner and effective technologies can be expanded to management and control, pollution mitigation and valorization of waste. The potential topics from the following research areas are expected: Global environmental health; Environmentally friendly processes and their effects on human health; Outdoor air quality, surface and ground water quality improvements; Toxic substances and hazardous wastes reduction from clean technologies. Growing awareness and an increased attention on environmental issues such as climate change, energy use, and loss of non-renewable resources have carried out a superior quality for research that provides potential solutions to these problems. Emerging microbiome approaches potentially can significantly increase agriculture productivity and human healthcare and henceforth can contribute to meet several sustainable development goals. The aim of this study is to illustrate the novel research contributions on innovative approaches to manage, mitigate and valorize wastes produced by different sectors, with the aim of transforming our society towards a sustainable and circular bioeconomy. Hence, research activities of the environmental Biotechnology are comprehensively focused up on major sectors e.g., bioremediation of organic and inorganic pollutants, environmental risk analysis of microbiomes, environmental assessment using microbial indicators, enzymes for environment, food and industrial applications, nanomaterials and nontoxicity, sustainable ecobiotechnology. The present study discussed aspects including risk factors in atmospheric, soil and water environment, public health improvement, changes of food trend, and living environment to elucidate the importance of environmental allergen as well as the global environmental protection and public health.

Keywords*: environmental pollution, metal contamination, xenobiotic, clean technologies, innovative approaches, environmental protection, public health*

Biography

Prof. Dr. Hosam Bayoumi Hamuda is working at Óbuda University. He is Environmental Microbiologist and Soil Biotechnologist dealing with the interactions between the microbiomes and the environment for increasing soil quality and saving the soil from pollutants in the agriculture. His investigations are on the role of waste management, soil quality, fertility, the crop production and environmental impacts related to the application of organic wastes; measurements soil microbial biomass and enzymatic activities in wastewater sludge amended soils; and roles of engineered metal oxide nanoparticles in biosphere. ***Research Interest****: Waste management; Biotechnology; Protection; Sustainable; PGPR; Microbial inoculants; gut microbiomes and human health and modern biology*

Oral Technical Sessions

Abstract of the VIth.
International Symposium–2022
Theme: "Biosphere & Environmental Safety"

Biosphere and Environmental Safety
VI.th International Symposium-2022

May 5-6, 2022
Óbuda University,
Budapest, Hungary
ISBN: 978-963-449-285-6

A REVIEW OF SUSTAINABILITY REPORTING PRACTICES IN SELECTED INDIAN CONSUMER PACKAGED GOODS SECTOR

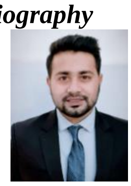
Ajinkya MAHALE, Vrishaali VYAS, Prakash RAO*

Symbiosis Institute of International Business (SIIB), Symbiosis International (Deemed University),(SIU), Hinjewadi,Pune,Maharashtra,India, Email: dydirector@siib.ac.in, Mob: 8806235770

The purpose of this research is to evaluate the sustainability disclosure practices of Indian Consumer Goods sector wherein six major FMCG companies have been assessed in order to determine the extent to which those companies report on sustainability. The content analysis was carried out from all the publicly available sources like annual reports, sustainability reports, business responsibility reports and CSR reports of the companies in order to check the compliance with the voluntary frameworks reporting practices like CDP, GRI and UNGC Global compact Framework. The mandatory disclosure requirements under SEBI Listing obligations and Disclosure requirements 2015 were evaluated using Wilcoxon Signed ranked test on SPSS Software. . The results showed that all the six sampled companies showed compliance in line with SEBI listing obligations and disclosure requirements 2015. Furthermore, the extent of integration of environmental, social and governance (ESG) factors in the reports were evaluated on the basis of quality of quantified data and metrices disclosed by an Organization on ESG Parameters. It was concluded that there is a prominent trend of sustainability reporting in the Indian FMCG sector and five out of six companies have adhered to the integrated reporting framework to disclose their sustainability practices. The More stringent disclosure regulations like Business responsibility reporting BRR framework in India and recently proposed Standard by U.S Securities and Exchange commission will certainly demand more accountability from Organizations to disclose Climate-related risks and their actual or likely material impacts on the company's business, strategy, and long term value along with the company's governance of climate-related risks and relevant risk management processes

***Keywords**: Business responsibility, consumer goods, Corporate Social responsibility, ESG, reporting frameworks, Sustainability, Carbon Disclosure Project (CDP), Securities and Exchange Board of India (SEBI), Global Reporting Initiative (GRI), United Nations Global Compact (UNGC)*

Biography



***Ajinkya Mahale** is pursuing Post graduation program in Energy and Environmental management From Symbiosis International University. He has hands-on experience in areas of sustainability like water stewardship and Sustainable finance. He is a passionate professional, an avid learner, and aspires to paint his career canvas on a broader scope of sustainability.*

***Vrishaali Vyas** has completed her Bachelors in Environmental Science from Fergusson college, Pune. After completing her graduation, she pursued a Master of Business Administration degree in Energy and Environment from Symbiosis Institute of International Business, Pune. She now works as a research analyst in a consulting firm where she pursues her passion for reporting*

***Dr. Prakash Rao** has 39 years of experience in the field of energy and environment with interests in climate change and sustainability. He holds a Ph.D. from the University of Bombay. Has published around 86 research papers, notes and book chapters in peer reviewed international journals and He has published four books with a recent publication on Environmental impacts of Tourism with IGI Global Publishers, USA. He is the Deputy Director and Head of the Energy and Environment Programme at Symbiosis Institute of International Business (SIIB),a constituent of Symbiosis International University, Pune*

Abstract of the VIth.
International Symposium–2022
Theme: "Biosphere & Environmental Safety"

Biosphere and Environmental Safety
VI.th International Symposium-2022

May 5-6, 2022
Óbuda University,
Budapest, Hungary
ISBN: 978-963-449-285-6

INTEGRATED MANAGEMENT OF MINING REJECTS: CASE OF THE ABANDONED MINE OF SIDI BOU-OTHMANE MINE (CENTRAL MOROCCO)

Abdelmalek GOUMIH[1*], Mariam EL ADNANI[2], Rachid HAKKOU[3], Mostafa BENZAAZOUA[4], Salah OUHAMDOUCH[5,6]

[1]Laboratoire GéoSciences Semlalia, Département de géologie, Faculté des Sciences Semlalia, Université Cadi Ayyad, Marrakech, Morocco, [2]Ecole Nationale Supérieure des Mines de Rabat, Avenue Hadj Ahmed Cherkaoui, Agdal, Rabat, Morocco, [3]Laboratoire de Chimie des Matériaux et de l'Environnement, Faculté des Sciences et Techniques, Université Cadi Ayyad, Marrakech, Morocco, [4]Université du Québec en Abitibi Témiscamingue, Boul. de l'Université, Rouyn-Noranda. QC, Canada, [5]Faculté des Sciences Semlalia, Université Cadi Ayyad, Marrakech, Morocco, [6]Applied Sciences Laboratory, Water and Environment Management Team, National School of Applied Sciences, Abdelmalek Essaadi University, Al Hoceima , Morocco.,
*Corresponding author: a.goumih@uca.ma

The abandoned mine of Sidi Bou-Othmane (Pb and Zn) is located in the Hercynian massif of central Jebilets at 38 km northwest of the Marrakech city (central Morocco). The mine generated more than 1.82M tons of waste abandoned without any environmental preservation measures during its activity. In this respect, this study attempts to evaluate the acidity-generating potential of the mining rejects and to study their geochemical behavior. Physico-chemical and mineralogical characterizations of the mining rejects were carried out. The acidity production potential was predicted using static tests, and the geochemical behavior was studied using kinetic tests in mini alteration cells. The static tests showed that the Sidi Bou Othmane mining rejects are rich in carbonates and illustrate a very low acidity potential (AP) ranging from 0.99 to 38.14 kg $CaCO_3$/t and a net neutralization potential (NNP) ranging from -20.06 to 66.84 kg $CaCO_3$/t. The kinetic tests showed that the rinsing waters have a neutral pH (6.33 to 7.87), and the sulfate concentrations are maintained at very low values (37.13 to 1454.32 mg/l). The evolution of metal concentrations shows low levels of iron (2.85 mg/l), copper (4.89 mg/l), nickel (0.15 mg/l). While lead, zinc, arsenic, cadmium, and chromium have concentrations very low or below the detection limit.

***Keywords**: Adsorption, wastewater, pesticide, optimization, biocomposite, kinetic*

Biography

Dr. Abdelmalek is an Assistant Professor and member of the Laboratory of Geoscience, Faculty of Science Semlalia, Cadi Ayyad University, Morocco. His research field is focused on the abdoned mine resotoration and heavy metals uptak. He publised more than 20 articles.

THE PERMEABILITY VARIABLES OF GRANULAR MATTER

Emőke IMRE[1]*, Zsombor ILLÉS[2], Ágnes BÁLINT[3,9] , Henry GONZALES[3], Levente RÉPÁSSY[3], Dang Thi QUYNH HUONG[3], Lizeth Lamas LOPEZ [3], Daniel BARRETO[4], Giulia GUIDA[5], Maria DATCHEVA[6], Wiebke BAILLE[7], Vijay P. SHINGH[8]

[1]Óbuda University, Bánki Donát Faculty, and Hydro-Bio-Mechanical Systems Research Center, Budapest, Hungary, e-mail: imre.emoke@uni-obuda.hu, mobile: +36202892656, [2]Department of Engineering Geology and Geotechnics, Budapest University of Technology and Economics, Budapest, Hungary, e-mail: zsombor. illes@epito.bme.hu, phone: +3614633004; [3]Institute of Environmental Engineering and Natural Sciences, Óbuda University, Budapest, Hungary, e-mail: balint.agnes@rkk.uni-obuda.hu, mobile: +36303721342, [4]Edinburgh Napier University, U.K., e-mail: d.barreto@napier.ac.uk, [5]Università di Roma Tor Vergata. [6]Institute of Information and Communication Technologies, Bulgarian Academy of Sciences, Bulgaria, [7]Ruhr University Bochum, Germany, [8]Dept. of Biological and Agricultural Engineering, Texas A&M University, USA. [9]Hydro-Bio-Mechanical Systems Research Center, Budapest Hungary

No "unique" relation between soil parameters and grading curves of granular matter can be elaborated in practice since there are "too many" interpolation points (no precise interpolation is possible). If some statistics are used for the characterisation of the grading curves (e.g., d10), then infinite many grading curves may be related to the same value. For the same grading curve, different permeability values are measured at different densities. A model discrimination study was started to suggest a saturated hydraulic conductivity k – grading curve – density relation using some new measurements. The following variables were tested: (i) various grading curve parameters, (ii) combined variables of harmonic mean diameter and density like specific surface or hydraulic radius, (iii) density parameters. Two newly measured sets of data were considered with identical soil composition and different density (in more and less dense states). Both data sets consisted of 3 series of optimal 2-fraction granular soils, the fractions were: 0.25-0.5 mm, 0.5-1 mm, 1-2 mm 2-4 mm. Each series consisted of 5 mixtures with different, fixed relative base entropy A values (i.e. mean log d values). In addition, two earlier data sets were used to test the extension of the relations into larger data sets. According to the very first results, the regression was acceptable only if extra density parameters were applied together with either the (i) or the (ii) type parameters. The extended data base increased the regression R2.

***Keywords**: : fractal, grain size distribution, model fitting, model discrimination, permeability*

Biography

***Name:** Dr. habil. Emőke Imre, **Scientific degree:** habilitation in 2015 at BUTE, Hungary, Budapest, **Institution:** Óbuda University, Hydro-Bio-Mechanical Systems Research Center and Bánki Donát Faculty of Safety Engineering, **Phone:** +36202892656; **E-mail:** imre.emoke@uni-obuda.hu, **Position:** Associate Professor. **Specialty and publications:** dikes, coupled consolidation models, applied math, unsaturated soils, grading entropy of granular matters, in situ -situ testing (e.g. CPT dissipation tests, evaluation methods and software preparation), laboratory experiments. ISSMGE TC102, TC106 and TC201 member.*

ISBN: 978-963-449-285-6

ASSESSMENT OF SOIL POLLUTION BY HEAVY METAL IN INDUSTRIAL AREA OF SKIKDA CITY NORTH ALGERIA

Amina HAFSI[1], Ahsene BOUREFIS[1] , Farès KESSASRA[2], Abdellah BOUSHABA

[1]Affiliation Department of Geology and Environment, University les Fréres Mentouri, Constantine 1, [2]Laboratory of Geological Engineering, Team 3 "Geology", University of Jijel, Algeria, Department of Earth and Universe Sciences, University of Jijel, Central Campus, Algeria, [3]Department of Geology, Sidi Mohamed Benabdellah University, Fes, Morocco

Heavy metals in soil are a major threat to ecosystems and human health. The rapid development of industrialisation has created a serious risk of soil contamination by heavy metals. The Safsaf sub-basin, with its high industrial intensity, was chosen as a typical area for the study. Factors and interactions affecting the distribution of heavy metals in soil (Cd, Zn and As). The results of the analysis were extended to predict areas of high risk of soil contamination by heavy metals in the Safsaf river basin. The results showed that Cd, As and Zn were significantly affected by local industrial and anthropogenic. The purpose of this study is to analyse the impact of pollution on soils generated by industrial zone of Skikda city; located in the North-East part of Algeria. 10 samples were collected around the industrial area. They were collected in two seasons, in July 2018 and December 2021, For soil, physical parameter measurements, equivalent calcium carbonate (% CaCO), and MTE were carried out in the laboratory. Soil analysis indicates the presence of cadmium ions with an average ranging 2.03 to 26.05mg/kg. These concentrations exceed the French standard evaluated at 2 mg/kg. These high concentrations could be due to industrial factors and anthropogenic wastes, the same thing for Zn and As which largely exceed the standards with values which vary respectively between 98.03 to 203.65 mg/kg and 12.96 to 60.5 mg/kg which promote the liberation and accumulation of cadmium in water and soil. The combustion of fossil energy sources, heavy oils and spilled fuels, road transport, and dust can bring in small amounts of Cadmium. A temporal monitoring is recommended, and other metallic trace elements such as iron, lead, strontium, should complete our impact study.

***Keywords**: soil, pollution , heavy metal, Skikda city*

Biography

Amina Hafsi I got my doctorate at the age of 26 years at the university of Mentouri brothers, Constantine 1.I got my master in georesource and environment of the university of Mohamed Saddik Benyahia, Jijel.I am in the field of environment, the transfer of heavy metals between soil and groundwater

ISBN: 978-963-449-285-6

STUDY AND EVALUATION OF THE POLLUTION IN ETM IN THE VALLEY OF OUED SAF -SAF AND OUED ZERAMNA, SKIKDA, NORTH-EAST OF ALGERIA

Amina BOUSSELIOU[1*], I. BOUDRAA[2,3], S. CHELLAT[1], H. BELAIDI[1]

*[1]Geology and Environment Laboratory, University of Constantine 1, Constantine, Algeria, [2]Constantine 1 University, Department of Chemistry, Pollution and WaterTreatment Laboratory, Constantine1, Algeria. [3]Environmental Molecular and Structural Chemistry Research University Constantine1, Algeria. *corresponding author:hydrgeo23@gmail.com*

The city of Skikda is ranked third nationally after Algiers and Ouargla, in terms of volume of different waste discharged without treatment it exceeds 250,000 m3/d. Thus, according to a recent study by the Ministry of Environment, the coastal area Skikda is mined by 29 discharge points. This situation forced the establishment of a wastewater treatment and treatment plant (WWTP). The WWTP located in Bantous treats wastewater from the three municipalities of Skikda, Hammadi Krouma and El Hadaïek. This makes it possible to improve the quality of wastewater before its reuse, but there are still other wild discharges that require control and monitoring in order to minimize its pollutants, a solid and liquid sample has been taken to measure the degree of pollution of possible heavy metals in Oeud Safsaf and Oued Zeramna. The results of the atomic adsorption analyses show a high percentage of ETM pollutants in liquid and solid samples show an iron level that varies from 0.2 mg/l to 0.6 mg/l, copper between 0.02 mg/l and 0.03 mg/l, arsenic reaches 0.9 mg/l, cadmium varies between 0.02 mg/l and 0.05 mg/l. Those rates exceed all standards, Algerian, WHO, AFNOR.

***Keywords**: Coastal, Skikda, WWTP, ETM, Pollution*

Biography

2013 I have got my baccalaureate in experimental sciences at the age 19 years, in 2016 I have completed my license in geology specialising in hydroscience at the age 22 years from Constantine University, 2018 I have gotamaster's degree of 24 years in environmental geology from Constantine University, from 2021 I stated my PhD at the universityConstantine1 in Mineral and Geomaterial resources and the Environment.

Abstract of the VI[th]. International Symposium–2022
Theme: “Biosphere & Environmental Safety”

Biosphere and Environmental Safety
VI.th International Symposium-2022

May 5-6, 2022
Óbuda University, Budapest, Hungary
ISBN: 978-963-449-285-6

GRAPHENE OXIDE INDUCES A MODIFICATION OF THE PEROXIDASE AND MDA LEVELS IN MALE MICE

Asmaa RHAZOUANI[1,2,3*], Halima GAMRANI[2], Khalid AZIZ[4], Mustapha My BOUYATAS[2], Lhoucine GEBRATI[5], Faissal AZIZ[1,3*]

[1]Laboratory of Water, Biodiversity & Climate Change, Faculty of Sciences Semlalia, Cadi Ayyad University, Marrakech, Morocco. [2]Team of Neurosciences, Pharmacology and Environment (ENPE), Faculty of Sciences Semlalia, Cadi Ayyad University, Marrakech, Morocco, e-mail: asmaa96rhazouani@gmail.com, [3]National Centre for Studies and Research on Water and Energy (CNEREE), Faculty of Technical Sciences, Cadi Ayyad University, Marrakech, Morocco, e-mail: f.aziz@uca.ma, [4]Laboratory of Materials, Biotechnology, and Valorization of Natural Resources, Department of Chemistry, Faculty of Sciences, University Ibn Zohr, Agadir, Morocco, [5]Laboratory of Materials, Processes, Environment and Quality, Cadi Ayyad University, Safi, Morocco

Nanotechnology has been an important field of research and development since the beginning of this century. The use of nanoparticles on a global scale continues to grow, particularly in the medical, industrial and environmental fields. Graphene oxide (GO), a nanoparticle, is an interesting nanomaterial. It has been widely used in biological research due to its important properties (nano-size, specific surface area, mechanical strength, biocompatibility and hydrophilic potential). However, the toxic effect of GO on biological systems and living organisms is a limiting factor that restricts its use in the medical field. This study aims to synthesize and study the effects of this nanomaterial on the antioxidant system of male mice. After synthesizing this nanomaterial, a size analysis was performed using a Mastersizer 3000 laser diffraction apparatus. The enzymatic activity of peroxidase (PO) was measured in the liver and brain of mice that received the 8 mg/kg dose of GO, and malonedialdehyde (MDA) was determined by the spectrophotometric method in the presence of thiobar bituric acid (TBA). The particle size analysis results showed that our nanomaterial has a uniform distribution, with an average grain size of about 50 nm, which means that our sample has a nanometric size. On the other hand, the oxidative stress assay showed an increase in peroxidase and (MDA) activity after GO intoxication. Our results show that GO induced toxic effects in mice, but the mechanism by which this occurs requires further study.

***Keywords**: Biocompatibility, graphene oxide, malonedialdehyde, nanometric size, oxidative stress, peroxidase*

Biography

Asmaa RHAZOUANI is a third-year Ph. D student at the Faculty of Sciences Semlalia of Cadi Ayyad University in Marrakech. She has published two papers in reputable journals. Both publications are reviews of the literature, the first entitled Synthesis and Toxicity of Graphene Oxide Nanoparticles: A Literature Review of In Vitro and In Vivo Studies. The second publication is: Can the application of graphene oxide contribute to the fight against COVID-19? Antiviral activity, diagnosis and prevention.

ISBN: 978-963-449-285-6

SYNTHESIS AND SURFACE MODIFICATION OF MAGNETIC Fe_3O_4/SiO_2/OPCs NANOPARTICLES AND ITS APPLICATION IN UPTAKE OF SCANDIUM (III) IONS FROM ACIDIC MEDIA

Ali Dawood SALMAN[1,2*], Tatjána JUZSAKOVA[1], Moayyed G. JALHOOM[3], Phuoc-Cuong LE[4,5] , Mohammad A. AL-MAYYAHI[2],Thamer Adnan ABDULLAH[1], Domokos ENDRE[1]

[1]Sustainability Solutions Research Lab, University of Pannonia, Veszprém, Hungary, [2]Department of Chemical and Petroleum Refining Engineering /College of Oil and Gas Engineering, Basra University, [3]Department of Production Engineering and Minerals, University of Technology Baghdad-Iraq, [4]Institute of Research and Development, Duy Tan University, Danang, Vietnam., [5]Faculty of Environmental and Chemical Engineering, Duy Tan University, Danang, Vietnam

Bauxite residue or red mud (RM) is a hazardous highly alkaline waste generated during the Bayer process of alumina production. Hungarian red mud includes acceptable quantities of scandium, making it an interesting source for rare metal processing and manufacture. A new approach for selective separation of scandium from red mud leachate was proposed in this work. Different organophosphorus compounds (OPCs), such as bis(2-ethylhexyl) phosphoric acid (D2EHPA), tributyl phosphate (TBP), and trioctylphosphine oxide (TOPO), were immobilized over nanocomposite (Fe_3O_4/SiO_2/OPCs). Subsequently, the prepared nanocomposites were employed as solid phase extractants. Because the physicochemical properties of Fe(III) and Sc(III) are similar and the presence of a considerable amount of iron in red mud makes it difficult to recover scandium (III). The prepared HCl leachate was treated with diethyl ether to extract Fe(III) as $HFeC1_4$ .The findings show that of the three SPE studied, Fe_3O_4/SiO_2/TBP performed the best. The results showed that, 96% of Sc was extracted at weight of Fe_3O_4/SiO_2/TBP of 0.1g, a ratio of 5ml:0.1g , pH <0 for 1 minute contact time, and a temperature of 25 ^oC. Sc can be efficiently obtained by stripping from the Fe_3O_4/SiO_2/TBP by 1 mol/L HCl with stripping efficiency 94%.

***Keywords**: Scandium, D2EHPA, Trioctylphosphine oxide, Tributyl phosphate, Red mud.*

Biography

Ali Dawood Salman completed his Master of Chemical Engineering studies at University of Technology Baghdad, Iraq. Since 2016 he has been working as assistant lecturer at the College of Oil and Gas Engineering Basra University, Iraq. Currently he is involved in PhD studies and he is researcher in Laboratory for Surfaces and Nanostructures (LASUNA), Faculty of Engineering, University of Pannonia, Veszprem, Hungary..

FELDSPAR'S ROLE IN PROVIDING SOIL WITH MACRONUTRIENTS K AND CA (EXAMPLE: WADI EL-ANNAB NORTHEAST OF ALGERIA)

Hassni BELAIDI[1]*, A. BOUSSELIOU[1], S. KITONI[2], S. CHELLAT[1]

[1]*Geology and Environment Laboratory, University of Constantine 1, Constantine, Algeria,*
[2]*Department of Process Engineering, Faculty of Process Engineering. University Salah Boubnider Constantine 3, Algeria,* *Corresponding author: hassnibelaidi@gmail.com

Feldspar is an abundant mineral group and make up about 60% of the earth's crust. They are present in many sedimentary deposits and are found in almost all igneous and metamorphic rocks. The crust-mantle interaction at the plate boundary and inside the plate is the primary source of these minerals. Common feldspar includes orthoclase (KAlSi3O8), albite (NaAlSi3O8), and anorthite (CaAl2Si2O8). Weathering of feldspar is important in soil formation, especially for increasing soil fertility for food production. The feldspar group of minerals are an important mineral to sustain life on the Earth. The feldspar group minerals play an important role in the overall dynamics of macronutrients such as K and Ca in soils. The massif of Wadi El-Annab is made up of igneous rocks. This massif is surrounded by the forest from all sides and a big part of this massif is covered with plants. This region is characterised by significant rainfall and a good hydrographic system. Study of this massif by thin sections shows that it consists mainly of 45% feldspar group, 19% of quartz, and 35% of biotite. The calcite is a secondary mineral. The feldspar group include orthoclase and plagioclase. The plagioclase is about 70% of all feldspar. The orthoclase represents 30% of all feldspar. The feldspar is altered and show microfractures. The alteration of the feldspar is mainly because of water while the microfractures are because of the incursion of plant roots in the floor.

***Keywords**: Feldspar, Macronutrients, Soil, Wadi El-Annab, weathering*

Biography

In 2018 I have completed my license in geology of mineral resources at the age of 21 years from Jijel University, in 2020 I have got a master's degree of 23 years in mineral resources, geomaterials and environment from Jijel University, in 2021 I started my PhD at the University of Constantine 1. I'm interested to research in all geological fields, especially those attached to minerals and natural resources.

HYDROGEOCHEMICAL ASSESSMENT OF THERMAL WATERS FROM SOUK AHRAS GEOTHERMAL SYSTEM. NORTH EAST OF ALGERIA

Halima BOUDRA[1], F. BOUAICHA[1], W. MELOUAH[2], M. BOUKHATEM[1].

[1]*Geology and Environment Laboratory, University of Constantine 1, Constantine, Algeria,* [2]*Faculty of Hydrocarbons, Renewable Energies and Earth and Universe Sciences Kasdi Merbah University, Ouargla, Algeria*., *Corresponding author: halimaboudrahydrogeologie@gmail.com

The geothermal resources of Algeria are numerous; they are manifested in the form of thermal springs or that are widespread throughout the Algerian territory, and especially in the North-East where the tectonic manifestations are abundant. The region of Souk Ahras, belongs to the hydrothermal system of carbonate karstified Cretaceous, located near the Algerian-Tunisian border has many hydrothermal springs, the most important of which is the source of Hammam Tassa and Ouled Zaid, the temperatures of these springs between 39 and 40°C. According to the results of chemical analysis that were conducted on the thermal springs in the study area at different periods, source El Demssa, Tassa, Ouled Zaid, El Khengua. The thermal springs have moderately high conductivities due to the presence of a triassic evaporite formation. The pH indicates slightly acidic waters in all sampling sites, Representation of the results in the Piper diagram, all hydrochemical facies of sodium bicarbonate character; this is due to the influence of the lithology of the study area.

Keywords*: thermal springs, hydrochemical facies, Algerian–Tunisian border, piper diagram, lithology, tectonic*

Biography

In 2018, I had completed my license in hydrogeology from Jijel University, In 2020 I had got a master's degree in hydrogeology from Jijel University, in 2021 I had started my PhD in hydrogeology at the University of Constantine I, my research title:" Characterization and functioning of the geothermal system of El Taref and Souk Ahras region. North-East of Algeria"

ISBN: 978-963-449-285-6

BIO-BASED AND BIODEGRADABLE PLASTICS DERIVED FROM OLIVE POMACE

Ghizlane AKHOUY[1,2*], Lhoucine GEBRATI[1,2], Khalid AZIZ[3], Faissal AZIZ[2,4]

[1]Laboratory of Materials, Processes, Environment and Quality, Cadi Ayyad University, Safi, Morocco, [2]National Center for Research and Studies on Water and Energy (CNEREE), Cadi Ayyad University, Marrakech, Morocco, [3]Laboratory of Materials, Biotechnology, and Valorization of Natural Resources, Department of Chemistry, Faculty of Sciences, University Ibn Zohr, Agadir, Morocco, [4]Laboratory of Water, Biodiversity, and Climate Change, Faculty of Sciences Semlalia, Cadi Ayyad University, Marrakech, Morocco. Corresponding author: ghizlaneakhouy86@gmail.com

This study aimed to recover organic waste, especially olive pomace, to develop "sustainable" expanded materials in food packaging. The first step consists of extracting different biopolymers from olive pomace. Then the elaboration of nanocomposites based on those biopolymers will be exhibited, using the electrospinning methods under controlled parameters. After optimizing these conditions and their resistance to water, morphological properties, biodegradability, and antimicrobial activities will be determined and optimized. Furthermore, essential oils, after their extraction from two plant species, will be encapsulated into the nanofiber structures to enhance the biomembrane antimicrobial activities. Fourier Transformed Infrared (FTIR) spectra of the nanofibrous mats will be collected using Bruker ALPHA FTIR Spectrometer. Differential thermal analysis (DTA) and Thermogravimetric Analysis (TGA) will be performed to understand the thermal behavior of nanofibers. Porosity measurement tests will be performed to understand permeability to gases. X-ray diffraction analysis (XRD) will be conducted to determine the crystallographic structure of a nanofibrous mat. The contact angle measurements were conducted to investigate the surface hydrophobicity of the fibrous mat samples. This study will transform olive pomace waste into a solution to today's environmental and societal challenges, namely the plastic issue.

***Keywords**: antimicrobial activities; biopolymers; biodegradable; electrospinning; food packaging; olive pomace*

Biography

Ghizlane AKHOUY is a second-year PhD student at the national school of applied sciences, Cady Ayyad University Marrakech, Morocco. The theme of her work is Nano-membrane based on electrospun biocomposites: synthesis and applications. Currently, she is in aninternship at the National Centre of Study and Research on Water and Energy

ISBN: 978-963-449-285-6

NOVEL LOW-COST BIO-SORBENT FROM OLIVE POMACE TO ADSORPTION OF PHENOLIC COMPOUNDS FROM OLIVE OIL MILL WASTEWATER

Imane HAYDARI[1,2*], Laila MANDI[1,2], Amina LISSANEDDINE[1,2], Khalid AZIZ[3], Naaila OUAZZANI[1,2], Faissal AZIZ[1,2]

[1]Laboratory of Water, Biodiversity, and Climate Change, Faculty of Sciences Semlalia, Cadi Ayyad University, Marrakech, Morocco. f.aziz@uca.ma, [2]National Center for Research and Studies on Water and Energy (CNEREE), Cadi Ayyad University, Marrakech, Morocco, [3]Laboratory of Materials, Biotechnology, and Valorization of Natural Resources, Department of Chemistry, Faculty of Sciences, University Ibn Zohr, Agadir, Morocco

The olive oil mill wastewaters (OMWW) pose serious environmental problems in Mediterranean countries; therefore, their treatment is greatly interesting. This study aimed to prepare a new low-cost bio-sorbent to remove phenolic compounds based on olive pomace. The new bio-adsorbent was characterized by scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS), Fourier transform infrared spectroscopy (FTIR). Different parameters influencing the adsorption of phenolic compounds such as contact time, solution pH, concentration and temperature were studied. The kinetic data followed the pseudo-second-order model better than the pseudo-first-order model. Thermodynamic parameters including $\Delta G°$, $\Delta H°$ and $\Delta S°$ were also studied, suggesting an endothermic process. Langmuir and Freundlich's isothermal models were used to describe the equilibrium data; the results obtained showed that the equilibrium data was best fitted to the Langmuir model. The results showed that the bio-sorbent had a better removal efficiency of phenolic compounds with an adsorption capacity of 789 mg g^{-1}.

***Keywords**: Biosorbent; Olive oil mill wastewater; Olive pomace; Optimization; Phenolic compounds.*

***Acknowledgment**: This work was supported by the Morocco-Tunisian bilateral scientific cooperation project (20 /PRD-MT-02).*

Biography

Imane HAYDARI is a second-year PhD student at the Faculty of Sciences Semlalia, Cady Ayyad University Marrakech, Morocco. The theme of her work is industrial wastewater treatment and the recovery of valuate by-products under a Moroccan-Tunisian cooperation project (20/PRD-02). Currently, she is in an internship at the National Centre of Study and Research on Water and Energy.

ISBN: 978-963-449-285-6

EVALUATION OF SURFACE WATER QUALITY FOR DRINKING PURPOSES: A CASE OF GUENITRA DAM (NORTH-EAST ALGERIA)

Selma HADEF*, Faouzi ZAHI, Taha Hocine DEBIECHE, Abdelmalek DROUICHE

Geological Engineering Laboratory (LGG), University of Mohamed Seddik Benyahia - Jijel, Algeria
*Address: B.P. 98 Ouled Aissa, 18000 Jijel, Algeria, *e-mail: selmahadef18000@gmail.com, Phone: 0783085766*

The Guenitra dam is located in the south-western part of Skikda region (north-eastern Algeria). It occupies the downstream part of its catchment area with a total capacity of 120 hm^3 and a regulatable the volume of 48hm^3/year. Its waters are used for different purposes (drinking water, industry and irrigation). The latter is exposed to anthropogenic activities including mainly urban waste and leachates from the abandoned polymetallic sulphide mine of Sidi Kamber. A six-month monitoring (November 2017 to April 2018) was carried out on the waters of the Guenitra dam by the National Agency for Hydraulic Resources of Constantine (ANRH), with the aim of evaluating the water quality of the Guenitra dam based on the determination of the water quality index (WQI) and the organic pollution index (OPI). The OPI shows that 80% of the samples belong to the moderate quality type of water (3< OPI <3.9). While the WQI shows that 70% of the samples have a good quality (25<WQI<50), which is suitable for drinking purposes, with the exception of the March and April waters which revealed poor quality and unsafe water (WQI >75). This degradation of water quality is seasonal due to variations in water inflow to the dam.

***Keywords**: Algeria, Guenitra dam, organic pollution index (OPI), pollution, water quality index (WQI).*

Biography

Selma Hadef is currently a fourth-year PhD student in hydrogeology at the Geological Engineering Laboratory (LGG), Department of Earth and Universal Sciences, Faculty of Natural and Life Sciences, Mohamed Seddik Benyahia University - Jijel, Algeria, and her studying under the supervision of Dr. F. Zahi and Pr. T.-H. Debieche. Her doctoral work focused on the physico-chemical characterisation of the waters of the Guenitra dam catchment area (Skikda, northeast Algeria). She has published an article in reputed journal and participated in four national and international conferences in the field of hydrogeology and hydrochemistry.

THE TOXICOLOGICAL EFFECTS OF MICROPLASTICS ON THE ENVIRONMENT AND HUMAN HEALTH

Jihane BAGHOR[1*], Faissal AZIZ[2], Jamal MABROUKI[1], El Hajjaji SOUAD[1]

*[1]Laboratory of Spectroscopy, Molecular Modeling, Materials, Nanomaterial, Water and Environment, CERNE2D, Mohammed V University in Rabat, Faculty of Science, Avenue Ibn Battouta, Agdal, Rabat, Morocco, [2]Laboratory of Water, Biodiversity, and climate change, Faculty of sciences Semlalia, Cadi Ayyad University, Marrakech, Morocco, * j.baghor@gmail.com*

The water sector continues to face the challenges of the scarcity of these resources under the effects of climate change, overexploitation of groundwater and contamination by organic and inorganic micropollutants in particular microplastics (MPs). The main sources of MPs in water are vehicle tires, textile laundries, building materials, personal care products, food packaging etc. Exposure to MPs can result in toxicity through oxidative stress, inflammatory damage, and increased uptake or translocation. Several studies have demonstrated the potential for metabolic disruption, neurotoxicity, and increased cancer risk in humans. In addition, microplastics have been found to release the compounds that comprise them as well as those adsorbed on their surface. MPs also have a significant environmental impact, the most studied being in marine environments. Once released or detached from their original plastic product, microplastics can travel through waterways and enter ecosystems that support a variety of marine organisms such as zooplankton, polychaetes, fish and bivalves. In addition to bioaccumulating in the digestive tract, MPs can also be transported to other tissues/organs such as the circulatory system and liver, and adhere to gills or soft tissue. In another example, environmental pollutants and pathogenic microorganisms can use MPs as a vector to enter animals and cause damage. They can also adversely affect soil biota, such as earthworms, and alter the biophysical properties of the soil, including its aggregation, bulk density, and water holding capacity.

***Keywords**: Microplastics, effects, environment, human health, toxicity.*

Biography

Ms. Jihane Baghor is a young Moroccan woman, 24 years old, she got her master degree in 2021 at the Faculty of Sciences Hassan II of Casablance, Morocco. She is now in her first year of doctoral studies at the Faculty of Sciences Mohamed V of Rabat, Morocco, Center for Water, Natural Resources, Environment and Sustainable Development, Laboratory of Spectroscopy, Molecular Modeling, Materials, Nanomaterials, Water and Environment.

[1]Rejtő Sándor Foundation, Budapest, Hungary, ingtex@t-online.hu, +36309245612, [2]Institute of Environmental Engineering, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Budapest, Hungary szabo.lorant@rkk.uni-obuda.hu. +36303865097

Abstract of the VIth. International Symposium–2022
Theme: "Biosphere & Environmental Safety"

May 5-6, 2022
Óbuda University, Budapest, Hungary
ISBN: 978-963-449-285-6

CARBON FIBER, THE BLACK WONDER

Rudolf SZABÓ[1], Lóránt SZABÓ[2]

In recent decades to meet the growing demands of users the performance of machines and equipment has increased significantly due to the widespread use of electronic solutions and accurate manufacturing. However, this has also increased energy demand and the CO_2 emissions. There is virtually no alternative to lightweight constructions: the carbon fibres reinforced materials (FRP), that are superior to steel and aluminium in almost all respects when it comes to cutting the weight and a number of beneficial properties. And, in terms of specific stiffness and lightness, carbon fibre reinforced plastics is simply unbeatable. The aerospace, automotive, high performers machine parts, the wind-power industries, the hydrogen storage vessels producers have been aware of this they are being used in rapidly increasing quantities in more and more areas. The presentation will to give provide an overview of the use of the CFRP.

***Keywords**: applications, carbon fiber, composites, lightness, stiffness, tension*

Biography

Education:
1964-68 Textil Technical School (Spinningtech.) Budapest
1969-74 Techincal University of Budapest (Faculty of Mechanic Enginiering)
1983-84 Techincal University of Budapest (Faculty of Machine Construction)

***Professional Activities:** His main activity in the first place considers to the weaving technology and technical textiles. During my work activities, he had already worked technological factory organizations most of the Hungarian plants. Today, my professional activity focuses on the field of composite. He had written more than 150 articles and 10 notes written, numerous lectures at international conferences about his professional experiences. he is in an active professional relationship with the Hungarian textile plants and the foreign textile machine manufacturers. He maked lectures many times on the international Confreres German, English and Hungarian languages in Germany, Belgium, Turkey, Japan and Carpathian basin many times, he was interpreter on of numerous master courses in abroad. He had been the executive editor of Magyar Textiltechnika for 15 years; currently he is the president of the Sándor Rejtő Foundation.*

PHYTOREMEDIATION OF POTENTIAL TOXIC ELEMENTS BY NATIVE TREE SPECIES IN MINED- SPOILED SOILS IN MÁTRASZENTIMRE, HUNGARY

Jovito L. OPEÑA[1,2*], Gábor Endre HALASZ[2], Jószef Tibor ÁRGYELÁN[3], Mark Kalman HORVATH[2]

[1]Marinduque State College, Boac, Mariduque Philippines, [2]Hungarian University of Agriculture and Life Sciences, Institute of Environmental Sciences, Department of Chemistry, Gödöllő, Hungary, [3]Nitrokémia PLC, Balatonfüzfö, Hungary, [*]Corresponding author: E-mail: jovito1565@gmail.com

Potential toxic elements such as Arsenic (As), Cadmium (Cd), Copper (Cu), Lead (Pb), and Zinc (Zn) are commonly left behind after mining operation. Being non-biodegradable, these elements serve as source of contamination for the soil and water ecosystems and create hazards to human health. This research work evaluated the phytoextracting ability for potential toxic elements by four (4) endemic tree species that are predominantly growing in an abandoned mining spoil sites in Mátra mountains in Hungary. Plant and soil samples were collected in the field and analyzed using ICP-OES. Results showed that the soil was highly contaminated with heavy metals, largely Pb, As, and Zn which were 10x to 60x more than the typical non-contaminated Hungarian soil. Among the trees evaluated, Carpinus betulus showed the highest potential for Pb dendroremediation, having a mean concentration value of 4071.67 mg kg^{-1}dry weight in roots, 439.06 mg kg^{-1} dry weight in stems and 92.53 mg kg^{-1} dry weight in leaves. Betula pendula and Salix caprea bioaccumulated 475.8 and 395.97 mg kg^{-1} dry weight of Zn in their leaf biomass. Both trees had a Bio-concentration Factor (BCF) value of >1.0 but < 10 which classified them as potential phytoextractors of Zn. Salix caprea gave the highest Translocation Factor (TF) for Cd while Betula pendula gave the highest TF for Zn.

Keywords: *potential toxic elements, dendroremediation, bioconcentration factor (BCF), translocation factor (Tf)*

Biography

ISBN: 978-963-449-285-6

A NOVEL HYDROGEL BEADS BASED COPPER-DOPED *CERASTODERMA EDULE* SHELLS FOR HIGHLY FUNGICIDE SORPTION FROM GROUNDWATER

Khalid AZIZ[1*], Rachid MAMOUNI[1], Nabil SAFFAJ[1], Faissal AZIZ[2]

[1]*Laboratory of Biotechnology, Materials and Environment, Faculty of Sciences, Ibn Zohr University, Agadir, Morocco ,*[2]*Laboratory of Water, Biodiversity & Climate Changes, Faculty of Science Semlalia, Cadi Ayyad University, Marrakech, Morocco.* *Corresponding author: khalid.aziz@edu.uiz.ac.ma

The engineering of a novel biocomposite based on Cerastoderma edule shells doped with copper and alginate (Ce-Cu@Alg) by forming hydrogel beads was used for batch and dynamic adsorption thiabanedazole (TBZ) pesticide from water. The prepared biosorbent was analyzed by various characterization techniques such as scanning electron microscopy (SEM), X-ray diffraction analysis (XRD), Brunauer-Emmett-Teller analysis (BET), energy dispersive spectroscopy (EDS), thermogravimetric and differential analysis (TGA-DTA). The results of the TBZ batch biosorption by Ce-Cu@Alg composite showed that the Langmuir model was the most adequate to describe the adsorption process, with a maximum adsorption capacity value of 21.98 mg/g. Moreover, the adsorption kinetics was adjusted by the pseudo-second-order model. On the other hand, the TBZ sorption on a fixed bed of Ce-Cu@Alg beads was effective at high column height, low effluent flow and low solution concentration. The Thomas model was best fitted to the kinetic data. This new study clearly shows the possibility of using this new hybrid biocomposite in the industrial sector to treat large effluent volumes.

***Keywords**: Adsorption, biocomposite, wastewater, pesticide, optimization, kinetic*

Biography

Khalid AZIZ has completed his PhD in the year 2022 at Ibn Zohr University (Morocco), working on elaborating biomaterials and biocomposites for removing emerging pollutants from wastewater. He had more than ten research papers.

[1]Laboratory of Biotechnology, Materials and Environment, Natural Substances and Environment Team, Polydisciplinaire Faculty of Taroudant, University Ibn Zohr, Morocco, k.sbihi@uiz.ac.ma, [2]National Centre for Research and Study on Water and Energy (CNEREE), University Cadi Ayyad, Marrakech, Morocco. f.aziz@uca.ma, [3]Laboratory of Water, Biodiversity & Climate Changes, Semlalia Faculty of Sciences, Marrakech, Morocco, [4]Department of Biology, Faculty of Sciences Semlalia, University of Cadi-Ayyad, Marrakech, Morocco, [5]Laboratory of Materials and Environment, Faculty of Sciences, Ibn Zohr University, Agadir, Morocco.

ISBN: 978-963-449-285-6

POTENTIAL OF LOCAL FRESHWATER MICROALGAE *CRATICULA SUBMINUSCULA* FOR HEXAVALENT CHROMIUM REMOVALS: TOLERANCE, OPTIMIZATION, KINETICS AND ISOTHERM STUDIES

Karim SBIHI[1,2*] Sara EL HAMJI[2,3], Siham LGHOUL[4], Khalid AZIZ[5] , Noureddine EL BARAKA[5], Faissal AZIZ[2,3]

The removal of heavy metals from contaminated wastewater using microalgae has recently attracted more and more attention. This study investigated the removal of Cr(VI) by freshwater microalgae, Craticula subminuscula, collected from a Moroccan river in High Atlas mountain. Results showed that the optimal conditions for Cr(VI) removal by this microalgae were pH of 1.09, microalgae inoculation concentration of 10.91mg.L^{-1} and treatment time of 129.47 min, with the chromium removal efficiency of 95.32%. The biosorption process of Cr(VI) by C. subminuscula under optimal conditions followed the pseudo-second-order model, with the rate constant and the theoretical and experimental biosorption capacity of 0.0004 g.mg^{-1}.min^{-1}, 289.01 mg.g-1 and 277.57 mg.g^{-1} respectively. The isotherms adsorption of Cr(VI) was described well by the Langmuir model, biosorption maybe dominates the adsorption process. Fourier-Transform Infrared Spectroscopy (FTIR) analyses of the biomass revealed that the affinity of Cr(VI) by functional groups in the microalgal cell walls was the main mechanism for their removal by C. subminuscula.

***Keywords**: Biosorption, Cr(VI), Craticula subminuscula , Removal kinetics, Optimization*

***Acknowledgement:** This work was supported by the Morocco-Tunisian bilateral scientific cooperation project (20 /PRD-MT-02).*

Biography

Dr. Karim SBIHI *is an Assistant Professor and member of the Laboratory of Biotechnology, Materials and Environment, Research, Polydisciplinaire Faculty, University Ibn Zohr, Taroudant, Morocco. His Principal research is the use of algae for wastewater treatment and the algae bio-remediation technology to manage a variety of industrial effluents, including chemical, textile and leather industries.*

ISBN: 978-963-449-285-6

ENVIRONMENTAL IMPACT OF BARITE WASTES FROM THE AIN MIMOUN MINE, KHENCHELA, NORTH-EAST ALGERIA

Meriem **BOUKHATEM*, N. CHABOUR, F. BOUAICHA, R. KOURICHE, H. BOUDRA**

*Geology and Environment Laboratory, University des Frères mentouri Constantine 1, Constantine, Algeria, *Corresponding author: boukhatem.meriem2100@gmail.com*

The barytic deposit of Ain Mimoune is a complex vein of hydrothermal type, which represents a very interesting mining potential on an economic level in view of the quality and quantity of the extracted ore. It is located at the northern flanks of the Khenchela anticline. To this effect the mining industry in Algeria occupies of the exploitation of this type of ore especially in the oil field. In spite of productivity of the factory and the good quality of the concentrate resulting from the jig REMER, a loss in useful mineral in the waste rock. This waste presents a serious threat for the environment and the habitat. In order to verify the impacts of these mine wastes, a mineralogical and hydrogeochemical study was carried out. Principal component analysis (PCA) was applied to samples taken from different mining sites in order to better understand the geochemical associations characterizing this study area as well as the possible origin of existing metallic contaminants. The analyses show a high degree of pollution by Ba with a maximum value of 9000 mg/kg for the samples downstream of the treatment plant on soils and 124.66 mg/L for surface and groundwater. Concentrations in waters in some stations largely exceed the norms of potability (W.H.O. norm, AFNOR norm). In the soil, the Ba and Pb content exceed that considered as natural. The results show the degradation of the environment in the proximity of the mining center. This is translated by the high content of barium Ba, lead Pb, NO_3 and NH_4.

***Keywords**: barytic, Ain Mimoune, hydrothermal, environment, pollution, barium*

Biography

Meriem Boukhatem, is a second year educational hydrogeology PhD student at the University of Constantine 1 at Algeria, She had completed her license degree at the age of 22 years from Constantine 1 University. In 2020, she had obtained her master's degree in hydrogeology from Constantine 1 at the age of 24 years.

May 5-6, 2022
Óbuda University, Budapest, Hungary
ISBN: 978-963-449-285-6

THE ROLE OF SOCIAL MEDIA BLOGS IN INFLUENCING DAIRY FUNCTIONAL FOODS AND HEALTHY LIFESTYLE IN HUNGARY

Mohammad MOHAMMAD

Institute of Marketing and Management, Faculty of Economics/ Hungarian University of Agriculture and Life Sciences (MATE) Kaposvár Campus, Kaposvár, Hungary, e-mail: almendooo@gmail.com, +36204194250

In recent years, functional food blogs on social media provide an important channel and chance for electronic word-of-mouth (eWOM) which started to take place quickly and became more popular of new source of reading material for blogs on social media users. However, there are not much studies published to understand what factors from dairy functional foods (DFFs) blogs play critical roles in predicting readers' intention to try and taste local food and beverages of healthy foods. After reviewing previous studies, we could develop a conceptual research model containing three main categories of variables: Inspiring taste desire contains (experiencing appeal toward DFFs and generating empathy toward DFFs), Forming taste awareness contains (providing image of DFFs, delivering knowledge toward DFFs and presenting guides toward DFFs) and Facilitating interpersonal interaction contains (social influence of DFFs and cybercommunity influence of DFFs), and according to previous suggested studies these potential variables might influence blog readers' behavioural intention to taste directly of dairy functional food. Collected data for the research model going to be analyzed using the structural equation modelling approaches.

***Keywords**: Functional food, dairy, social media, blog, lifestyle, Hungary*

Biography

Mohammad Mohammad is PhD Student since 2018 completed his Master study in 2018 in Engineering of Animal Nutrition and feed Safety from Kaposvár University. Completed Engineering of Agronomy specialized in animal production in 2014 from Faculty of Agriculture in Damascus University.

ISBN: 978-963-449-285-6

IMPACT OF HEALTHY BEHAVIOUR ON CONSUMER ATTITUDE TOWARD DAIRY FUNCTIONAL FOODS

Mohammad MOHAMMAD

Institute of Marketing and Management, Faculty of Economics/ Hungarian University of Agriculture and Life Sciences (MATE) Kaposvár Campus, Kaposvár, Hungary, e-mail: almendooo@gmail.com, +36204194250

Due to growing consumer concern toward healthy lifestyle and the concept of diet directly impact healthiness, functional foods have played a key role in healthy habits. Functional foods are a new category of products that promise consumers improvements in targeted physiological functions. The main goal of this study is to analyze how healthy behavior during the motivators and barriers influence consumer attitudes toward dairy functional food and willingness to consume dairy functional foods in Hungary. At the same time, this study tries to analyze the moderating role of gender, and the differences between men and women. For this purpose, a conceptual model is adapted to the field of study with integrating different models and theories. That's why four dimensions of attitude toward dairy functional food were found: Reward from using dairy functional foods, Necessity for dairy functional foods, Confidence in dairy functional foods and Safety of dairy functional foods. All that to determine the factors that potentially impact the willingness to consume dairy functional food in Hungary.

***Keywords**: Consumer attitude, Functional food, Dairy, Healthy food, Lifestyle, Hungary*

Biography

Mohammad Mohammad is PhD Student since 2018 completed his Master study in 2018 in Engineering of Animal Nutrition and feed Safety from Kaposvár University. Completed Engineering of Agronomy specialized in animal production in 2014 from Faculty of Agriculture in Damascus University.

ISBN: 978-963-449-285-6

MANAGEMENT PLAN FOR A DECLINING POPULATION OF THE SOUSS VALLEY TORTOISE IN AN ARID STEPPE-LAND OF WEST-CENTRAL MOROCCO

Nawal HICHAMI[1*], Mohamed ZNARI[2]

[1]Laboratory of Biotechnology & Sustainable Development of Natural Resources. Polydisciplinary Faculty of Beni Mellal, Sultan Mulay Slimane University, Mghila, Beni Mellal, Morocco, [2]Natural History Museum of Marrakech, Cadi Ayyad University, Ave Allal El Fassi, Marrakech, Morocco, E-mail* nouna.hichami@gmail.com

The endangered Moorish tortoise Testudo graeca is the unique terrestrial chelonian species in Northwest Africa. In SW Morocco, the endemic subspecies, the Souss valley tortoise T. g. soussensis, occupies semi-arid to arid low-quality habitats of SW Morocco and is subject to serious threats. A long-term mark-recapture program from 2001 to 2012 allowed estimating population size and structure, sex ratio, and survivorship in one of the well-known populations in a degraded and overgrazed arid steppe land of west-central Morocco. Spring population size considerably decreased to more than half in less than ten years, with a mean density lower than 3 ind ha^{-1} in 2012 compared to its last known density estimated in 2003. In spring 2012, the population structure exhibited an unbalanced male-biased sex ratio (61:39) and a scarcity of juveniles (<5%). We identified five major conservation problems in the study area: (i) over-collecting of tortoises for the pet trade; (ii) direct disturbance; (iii) habitat destruction and overgrazing, and iv) tortoise handling mostly for field research, and v) increased extinction risk due to the small population size. Using the VORTEX software, we carried out a population viability analysis based on published and obtained population and life history parameters. With no management action, the population would go extinct during the forthcoming 40 years after the last estimate. The most efficient management option for the long-term persistence of the population would be to reduce nest and neonate mortality by 90%. To attenuate the impact of the threatening factors, we developed a management plan that includes population reinforcement and habitat restoration options.

Keywords*: arid steppe, conservation, population characteristics, Souss valley tortoise, threats, viability.*

Biography

Nawal HICHAMI is currently an Assistant professor at Sultan Mulay Slimane University (Morocco). She obtained her PhD at 35 years from the Faculty of Sciences Semlalia Cadi Ayyad University and did postdoctoral studies at the University of Bourgogne in Dijon, France. She had published more than 12 articles in reputed journals. Her research field is focused on animal biodiversity, behavior, herpetology and ecology.

Abstract of the VI[th]. International Symposium–2022
Theme: "Biosphere & Environmental Safety"

May 5-6, 2022
Óbuda University,
Budapest, Hungary
ISBN: 978-963-449-285-6

IMPACT OF USING REFUSE-DERIVED FUEL IN CO-PROCESSING TOWARDS THE QUALITY OF CLINKER AND CEMENT

Sadhan Kumar GHOSH[1,3*], Somnath PODDAR[2]

*[1]Department of Mechanical Engineering, Jadavpur University, Kolkata, India, [2]School of Environmental Studies, Jadavpur University, Kolkata, India, [3]International Society of Waste Management, Air and Water (ISWMAW), *Corresponding author: sadhankghosh9@gmail.com*

Cement industry is an energy intensive industry, rank 2nd in terms of energy consumption. To reduce the fossil fuel burning leading to high GHG emissions in a cement plant, wastes are utilised in the form of refuse derived fuels (RDF). The RDF substitutes the energy and raw material in cement kiln. This is called co-processing where RDF is called AFR (Alternative Fuel and Raw material). RDF is not homogeneous in nature and its composition can affect the quality of cement. While using the RDF as AFR, the quality & composition of RDF should not impact the quality of cement. The objective of the research work is to analyse the pozzolanic potential of different MSW as sources of RDF in cement plant and to identify the effect of RDF ash contamination into the clinker towards the hydration qualities of cement. Reduction in GHG emissions, fuel and raw material saved are also calculated. This study is divided into two parts, 1st part the potential of MSW to use as RDF and the composition of the RDF ash is analysed. In 2nd part the effects of RDF ash on the hydration characteristics of cement are analysed. Secondary data from literature and reports are used in this study. This will contribute to the understanding of pozzolanic properties of RDF ash and effect of ash contamination on the cement produced. The reduction in harmful emissions and the environmental gain due to co-processing are analysed. This study will be helpful for further research on the subject.

***Keywords**: Analysis, Ash composition, Cement quality, Co-processing, RDF, RDF ash*

Biography

Prof. Sadhan Kumar Ghosh, PhD (Engg.) is the professor in Mechanical Engineering in Jadavpur University, India. He is the well-known international expert of UNCRD, APO, IGES, SACEP and ISO in the field on waste management and circular economy. His other areas of interests are Energy recovery from Wastes, Co-processing, E-waste, Plastics Waste, HCW, C&DW and Haz. waste management, Recycling & Recovery, Sustainable Supply Chain of Waste Management, Environment management systems, Sustainable Development, 3R strategies and Implementation, Green manufacturing & Productivity, TQM, ISO Standards, SME improvement and MSME cluster development. He has more than 250 publications, three patents and is expert in various committees.

Mr. Somnath Poddar, a student pursuing M-Tech in Environmental Biotechnology, School of Environmental Studies department, Jadavpur University, Kolkata. Research scholar under the supervision of Prof. Sadhan k. Ghosh Principal investigator of the project, Ocean Plastic Turned into an Opportunity in Circular Economy – OPTOCE, Department of Mechanical Engineering, Jadavpur University. The area of research covers refuse derived fuels (RDF), pre-processing, co-processing of RDF in cement kiln, economic and environmental impact of co-processing of NRPW in cement manufacturing industry.

ISBN: 978-963-449-285-6

NATIONAL SECURITY: INTERPLAY OF ENVIRONMENTAL, HUMAN AND FOOD (IN)SECURITIES IN NIGERIA

Bitrus Eniyekenimi DAUKERE[1], *Olatunde Isaac OLANIYI[2]

[1]Department of Geography, Nigerian Army College of Education, Ilorin, Nigeria, dauksenies@gmail.com, +234 806 37663 0421, [2]Department of Political Science, Nigerian Army College of Education, Ilorin, Nigeria, latundeolaniyi@gmail.com, +234 808 363 3020

The recognition of safe biosphere and environment as critical elements in security architecture has received increased multidisciplinary attention in recent years. Issues of environmental security have deepened the depth and broadened the scope of security discourse. The security or otherwise of the Nigerian geopolitical construct is a reflection of its environmental security as well as the dynamic interplay of human and food security. This paper examines human, food and environmental dimensions of security in Nigeria, with focus on how each dimension mutually reinforces the other and combines to impact national security. The study relied on secondary data from both quantitative and qualitative methods. Using content analysis, it is observed that environmental issues are central to the (in) security of Nigeria and its people. It argues that the environmental degradation resulting from extractive productions in the Niger-Delta region coupled with the continued desertification of the arid north cummulatively stress the security balance of the country. The study reveals that environmental (in) security constitutes the remote cause of farmer-herders crises, kidnapping, cattle rustling, banditry and piracy in Nigeria. These insecurity indicators have also threatened food security in the country. The paper therefore recommends compliance with environmental safety protocols and resilient development practices in industrial and extractive sectors and divestment from non-renewable energy. It argues further for government's effective management of ensuing competition over water resources in the middle–belt and southern parts asides provision of adequate water channels in the northern part of the country. The paper concludes that addressing the man-made and nature induced environmental issues constitute the roadmap to a strengthened national security.

***Keywords**: environmental security, farmer-herder crises, food security, national security, sustainable development*

Biography

Bitrus Eniyekenimi Daukere is a Lecturer in the Department of Geography, Nigerian Army College of Education, Ilorin, Nigeria where he teaches courses in Human geography, geographic information systems, and remote sensing. He serves as the examinations officer of his department. He had published in reputed journals and has a particular interest in issues related to spatial crime analysis, environmental criminology, applied spatial statistics and geographic information analysis as well as urban geography. Visit linkedin.com/in/daukere-bitrus-eniyekenimi-paul to connect with him.

ISBN: 978-963-449-285-6

AN ASSESSMENT OF THE PRESENT CONDITION OF A WETLAND IN A DEVELOPING CITY: THE CASE OF PALLIKARANAI MARSH, CHENNAI, INDIA

Mythili MADHUSUDHAN[1], N. K. AMBUJAM[2]

[1]*School of Architecture, Meenakshi College of Engineering, 12, Vembuli Amman Koil Street,, West K. K. Nagar, Tamilnadu, India, Email: mythili.m@mce.edu.in,*[2]*Centre for Water Resources, Anna University, Chennai-25, Tamilnadu, India, Email: nk.ambuj@gmail.com*

The impact of human habitation on ecosystems in developing countries, while studying the case of a wetland situated in the city of Chennai, India, is the focus of this paper. City growth resulted in increased attention towards the wetland site and simultaneously, an influx of population in this area. This also resulted in shrinking of the marsh accompanied by deterioration of nearby water bodies. Highlighting the need for appropriate monitoring of environmental resources, the region could be viewed from the perspective of sustainable management and tools for the same are called for. Time series data from Landsat images and historical cadastral maps from the same time period are used for analysis. Trend analysis, studies from secondary sources, field observations and key-informant interviews have culminated in this research. The primary losses were found to be in terms of landscape value, changes in hydrology, biodiversity and anthropogenic impacts. The authors have found that in this transformation of the water-landscape, the problems characterizing the resultant urban unit such as inundation and storm water conveyance are a direct consequence of the loss of natural resources, and this emphasizes the need to save the water body. The present condition of the marsh is thereby evaluated, the major issues examined and recommendations for the governing authorities and the public are made.

***Keywords**: Impacts of urbanization, Eco-social, Water bodies and Wetlands, Land use Land Cover changes, Mapping of Water bodies, Chennai, Pallikaranai marsh*

Biography

Mythili Madhusudhan is a Professor at School of Architecture, Meenakshi College of Engineering
N. K. Ambujam is a Professor at School of Architecture, Meenakshi College of Engineering

ISBN: 978-963-449-285-6

PROSPECTS AND GEOTHERMAL POTENTIAL OF MILA

Rima KIFOUCHE*, H. BOUSBAA, F. BOUAICHA, H. SHOUT

Laboratoire de géologie et environnement, Université Constantine 1, Route Ain El Bey Zouaghi Slimane Constantine, Algeria, *Corresponding author: kifouche.rima@gmail.com

That work deals a determination the geothermal potential and prospects of the Mila region. Thermal baths in Algeria are characterized by a high concentration of hot springs in the North-East of the country. At the last census, more than 282 thermal resurgences have been inventoried in northern Algeria, with temperatures varying between 30°C and 96°C. Geothermal resources in Algeria are of the low-energy type. Three geothermal zones have been delineated according to some geological and thermal considerations: the first: the Tlemcenian dolomites in northwestern part of Algeria, the second: is the carbonate formation in the northeastern part of Algeria and the third: the sandstone Albian reservoir in the Sahara in southern Algeria. Our study area is Mila, is located in the North-East of Algeria, 50km from Constantine, which is part of the Kebir Rhumel watershed, it is characterized by a rugged relief. The geothermal resources of Mila region emerge in favor of tectonic conjugate directions N-S, E-W and NW-SE. Mila region is characterized by a Mediterranean climate, sub-humid in the north and semi-arid in the south. All types of geochemical facies are found: bicarbonate, sulphated and chloride from carbonate formations, gypsiferous and evaporate. Exploitation of geothermal energy remains very limited given the existing geothermal potential, crenotherapy is the main use. Except for a few cases in the south of the country.

***Keywords**: thermal, geothermal potential, low-energy, Mila, crenotherapy*

Biography

Rima Kifouche is a PhD student as well as research assistant at Université frères Mentouri Constantine 1. Department of geology. Laboratoire de géologie et Environnement (LGE); Hydrogeologist, Master in Environmental Geology. Currently, her research focuses on geothermal energy and resources, factors of pollution of water resources and their impact on the environment. She is also working on pollution of surface water and their impact on the environment. The methods used relate to the collection of samples and their chemical analysis as well as the use of appropriate software for interpretation. Skills and experience: Hydrogeology, water quality, water chemistry, ground water chemistry, water resources, environmental pollution, geothermal energy, geothermal resources, Geostatistical Analysis and SIG.

ISBN: 978-963-449-285-6

THE CASE OF THE SHRINKING PALLIIKARANAI MARSH, CHENNAI, INDIA: ENVIRONMENTAL ECONOMICS TO THE RESCUE?

Mythili MADHUSUDHAN[1], N. K. AMBUJAM[2]

[1]School of Architecture, Meenakshi College of Engineering, 12, Vembuli Amman Koil Street,, West K. K. Nagar, Tamilnadu, India, Email: mythili.m@mce.edu.in,[2]Centre for Water Resources, Anna University, Chennai-25, Tamilnadu, India, Email: nk.ambuj@gmail.com

The intangible benefits provided by water bodies and wetlands in urban areas often tend to go unnoticed. In order to assess the true values of welfares and benefits to society, social benefit cost analysis (SBCA) presents itself as a useful tool. In this paper, hedonic pricing method (HPM) has been used in apprehending the environmental and aesthetic benefits of Pallikaranai marsh, Chennai, India, and the results are used in analysis of costs versus benefits. We attempt to quantify the impact of the presence of water bodies in urban settings and distance from the Pallikaranai marsh has been found to be the significant variable and the price rate of residential land decreases by .367/m^2 for every metre distance away from the marsh. Many other smaller water bodies surround the marsh. Another variable, denoted by the component of interaction of distance from the marsh and distance of other smaller water bodies is found to be a significant variable, while the distance from other smaller water bodies is found to be not a significant variable. The results of the analysis describe and demonstrate the role of water bodies in the urban context and provide data for land planners and water managers to make informed decisions in the planning and management agenda.

***Keywords**: Urban water bodies and wetlands; Urban environmental quality; Hedonic Pricing Method; HPM; Social Benefit Cost Analysis; SBCA; Restoration of water bodies; Restoration of marshes; Pallikaranai; South Chennai*

Biography

Mythili Madhusudhan is a Professor at School of Architecture, Meenakshi College of Engineering
N. K. Ambujam is a Professor at School of Architecture, Meenakshi College of Engineering

INNOVATION BY SUBSIDIES IN AGRICULTURAL PRODUCTION IN HUNGARY IN 2010S

Sándor J. ZSARNÓCZAI

National University of Public Service, Faculty of State Scientific and International Studies, Kálmán Széll State Finance Research Workshop, H-1083 Budapest, Ludovika tér 2.
Óbuda University, Rejtő Sándor Faculty of Light Industry and Environmental Engineering Institute of Environmental Engineering and Natural Sciences, Doberdó u. 6, H-1034 Budapest, Hungary, e-mail: zsarnoczai@yahoo.co.uk

One of the main issues is income conditions of agricultural producers for period of 2008 and 2020 in Hungary in order to keep producers in this sector and in rural areas. The analyse method the special program for social sciences. The study analyses the income conditions of agricultural producers based on the total factor income per annual working unit. Total factor income per annual working unit has very strong correlations with gross value added –GVA in current price by 0.988, because of if the agricultural production, as output increased – even with less or little input as current production use – therefore the gross value added also can increase, which can be base for increasing income of annual working unit. This prosperity process can be followed by increase of total factor income per annual working unit (AWU) for period 2008-2020, when this has increased two times more by 210% for this time period. Total factor income per annual working unit has very strong correlation with total factor income by 0.969, when in Hungary the total factor income has increased by 162.7%, which also stimulated increase of total factor income per annual working unit. Gross value added should make considerable influence on the increase of the total factor income per AWU. Therefore, corelations have been very strong between themselves by 0.991 for the same period. The number of AWU should also decrease somehow, in order to increase the total factor per AWU, but it has only strong contradict correlations by Minus 0.585.

***Keywords**: Annual working unit, correlation system, gross value added, income conditions, statistical analyse, total factor income*

Biography

CSc, economic sciences, Hungarian Academy of Sciences, Scientific Qualified Committee, Budapest in 1991 and Dr. of University, World Economics, Budapest Corvinus University of Economics in 1991. Habilitate Doctor, in social sciences, in Management and Business Administration, Kaposvár University, in Kaposvár in 2017. Between 1987-2017 work at University of Agricultural Sciences, then at Szent István University in Gödöllő. From 2017 work at Óbuda University. Participation at Doctoral School of Economics and Regional Sciences at Hungarian University of Agriculture and Life Sciences in Gödöllő. The research areas: Economics, Business and Management, International Regional Economic Integration, EU Study, Regional economics, Rural Development, Environmental economics. He published 207 publications with 257 independent citation count, of which 189 foreign language citations. His publications were published in Arab, English, Spanish and Russian foreign languages. International scientific conferences in Turkey, Canada, Moldavia, Czech Republic, Slovakia, Lithuania, Romania and Russia. Research project in Finland, Sweden, Denmark, Italy, Spain, France.

MYCORRHIZATION OF ALEPPO PINE (PINUS HALEPENSIS) SEEDLINGS BY INOCULATION WITH THREE DIFFERENT ECTOMYCORRHIZAE SPECIES

Nidal ZRIKAM[1*], Lahcen OUAHMANE[1], Faissal AZIZ[2,3]

[1]Laboratory of Microbial Biotechnologies, Agro-Sciences and Environment (BioMAgE), Labeled Research Unit-CNRST N° 4, Cadi Ayyad University, Marrakesh, Morocco, e-mail: nidalazrika@gmail.com , [2]National Centre for Research and Study on Water and Energy (CNEREE), University Cadi Ayyad, Marrakech, Morocco. f.aziz@uca.ma, [3]Laboratory of Water, Biodiversity & Climate Changes, Semlalia Faculty of Sciences, Marrakech, Morocco.

Currently, in sub-humid regions in Morocco, the ecological conditions are becoming increasingly severe and mainly affecting the soil's quality (structure, micro-and macro-elements content, etc.). Reforestation is, therefore, more than ever, a major challenge and an absolute necessity. Ectomycorrhizal fungi are considered one of the recommended approaches for reforestation in sub-humid regions as a protection strategy against some adverse environmental conditions. This study aims to evaluate and compare the effects of three carpophorous grind of three species of ectomycorrhizae on growth, mineral nutrition, and chlorophyll pigments of Aleppo pine seedlings (Pinus halepensis) grown with sandy soil substrate. The results showed that mycorrhizal seedlings aged eight months showed an improvement in growth parameters (aerial and root biomass, plant height) and biochemical parameters (chlorophyll a and b), which are significantly higher in inoculated seedlings compared to non-inoculated seedlings. Inoculation increased mineral nutrition, phosphorus and nitrogen content, and mineral elements (Mg, Ca^{2+}, K) in mycorrhizal plants. Overall, this initial use of ectomycorrhiza isolates could significantly improve the growth, mineral nutrition and photosynthesis of pine plants under nursery conditions. Therefore, the use of appropriate fungal inoculation of these isolates is a recommended ecological strategy to restore degraded pine ecosystems.

***Keywords**: Aleppo pine, ectomycorrhizal, forest ecosystem, inoculation, reforestation*

Biography

Nidal ZRIKAM is a PhD student Enrolled in the second year of the thesis, in the training of life sciences and the environment, at the faculty of sciences Semlalia University Cadi Ayyad, Morocco, whose research focuses on mycorrhizal fungi and especially on the type of ectomycorrhiza and their applications in the forest ecosystem, which is of vital importance for growth, the nutrition and protection of these plants against various environmental constraints which can be summed up in biotic and abiotic stresses.

TOXICITY AND REMOVAL OF PHENOLIC COMPOUNDS BY THE FRESHWATER DIATOM *CRATICULA SUBMINUSCULA*

Sara El HAMJI[1,2*], Karim SBIHI[2,3], Jihen ELLEUCH[4], Naaila OUAZZANI[1,2], Imen FENDRI[4], Slim ABDELKAFI[4], Brahim OUDRA[1], Faissal AZIZ[1,2]

[1]*Laboratory of Water, Biodiversity & Climate Changes, Faculty of Science Semlalia, Cadi Ayyad University, Marrakech, Morocco,* e-mail: f.aziz@uca.ma, [2]*National Center for Research and Studies on Water and Energy (CNEREE), Cadi Ayyad University, Marrakech, Morocco,* [3]*Laboratory of Biotechnology, Materials and Environment, Natural Substances and Environment Team, Polydisciplinaire Faculty of Taroudant, University Ibn Zohr, Morocco,* [4]*Unité de Biotechnologie des Algues, Ecole Nationale d'ingénieurs de Sfax, Université de Sfax, Tunisie.*
*Corresponding author: elhamjisara@gmail.com

Phenolic compounds in olive mill wastewater (OMWW) are considered an environmental threat due to their water and soil toxicity. Several technics have been developed to remove those micropollutants; however, biological removal seems a suitable approach. Due to their metabolic versatility, microalgae have been identified as an efficient alternative for detoxifying organic and inorganic contaminants and removing toxic compounds. The ability of freshwater diatom Craticula subminuscula to grow in water containing different phenol concentrations has been tested. The phenol removal efficiency and cell growth rates were evaluated at different initial phenol concentrations, 50-250 mg/l. The highest specific growth and removal rate were achieved at 150 mg/l phenol. It was found that the percentage of phenols removal up to 54 % was achieved and allowed the microalgae to tolerate higher phenol concentrations reaching 150 ppm. The illustrated results indicate that the OMWW supply strategy can be purposefully tailored to regulate biomass production and organics compound biodegradation.

***Keywords**: Biodegradation, Craticula subminuscula, diatom, olive mill wastewater, phenols*

***Acknowledgment**: This work was supported by the Morocco-Tunisian bilateral scientific cooperation project (20 /PRD-MT-02).*

Biography

Sara El Hamji is a first-year PhD student at the Faculty of Sciences Semlalia, Cady Ayyad University, Marrakech, Morocco. The theme of her work is industrial wastewater treatment using microalgae under a Moroccan-Tunisian cooperation project (20/PRD-02). Currently, she is in an internship at the National Centre of Study and Research on Water and Energy.

A RELATION BETWEEN EXTREME DAILY PRECIPITATION AND EXTREME SHORT TERM PRECIPITATION

Yanina L. ROMERO[1*], J. BESSEMBINDER[2], N.C. van de GIESEN[3], F.H.M. van de VEN[3]

[1]Beuningen, The Netherlands, e-mail: p.bronkhorst8@upcmail.nl, [2]Climate Services, Royal Netherlands Meteorological Institute, De Bilt, The Netherlands, [3]Water Management, Delft University of Technology, Delft, The Netherlands

The Royal Netherlands Meteorological Institute (KNMI) published the KNMI'06 Climate Scenarios in 2006. These scenarios give the possible states of the climate in The Netherlands for the next century. Projections of changes in precipitation were made for a time scale of 1 day. The urban drainage sector is, however, more interested in projections on shorter time scales. Specifically, time scales of 1 hour or less. The aim of this research is to provide projections of precipitation at these shorter time scales based on the available daily scenarios. This involves an analysis of climate variables and their relations to precipitation at different time scales. On the basis of this analysis, one can determine a numeric factor to translate daily projections into shorter time scale projections. Eventually, these synthetic data can be used as an input for an urban drainage model. With such a drainage model and synthetic data for design storms the effects of climate change on the systems' performance can be assessed and the efficiency of adaptive measures can be investigated.

***Keywords**: correlation, extreme, precipitation, ratio, urban, variables*

Biography

Eng. Yanina L. Romero completed her MSc at the age of 34 years from Water Management at Delft University of Technology, The Netherlands. She is published in Climatic Change which has had numerous worldwide citations. She has worked as a software consultant, AutoCad drafter, and adviser at diverse engineering firms and as a wastewater policy worker. She currently reviews papers for diverse journals including Theoretical and Applied Climatology. Her last participation was at the 12th ICEEE online conference where she won the award for best young researcher. Ms. Romero currently resides with her husband in The Netherlands.

ISBN: 978-963-449-285-6

SUPERFICIAL POLLUTION OF QUATERNARY SOILS OF THE CITY OF ALI MENDJELI, CONSTANTINE, NORTHEAST OF ALGERIA

Smaine CHELLAT[1*], L. BOUDRAA[1], R. ZATOUT[1], A. BOUREFIS[1], M. HACINI[2]

*[1]Geology and Environment Laboratory, University of Constantine 1, Road Ain El Bey Zouaghi Slimane Constantine, Algeria, [2]Geology of Saharan laboratory, Department of earth sciences, Faculty of Hydrocarbon. University Kasdi Merbah Ouargla, Algeria. *Corresponding author:* smaine.chellat@gmail.com

The superficial soils of the city of Ali Mendjeli, located in the department of Constantine North-East Algeria, are characterized by decalcification clays, resulting from the alteration of limestone rocks and plio-quaternary marls. The set of analyses carried out on these soils, calcimetry, particle size, DRX, show a dominant calcium component, clay aggregates packed by carbonate cement. X-ray diffractometric spectra show a dominance of $CaCO_3$, as an essential mineral. They also show the presence of pollution by the elements: Pb, Zn, and Cu, caused by anthropogenic factors such as washing and maintenance of vehicles and machinery during the installations of the various building and road sites that have marked this new city. Their presence is confirmed, but the values as a function of time vary from one point to another. These indications of surface pollution require further analysis of groundwater in lower areas, exploited by farmers and local residents.

Keywords *Clays, decalcification, Soil, Ali Mendjeli, Pollution*

Biography

Smaine CHELLAT is a Professor at the University of Constantine 1, Faculty of Earth Sciences, Geography and Spatial Planning, Department of Geological Sciences. Between 1999 and 2009, he had been as a state engineer in geotechnics as a supervisor in national and international companies. Since 2009 to date, he has held the position of university professor, specializing in geology, sedimentology, Quaternary geology, pollution and environment, geological and archaeological heritage. Been involved in several research projects, responsible for the doctoral training team since 2020. Currently he leads a project on the interest of feldspars in northern Algeria, in 2021 member in a European project of indexing old and recent foraminiferous databases..

ISBN: 978-963-449-285-6

AN ANALYTICAL STUDY OF E-WASTE AWARENESS AND DISPOSAL BEHAVIOUR AMONGST RURAL, SEMI-URBAN AND URBAN CONSUMERS OF MAHARASHTRA

Viraja BHAT[1], Prakash RAO[2], Shubham BARJIBHE[3]

[1]Department, Symbiosis Institute of International Business,Pune, India

E-waste generation in India is proliferating day by day due to the eminent use of electronic devices as India is heading towards digitalization. According to the global E waste monitor 2020, India ranks third in E waste generation after US and China, contributing 3.23 million tons of E waste annually. According to the statistics in India, State of Maharashtra tops the E-waste generation chart with just 1% of it being recycled every year. Recycling infrastructure challenges and widespread informal recyclers network being the major road blocks nevertheless significant role is played by the consumers in facilitating formal recycling. E-waste has been common waste This enhanced the authors of the research paper to study and analyze the E waste awareness and disposal behavior among the Urban, Semi-urban and Rural population of Maharashtra. As a representation of the selected cites, two locations have been selected from each Urban, Semi-urban and rural areas of Maharashtra to carry out a detailed analysis by conducting a primary survey method. This analysis was specifically to know the awareness of the people about E waste, its management policies, disposal behavior and subsequent health impacts in the long run. From the survey questionnaire, it has been noticed that most of the population from rural and semi-urban areas are unaware of E-waste disposal methods. Further, the Data Analysis was carried out using statistical software (SPSS) for results and a clear understanding on whether different parameters have impact on consumer's disposal behavior and E-waste awareness. On the basis of the results from the survey, comparison of awareness of the people about E waste, its policies, health impacts, disposal behavior from all three areas have given a clear idea of why Maharashtra is facing challenges in E-waste management and how this issue can be resolved.

***Keywords**: E-waste, Consumer awareness, disposal behaviour, health impacts, urban, rural*

Biography

Dr. Viraja P. Bhat has more than 18 years of experience which comprises of industry as well as academics. She holds an engineering degree in electronics and communication from Karnataka University and Master degree in management from Pune University. She has completed her doctoral degree (Ph.D) from Symbiosis International University in the area of Electronic Waste Management. Her experience comprises of both industry and academia in the area of Software development, Project management, ERP. She works as an HOD-IT and Associate Professor at Symbiosis Institute Of International Business, Pune. She conducts training program for SAP University Alliance and data analysis using excel. MS Project. She has a very keen interest in the area of corporate social responsibility and she has been mentoring the students of SIIB for the ISR initiative (Kshitij) for more than 15 years, which has been proactive in various projects to develop the community. She has published papers and chapters in the area of electronic waste management, sustainability and corporate social responsibility

***Dr. Prakash Rao** has 39 years of experience in the field of energy and environment with interests in climate change and sustainability. He holds a Ph.D. from the University of Bombay. Has published around 86 research papers, notes and book chapters in peer reviewed international journals and He has published four books with a recent publication on Environmental impacts of Tourism with IGI Global Publishers, USA. He is the Deputy Director and Head of the Energy and Environment Programme at Symbiosis Institute of International Business (SIIB),a constituent of Symbiosis International University, Pune*

Shubham Barjibhe is currently pursuing MBA from Symbiosis Institute of International Business under Symbiosis International University. He completed his Mechanical Engineering from Sinhgad Academy of Engineering under Savitribai Phule Pune University. His research interest includes E-waste management, Analytical solutions and Sustainable Financing investments.

CHIRAL SEPARATIONS OF PHYRETROIC ACIDS USING CYCLODEXTRIN SELECTORS

Zoltán JUVANCZ*, Rita BODÁNÉ-KENDROVICS, Zita LACZKÓ

Institute of Environmental Engineering, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Budapest, Hungary

The pyrethroids insecticides are broadly used insecticides. They are used also near food insecticides in households because they have low toxicity for warm blooded living creatures. On the other hand, they show high toxicity not only for insecticides but for fishes too. Therefore, it is important to decrease the environmental burden of the pyrethroids. One of the effective ways to lessen the pollution to use chiral pure insecticide products instead of their racemic mixtures. For example, the chiral pure deltamethrin has same insecticide effects than eight times more amount racemic mixture of deltamethrin. The enantiomer pure products require enantiomer selective synthesis and analysis. The pyrethroids acids are chiral compounds; therefore, their enantiomer selective analysis is important task. This study shows various enantiomeric selective chromatographic methods: gas chromatography, supercritical fluid chromatography and capillary electrophoresis for separation of various pyrethroids acids. The chiral selective agents were based on cyclodextrin derivatives.

Keywords*: environmental analysis, chiral selective analyse, pyrethroids acids, cyclodextrin*

Biography

I had got my M.Sc. diploma from ELTE as chemistry researcher in 1975. I defended my D.Sc. title in 2003 at Hungarian Academy of Sciences. I had published more than 190 papers and lectures with more than 100 IF, and gaining almost 1600 citations. My research fields are chromatography on open tubular columns (GC, SFC, CE), and various topics of environmental protections. I visited various laboratories in USA, Germany, Sweden, and Switzerland. My best results dealt with chiral separations. I took part in the introductions more than 15 chiral selective agents. The endocrine disruptive chemicals and pharmaceutical pollutions are my research topics in environmental science. I am also interested in the educational part of environmental protections.

MOLLUSKAN TISSUES AS AN ACCUMULATION SITES FOR HEAVY METALS FROM LIBYAN COAST IN NORTH-EAST LIBYA

Eman R. B. OJALEY[1], Hussein B. B. JENJEN[1], Osama R. SHALTAMI[2], Ahmed M. MUFTAH[2]

[1]Department of Zoology, Faculty of Science, University of Benghazi, Benghazi, Libya, [2]Department of Earth Sciences, Faculty of Science, University of Benghazi, Benghazi, Libya.

A number of living marine gastropods (Phorcus turbinata and Patella caerulea) which are commonly inhabited the rocky beach of meso-infra littoral zones in the entire Circum-Mediterranean coast are collected from nine coastal localities (Benghazi "Ashbilia and Sabri)", Tocra, Tolmeita, Al Haniyah, Al Hamamah, Susa, Hawa Eftaih and Ras Al Hilal) in April, 2018. The inductively coupled plasma mass spectrometer (ICPMS) was performed on the soft body for measuring the environment-sensitive elements such as Fe, Sn, Sb, Cu, Zn, Pb, Ni, As, Hg and Se. All analyzed metals are mainly of anthropogenic origin (excluding Fe). The statistical treatment indicates that most heavy metals are mutually correlated, but there is an absence of strong correlations among some metals, which suggests that these metals are possibly of different sources. The concentrations of all metals are below the recommended guideline in seafood, except for As in Phorcus turbinata and Pb in Patella caerulea. Moreover, the Phorcus turbinata is a good accumulator for Fe, Ni, As and Hg, whereas Patella caerulea is a collector for Cu, Zn and Pb. Additionally, the contamination indices suggest that Susa (distillation station) and Sabri are the most polluted areas.

***Keywords**:* molluskan tissues, bioaccumulation, heavy metals, Libyan coast

Biography

ISBN: 978-963-449-285-6

NEXUS BETWEEN ECONOMIC GROWTH, AVAILABILITY OF FOSSIL FUELS AND OPPORTUNITIES FOR ACHIEVING ENVIRONMENTAL SUSTAINABILITY IN COUNTRIES OF CIS: THE CASE OF OIL AND GAS EXPORTING COUNTRIES

Dina MALGAZHDAROVA

Management and Organization Sciences/Hungarian University of Agricultures and Life Sciences, Kaposvar, Hungary, e-mail: dina.malgazhdarova@gmail.com, mobilr: +36205187845

The article investigates the relationship between indicators of the country's economic sustainability, the fuel, and energy potential of the state, and the country's environmental sustainability, as well as the major problems of the development of the fuel and energy complex. The major issues of the fuel and energy complex development and the necessity of the national production greening are analyzed, as well as its nexus with the economic growth within CIS countries exporting energy resources.

***Keywords**: Sustainable development, economic growth, resource safety, environmental sustainability, environment and economy*

Biography

Dina Malgazhdarova had completed her Master's degree in Economic studies at the age of 30 in 2013 from the University of Quebec in Montreal (Canada) and currently is a PhD student of Hungarian University of Agricultures and Life Sciences. She is also a Lead Consultant of the Agency for Defense and Development of Competition of the Republic of Kazakhstan under President of the Republic of Kazakhstan, also has a work experience in local Investment policy division being responsible for communication with international bodies and enforcement of Investment climate in Kazakhstan. She has published 15 papers in reputed local journals as well as participated in publication of the textbook (namely the part that touched the questions of environmental and economic sustainability) for students of Military Institute of Radioelectronics and Communication in Almaty city of Kazakhstan. Has a strong interest in studying and promoting the environmental sustainability as well as finding the ways to raise the efficiency of State bodies in her motherland.

ISBN: 978-963-449-285-6

CARBON ACCUMULATION IN LOW LAND PADDY SOILS MODERATED BY CERTAIN MANAGEMENT PRACTICES - AN OVERVIEW

P. SENTHILVALAVAN[1*], M. V. SRIRAMACHANDRASEKHARAN[1], R. MANIVANNAN[1], C. RAVIKUMAR[2], U. SURENDRAN[3], PRITPAL SINGH[4], K.P. RAGUNATH[5]

[1]Department of Soil Science and Agricultural Chemistry, Faculty of Agriculture, Annamalai University, Tamilnadu, India, [2]Department of Agronomy, Faculty of Agriculture, Annamalai University, Tamilnadu, India, [3]Centre for Water Resources Development and Management, Kozhikode, Kerala, India, [4]Punjab Agricultural University, Ludhiana, Punjab, India, [5]Agricultural Research Station, Bhavanisagar, Tamil Nadu Agricultural University, Tamilnadu, India, *Corresponding Author E-mail: senvalavan_m2002@yahoo.co.in

Carbon(C) is the only key to running in this worldly life and without carbon, nothing can be ensured, but the amount and form of C in different spheres of the earth make numerous changes that influence the lives of all living things. Soil carbon flux directly or indirectly affects the global climate and thus agriculture productivity. Ensuring human food security for the ever-increasing global population, critical challenges for the agriculture sector are inevitable. Improved soil and nutrient management practices are crucial to tackling these problems by enhancing agro-ecosystem productivity, soil fertility, and carbon sequestration via certain approaches become a must concern. "Paddy soils form the biggest manmade swamplands on the earth and are responsible for zenith potential of organic carbon (C) sequestration". Rice accounts for approximately 9% of the global cropland area and their environmental conditions are responsible for soil organic carbon storage, methane emanation, and to a smaller extent emit nitrous oxide. The present review signifies the present and future potential agricultural management practices, especially nutrient management practices and their effects on soil organic carbon (SOC) storage and sequestration. Increasing carbon inputs and reducing SOC losses in low land paddy soils need attention as its concern with GHGs that imply direct causes on global climate. Maybe life-cycle assessments of certain practices in low land paddy soils help in assessing the carbon footprints and sustaining the crop productivity. With this view, this review study was taken to shed light on the life of carbon in the terrestrial ecosystems and its accumulation in low land paddy soils moderated by nutrient management practices adapted for rice production.

***Keywords**: Carbon accumulation, Greenhouse gases, Low land paddy soils, Nutrient management practices, Soil organic carbon, Soil carbon pools.*

Biography

Dr. P. Senthilvalavan is an Assistant Professor in Department of Soil Science and Agricultural Chemistry, Faculty of Agriculture, Annamalai University, Tamilnadu, India. Twenty-two years of research and 15 years of teaching experience. Published more than 90 papers in reputed journals attended and presented 85 research papers in national and international conferences and has been serving as editorial board member/reviewer of reputed Journals. Worked with radio-isotopes like ^{137}Cs, ^{131}I, ^{60}Co, ^{90}Sr related to phyto-extraction and transfer co-efficiency in different crops. Certain projects completed funded by IPNI, TENMA. Presently, working with Soil fertility & Biology, Soil-Water Pollution and Conservation, Nano fertilizers, Biochar, Carbon management, and Problem Soils (N, P & Zn nutrition).

ISBN: 978-963-449-285-6

WIND ENERGY APPLICATION IN HUNGARY

Lóránt SZABÓ

Institute of Environmental Engineering, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Budapest, Hungary, e-mail: szabo.lorant@rkk.uni-obuda.hu

This paper deals with green wind energy application (depends on solar energy). Nowadays global energy consumption was increased increasingly due to the growing the population and standards of living style. Moreover, with increasing the global warming and environmental pollution, the development of renewable energy sources was becoming more essential. Wind energy is one of the most promising clean and sustainable energy. Wind power plants produce electricity by having rotating three blades. It has three main in its energy chain: wind turbine, gear box and electric generator. A wind turbine turns wind energy into electricity using the aerodynamic force from the rotor blades, which work like an airplane wing. If wind flows across the blades, the air pressure on one side of the blade decreases. The difference in air pressure across the two sides of the blade creates both lift and drag forces. The force of the lift is bigger than the drag and this causes the rotor to spin. The rotor connects to the generator, either directly (if it's a direct drive turbine) or through a shaft and a series of gears (a gearbox) that speed up the rotation and allow for a physically smaller generator. This translation of aerodynamic force to rotation of a generator creates electricity. The total capacity of wind power capacity is 329 MW in Hungary. Number of operating wind farms are 39, with 172 wind towers. Most of wind farms are in the Kisalföld region in Hungary.

***Keywords**: wind power, wind turbine blades, lift force, generator, wind farms in Hungary, clean energy.*

Biography

In 2012, he completed his PhD at the age of 50 years from Nyugat-Magyarországi Egyetem (University of West Hungary. He has published more than 96 papers in different journals. His research fields are air-jet looms, acoustics, and renewable energies

ISBN: 978-963-449-285-6

ODOUR PROBLEM OF ANIMAL KEEPING IN HUNGARY

Csaba ÁGOSTON

Institute of Environmental Engineering, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Budapest, Hungary
e-mail: agoston.csaba@rkk.uni-obuda.hu

Among the harmful effects of human activity on the environmental elements, the pollution of ambient air with odors has a special place. The peculiarity of the odor load is due to the fact that its nature and extent are directly perceived by the population, so the population smells common. A common undesirable side effect of animal keeping is an unpleasant odor. In addition, the change in the lifestyle of the rural population in recent decades has resulted in a decline in backyard animal husbandry. Backyard animal husbandry and its odor effect are nowadays a common cause of neighborhood disputes and legal lawsuits. In previous years, these disputes were often settled on the basis of local livestock regulations of municipalities. These regulations contained restrictions, albeit indirectly, in relation to odor emissions from livestock farming.

***Keywords**: environmental odour, air pollution, animal keeping, legislation*

Biography

Dr. Csaba Ágoston (PhD) is the President of the Association of Environmental Protection Service Providers and Manufacturers, Budapest, Hungary. He is Assistant professor at the Óbuda University

ISBN: 978-963-449-285-6

NEW METHODS FOR APPLYING THE SYMMETRY THEORY OF STEREOREGULAR POLYMERS FOR QUANTUM-MECHANICAL MODELLING OF PHOTOVOLTAIC TYPE MATERIALS

Csaba MÉSZÁROS[1]*, István Róbert NIKOLÉNYI[1], Ágnes BÁLINT[2,3]

[1]Department of Mathematics and Basic Natural Sciences / Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary, e-mail: Meszaros.Csaba@uni-mate.hu, Nikolenyi.Istvan.Robert@uni-mate.hu, [2]Institute of Environmental Engineering, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Budapest, Hungary, [3]Hydro-Bio-Mechanical Systems Research Center, Budapest Hungary, e-mail: balint.agnes@uni-obuda.hu

It is well-known, that the detailed experimental and theoretical investigation of basic structural and physical properties of different types of carbon nano - tubes plays a role of continuously increasing importance in the whole condensed matter physics, because of the very promising experimental investigation of the solar energy applications, too. Among them, the very powerful symmetry analysis methods based on the representation theory of line groups are recognized as the relevant ones. The quantum theory of collective elementary excitations has been developed by applications of the representation theory of line groups. In order to apply our own earlier theoretical results in this contemporary research area, we decided to extend them in more details, in order to give new, significant contributions to theoretical physics of the basic optical properties of the stereoregular polymers and carbon nanotubes at quantum-mechanical-, and quantum statistical levels.

***Keywords**: Alternative energetics, nanotechnology, symmetry theory, solar energetics, stereo-regular polymers*

Biography

Dr. habil. Csaba Mészáros (Csaba Mészáros is the author's name). ***Highest educational degree:*** *MSc Physics, Faculty of Natural Sciences, Novi Sad, Former Yugoslavia,* ***Scientific degree:*** *PhD in the field: Physics, ELTE, Budapest; Habilitation, in the field: Agricultural Engineering, SZIE, Gödöllő, Hungary,* ***Department:*** *Institute of Mathematics and Basic Natural Sciences.* ***Phone:*** *+36 28 522000/1553.* ***Position:*** *Associate Professor.* ***Specialties:*** *Experimental and theoretical determination of ordinary crystal structures and incommensurately modulated ones. Experimental and theoretical modelling of transport processes*

SOIL QUALITY IN THE SEBKHAS ENVIRONMENT (SOUTH-EASTERN CONSTANTINE), ALGERIA

Hadjer BOUSBA[1*], Ramdane MARMI[1], Kamel BOUFAA[2], Fouad BOUAICHA[1], Rima KIFOUCHE[1]

*[1]Geology and Environement Laboratory, University of Constantine 1, Route Ain El Bey Zouaghi Slimane Constantine, Algeria., [2]Geological Engineering Laboratory, University of Jijel, Cité Ouled Aissa, Algeria, *Corresponding author: hadjer.bousba@student.umc.edu.dz*

The sebkhas (Sabkhet Djendli and Garaat Ank Djemel) considered in our study are part of the Boulehilet plain (ex. Lutaud) located on the southern edge of Constantine's high plains. The soils surrounding these sebkhas are dotted with very sparse vegetation consisting mainly of halophytic plants. These two lakes are drained, respectively, by Oued el Madher and Oued Chemora. Chemical analyses of the soils (30 samples) show relatively high concentrations of sodium and sulphates. The latter are more present in the vicinity of Sebkhet Djendli, the source of which would be the leaching of the Triassic formations that lie just to the north-east of the Sabkha. However, the $CaCO_3$ content does not show a significant variation across the plain. As for sodium levels, they increase significantly with depth, especially on the eastern edge of Sebkhet Djendli. The soils of the Boulehilet plain are relatively salty and have a pastoral interest. Conductivity measurements carried out in 70 farmers' wells on the outskirts of Sebkhet Djendli indicate values that are sometimes quite high, exceeding 2000µs, thus corroborating the salinity of the water that is used for domestic supply. Trace elements analyses (Zn, Cu, Cr, Ni, Ba, etc.) of soil samples taken from auger-digged boreholes (12 samples) show relatively high levels. The presence of these metals is thought to be linked to mining waste from previous operations near these sebkhas.

***Keywords**: Salinity, Sebkhas, Sodium, Sulphates, Soils, Trace elements, Triassic formations.*

Biography

Hadjer BOUSBA, PhD Student (2nd year) in Faculty of Science of the earth, geography and land use planning. University of Constantine 1. She is interested in studying of Genesis, evolution of the Sebkhas of the Constantine high plains and impact of salinity on soils and waters (North-East Algeria).

CHANGES IN LAND USE AND STABILITY SURVEY IN GÖDÖLLŐ HILLSIDE

Krisztina DEMÉNY

Institute of Environmental Engineering, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Budapest, Hungary
E-mail: demeny.krisztina@rkk.uni-obuda.hu

The study of landscape change and changes in nature and the environment has become increasingly important. One driver of the dramatic reduction of natural or quasi-natural areas is urbanisation. Europe is one of the most urbanised regions of the world. 73% of the European population lives in towns, and according to estimates, this figure will reach 82% by 2050. Land use – and consequently, its impact on the environment – has changed dramatically not only in Europe but also beyond the continent. In Hungary, economic and social transformation after the political changeover played a major role in the evolution of the rapidly changing structure of the landscape. We need to devote special attention to the areas of most sensitive from the perspective of nature conservation (e.g. the situation of wetlands and forest lands) to be able to monitor their alteration and mitigate the anthropogenic impact if possible. This study focuses on land stability survey on an example of a micro-region.

***Keywords**: land use, land stability, nature conservation*

Biography

Krisztina Demény has completed her PhD in Environmental Sciences at the age of 2019 from Szent István University, Gödöllő. She is the assistant professor and Deputy Director of Institute of Environmental Engineering and Natural Science in Óbuda University. Her publication list can be found here: https://m2.mtmt.hu/gui2/?type=authors&mode=browse&sel=10019676. Her research fields: landscape protection, landscape ecology and land use change from analysing nature conserve perspective.

ISBN: 978-963-449-285-6

POTENTIAL USE OF ELV WASTE RE-CIRCULATION IN CO-PROCESSING

Sadhan Kumar GHOSH[1,2*], Abhishek KUMAR[1]

[1]Department of Mechanical Engineering, Jadavpur University, Kolkata, India, [2]International Society of Waste Management, Air and Water (ISWMAW), Corresponding author: sadhankghosh9@gmail.com

Transportation played a great role in the society in the civilization. Through the life cycle of vehicles, the impact on the environment takes place in various ways: energy and resource consumption, GHG emission, waste generation during manufacturing and use, and disposal at the end of their useful lives. To support disposal of ELV waste, recovery processes are in use especially, reuse of appropriate parts, recycling of plastics, glasses, ferrous and non-ferrous metals, fabrics, and other materials for making various recycled products. However, the use of the ELV wastes does not guarantee the use of 100 % materials leading to dumping in the waste dump yards. Co-processing utilizes waste to recover energy as well as material to the extent of 100%. The global ELV (end-of-life vehicles) generation is estimated to be 40 million ELV/ year contributed by only 4% of total global automobile ownership. It is estimated that the number of vehicles to become ELV will be 2,18,95,439 by 2025. There are significant economic and environmental benefits in recovering materials from ELVs. It has been estimated that passenger cars contain about 70% steel and 7-8% aluminium. The rest 20-25% is plastic, rubber, glass etc. ELV waste contains a significant quantity of fiber reinforced polymer (FRP) on which the literature does not mention any recovery processes but the land filling. FRP and other unused plastics need appropriate recovery process. This study focuses on the potential recovery process through co-processing rout in cement plants that may help implementation of circular economy concepts as well as reduce adverse impacts on environment. Impact on environment. This study reviews the possibilities of using FPR in co-processing in cement plants for resource circulation.

***Keywords**: End of life vehicle(ELV), Waste generation, Co-processing, Cement industries, Plastic waste*

Biography

Prof. Sadhan Kumar Ghosh, President, ISWMAW & IPLA Global Secretariat, chairman and editor in chief, IconSWM-CE, project leader, Global status of implementation of circular economy, Associate Editor, Waste Management, Journal, Elsevier, and International Journal of Materials Cycles and Waste Management. Professor & Former Head, Mechanical Engineering Dept, Chief-Coordinator, Centre for Sustainable Development & Resource Efficiency Management (CSD&REM) in Mechanical Engineering, Ex-Dean, Faculty council of Engineering and Technology at Jadavpur University, Kolkata.

Mr. Abhishek kumar is a student pursuing ME in Automobile Engineering, mechanical engineering department. Research scholar under the supervision of Prof. Sadhan k. Ghosh Principal investigator of the project, "Ocean Plastic Turned into an Opportunity in Circular Economy – OPTOCE", Department of Mechanical Engineering, Jadavpur University. The area of research covers preprocessing, Alternative fuel and raw material (AFR),Co-processing of NRPW in cement kiln.

ISBN: 978-963-449-285-6

EFFECTS OF LAND APPLICATION OF MUNICIPAL SOLID SEWAGE SLUDGE AND WASTE PLANT COMPOST ON WHEAT GROWTH AND SOIL ENZYMATIC ACTIVITIES

Tsend-Ayush ERDENEJARGAL, Hosam E. A. F. BAYOUMI HAMUDA*

Institute of Environmental Engineering and Natural Sciences, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Budapest, Hungary E-mail: ayush091999@gmail.com, E-mail: Bayoumi.hosam@uni-obuda.hu, +36303900813

With rapidly growing industrialization and urbanization, nowadays nations face countless problems; one of them is declining soil fertility. In this study we aimed to improve soil fertility and biological activity by adding organic amendments, which includes municipal solid sewage sludge (MSSS) and waste plant compost (WPC). Inappropriate utilization of organic matter can impact negatively on soil fertility and plant growth. A pot experiment study was conducted to investigate the potential of 6 weeks of consecutive application of municipal solid sewage sludge and waste plant compost response of wheat (Triticum durum) to different doses (0, 15, 30, and 45%: w/w) to restore brown forest soil functions. Plant growth, shoot biomasses and heights, ratios and chlorophyll content was considered. Soil fertility parameters including Soil pH, moisture content, total organic carbon, soil total nitrogen content and soil enzyme activities i.e. fluorescein diacetate, dehydrogenase, β-glucosidase, urease activity, and alkaline phosphatase as well as aryl-sulfatase were measured. Evaluating the results, it can be stated that organic waste has an improving effect on the enzymatic activities and plant growth parameters in all cases; therefore, it can be of great help to agriculture and crop production. It is shown that application of waste plant compost has more soil biological improvement than the municipal solid sewage sludge, with 15 and 30% organic waste.

***Keywords**: municipal solid sewage sludge, waste plant compost, wheat growth, soil enzymatic activities*

Biography

*Prof. Dr. Hosam Bayoumi Hamuda is working at Óbuda University. He is Environmental Microbiologist and Soil Biotechnologist dealing with the interactions between the microbiomes and the environment for increasing soil quality and saving the soil from pollutants in the agriculture. His investigations are on the role of waste management, soil quality, fertility, the crop production and environmental impacts related to the application of organic wastes; measurements soil microbial biomass and enzymatic activities in wastewater sludge amended soils; and roles of engineered metal oxide nanoparticles in biosphere. **Research Interest**: Waste management; Biotechnology; Protection; Sustainable; PGPR; Microbial inoculants; gut microbiomes and human health and modern biology*

ISBN: 978-963-449-285-6

ECO-INNOVATION AND ENVIRONMENTAL AND ECONOMIC MANAGEMENT

Yasmin HAMUDA[1], Hosam E. A. F. BAYOUMI HAMUDA[2*]

[1]Tomori Pál College, Budapest, Hungary, E-mail: hamuda.jasmin91@gmail.com, *[2]Institute of Environmental Engineering and Natural Sciences, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Budapest, Hungary, *E-mail:* Bayoumi.hosam@uni-obuda.hu, *+36303900813*

The concept of eco-innovation has begun to be considered as a solution to preventing environmental damage, since the 1990s. However, the effect of eco-innovation on environmental and financial performance has received limited attention. Eco-innovation is defined as new ideas, behavior, products, and processes that contribute to a decreased environmental burden as well as the economic management. Eco-innovation is expected to reduce amounts of environmental wastes in soil and water, air pollution, and material resource usage from economical point of view. However, the effect of eco-innovation on environmental and financial performance has received limited attention. Eco-innovation is considered as effective tools as it enhances energy efficiency and cleaner production, which in turn lowers carbon emission. Quality institutions have been considered as it enhances the quality of environment. Green technology innovation is essential to reducing the pollution emissions of enterprises. Under stronger environmental regulation, import trade has a significantly positive effect on green technology eco-innovation. Environmental regulation can enhance the technology spillover effect of import trade in high absorptive capacity regions and high R&D investment regions. Environmental regulation and green technology eco-innovation. Under different levels of environmental regulation, do the import trade behaviors of enterprises have different impacts on green technology eco-innovation? What influencing mechanisms are involved? The work of this thesis will try to answer these questions. How environmental regulation affects green technology eco-innovation needs more discussion. Moreover, few scholars have analyzed how environmental regulation affects green technology innovation from the perspective of import trade. The analysis of this work shows: First, there is a nonlinear relationship between environmental regulation and green technology innovation. When environmental regulation intensity is lower than the inflection point, environmental regulation will promote green technology innovation; when environmental regulation intensity is higher than the inflection point, environmental regulation will inhibit green technology innovation. Second, environmental regulations affect the technology spillover effects of import trade. When stricter environmental regulations are in place, import trade can significantly promote regional green technology innovation. Third, there is significant regional heterogeneity in the impacts of environmental regulation on the technology spillover effects of import trade. In regions with high levels of absorptive capacity and high R&D investment, the interaction between environmental regulation and import trade has a significantly positive effect on green technology innovation. This paper analyses the nonlinear relationship between environmental regulation and green technology innovation and discusses which kind of environmental regulation intensity is most beneficial to green technology innovation.

***Keywords**: eco-innovation, environmental management, economic management*

Biography

Prof. Dr. Hosam Bayoumi Hamuda is working at Óbuda University. He is Environmental Microbiologist and Soil Biotechnologist dealing with the interactions between the microbiomes and the environment for increasing soil quality and saving the soil from pollutants. His investigations are on the role of waste management, soil quality, fertility, the crop production and environmental impacts related to the application of organic wastes; measurements soil microbial biomass and enzymatic activities in wastewater sludge amended soils; and roles of engineered metal oxide nanoparticles in biosphere. ***Research Interest****: Waste management; Biotechnology; Protection; Sustainable; PGPR; Microbial inoculants; gut microbiomes and human health and modern biology*

ISBN: 978-963-449-285-6

FREQUENCY DISTRIBUTION OF HEAVY METAL CONTENTS IN NATURAL, URBAN AND MINING LOCATIONS IN MONGOLIA

Ariunkhishig MUNKHSUKH, Hosam E. A. F. BAYOUMI HAMUDA

Institute of Environmental Engineering and Natural Sciences, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Budapest, Hungary,
*ariunkhishig0888@gmail.com, *E-mail: Bayoumi.hosam@uni-obuda.hu, +36303900813*

As there are just a few researches on heavy metals in soil in Mongolia, the examination will be led to investigate the presence of any harmful metals in 22 samples with ICP-OES technique which is the most elemental analysis technique. Samples will be collected from mining area which is in the desert, urban area in the capital city and mountainous local city in Mongolia. The study will focus on determining the spread of heavy metal contents as well as its health risk assessment and contamination level. The results will be analyzed with Mongolian standard for toxic chemicals in soil. The modifications used to immobilize the pollutants may not be specialized for a certain metal, resulting in the release of a hazardous metal into the soil. Therefore, there will be a need for developing new methods that can effectively lead to removal of heavy metals from the contaminated soil. The dissertation will include: Introduction and aim, Literature survey, Materials and method, Result, Discussion, Recommendation and further tasks, Summary, Acknowledgement and References.

***Keywords**: distribution, heavy metal contents, natural, urban, mining locations, Mongolia*

Biography

Prof. Dr. Hosam Bayoumi Hamuda is working at Óbuda University. He is Environmental Microbiologist and Soil Biotechnologist dealing with the interactions between the microbiomes and the environment for increasing soil quality and saving the soil from pollutants in the agriculture. His investigations are on the role of waste management, soil quality, fertility, the crop production and environmental impacts related to the application of organic wastes; measurements soil microbial biomass and enzymatic activities in wastewater sludge amended soils; and roles of engineered metal oxide nanoparticles in biosphere. ***Research Interest****: Waste management; Biotechnology; Protection; Sustainable; PGPR; Microbial inoculants; gut microbiomes and human health and modern biology*

ISBN: 978-963-449-285-6

ANALYSIS OF LICHEN BIODIVERSITY IN DIFFERENT AREAS OF HUNGARY

Viktória TÖRÖK, Rebeka SZALÓKI, Ádám MEDVECZKI, Hosam E.A.F. BAYOUMI HAMUDA

*[1]Tomori Pál College, Budapest, Hungary, [2]Institute of Environmental Engineering and Natural Science Department, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Hungary, torok.viktoria94@gmail.com, *E-mail: Bayoumi.hosam@uni-obuda.hu, +36303900813*

In the present study, a comparison between air polluted and non-polluted areas was observed depending on the frequency and distribution of lichens. Comparing our test results, based on OKIR data, it was found that in the area of Tatabánya, and the most serious emission of harmful substances were sulfur oxides (SO_2) and nitrogen oxides (NO_x). It was found few or damaged samples, and even in the area of the new industrial park we did not find any samples at all. On the other hand, we found few, but healthy and abundant lichens in the vicinity of shopping centres and one of the industrial areas (sampling site "A"). Based on the retrieved data, we found that the emissions of SO_2 and NO_x have decreased somewhat over the past 6 years, but are still significant in the given area. In Budapest (e.g., the XXII district) the emission of harmful substances is almost a third of the values in Tatabánya in terms of SO_2, which is surprising given the presence of a significant amount of chemical industry. The emission of NO_x also remains well below the values in Tatabánya. On the other hand, based on the queried data, it was found that over the past 6 years, the emission of SO_2 has increased, while that of NO_x has decreased in the monitored area. We did not find an evaluable lichen sample within the investigated area. In the XIII district harmful substance emissions remain significantly lower compared to the previous test areas, in contrast to this, it was demonstrated that the second highest result in the emission of NO_x. The lichen samples are varied, in one location (sampling location "A") we found damaged and sparse colonies, but in the others we could find particularly rich and large colonies, mainly in the parks and areas along the Danube. In the XX district, the emission of SO_2 in the residential area of the district is extremely low, and that of NO_x is also significantly lower than the previously investigated ones. We observed healthy lichen colonies in the district. SO_2 emissions are not typical in the Várgestes area, and the amount of NO_x is negligible. At the sampling locations, it was found that the lichen colonies are extensive, healthy and grow abundantly. The most dominant lichen species of the investigated areas were: in Tatabánya area: Xanthoria parietina, Physcia ascendens, Hypogymnia physodes, Flavoparmelia caperata, where in Várgesztes area, it was found the following strains: Xanthoria parietina, Physcia ascendens. Buti n Budapest areas such as XIII district, Flavoparmelia caperata, Flavoparmelia caperata, Physcia ascendens, and only Flavoparmelia caperata was found in XX district and no lichens were detected in XXII district. Finally, it was concluded that in the industrial areas, Tatabánya and XXII district has a high level of pollution, which is not healthy for humans and other living beings. In addition, it can also have a negative impact on the ecosystem in terms of development and can also cause the buildings to corrode. The XIII district and XX district is characterized by significantly less air pollution data, and in addition, their environmental conditions can also have a positive effect on them. Thanks to the location next to the Danube, pollutants are cleared from the air in this area more quickly due to the wind. In addition, green zones are also common, where there is a chance for dirt to accumulate. On the other hand, the test sites "C", "D", and "E" are located near park areas and the Danube, where several factors ensure adequate air exchange and purification.

***Keywords**: lichen biodiversity, air pollution, distribution of lichens*

Biography

Prof. Dr. Hosam Bayoumi Hamuda is working at Óbuda University. He is Environmental Microbiologist and Soil Biotechnologist dealing with the interactions between the microbiomes and the environment for increasing soil quality and saving the soil from pollutants in the agriculture. His investigations are on the role of waste management, soil quality, fertility, the crop production and environmental impacts related to the application of organic wastes; measurements soil microbial biomass and enzymatic activities in wastewater sludge amended soils; and roles of engineered metal oxide nanoparticles in biosphere. ***Research Interest****: Waste management; Biotechnology; Protection; Sustainable; PGPR; Microbial inoculants; gut microbiomes and human health and modern biology*

Abstract of the VIth. International Symposium–2022
Theme: "Biosphere & Environmental Safety"

Biosphere and Environmental Safety
VI.th International Symposium-2022

May 5-6, 2022
Óbuda University,
Budapest, Hungary
ISBN: 978-963-449-285-6

EFFICACY OF DISPOSAL WASTEWATER SLUDGE AS "CLEAN" FERTILIZER

Hosam E.A.F. BAYOUMI HAMUDA[1], Fatma H. EL-FALLAH[2], Márta BERECZ[1], András SZEDER[1], András MÉNESI[1], Júlia KASZÁS[1]

*[1]Tomori Pál College, Budapest, Hungary, [2]Institute of Environmental Engineering and Natural Sciences, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Budapest, Hungary, *E-mail: Bayoumi.hosam@uni-obuda.hu, +36303900813*

Extensive areas of irrigated soils are unproductive, due to the accumulation of salts in the soil profile occupied by root systems. It is estimated that about 15% of the total land area of the world has been degraded by salinization and soil erosion, which are among the major causes of desertification. The expected increase in the world's population (~10 billion by 2050) needs food productivity to step up within a few decades. Organic fertilization is highly sustainable when compared to other options to date when taken into consideration as a solution to the highlighted issues. It is possible to use biological soil properties for evaluating the effects of organic matter application on soil characteristics. Different approaches have been suggested to solve these issues of soil destruction. This study focuses on selected organic materials (e.g., different agro-industrial by products, and composts) as effective tools to improve different soil properties of soils. However, further experimental investigations are needed to validate this approach in a wider range of soils, also combining waste recycling with other sustainable agronomic practices. The same amendments could likely be considered for soil remediation in the affected areas due to their high organic matter content. In fact, organic matter has several beneficial effects on agricultural fields, such as the slow release of nutrients, soil structure improvement, and the protection of soils against erosion. Selected studies were focusing on the effects of application of various organic matters (i.e., different organic waste materials, mixture of green waste compost) to two soils. In particular, such effects can be referred to chemical, biological, and physical soil properties. The observed results offer powerful evidence on the potential of organic fertilizers in improving soil properties. Such results showed the improving soil structure, increasing different enzyme activities and soil organic carbon, total nitrogen and extractable phosphorus and Increasing soluble and exchangeable-K^+. Urease activity was increased by more than 150% in the mixed treatment, compared to the control. The incorporation of organic manure into the soil significantly increased soil phosphatase activity and soil respiration rate. 15 $g \cdot kg^{-1}$ of compost significantly improved soil physical-chemical properties, especially C and N contents. Enzyme activities were substantially promoted in presence of both amendments. However, there is no clarity whether organic matter, composts of organic wastes are as plant-friendly as the manure-based composts are believed to be. It is also not clear as to whether the action of green compost as a fertilizer depends on the species of plants being fertilized by it. This raises questions whether green organic composts are beneficial (or harmful) at all application rates or if there is a duality in their action which is a function of their level of application. The study reveals that, in general, organic matter composts of all are highly potent fertilizers.

***Keywords**: organic wastes, clean fertilizers, chemical, biological, physical soil properties*

Biography

Prof. Dr. Hosam Bayoumi Hamuda is working at Óbuda University. He is Environmental Microbiologist and Soil Biotechnologist dealing with the interactions between the microbiomes and the environment for increasing soil quality and saving the soil from pollutants. His investigations are on the role of waste management, soil quality, fertility, the crop production and environmental impacts of organic wastes; soil microbial biomass and enzymatic activities in wastewater sludge amended soils; roles of engineered metal oxide nanoparticles in biosphere. ***Research Interest****: Waste management; Biotechnology; Protection; Sustainable; PGPR; gut microbiomes and human health and modern biology*

ISBN: 978-963-449-285-6

EFFECTS OF DIFFERENT PESTICIDES ON THE ACTIVITY OF SOME ENZYMES IN THE RHIZOSPHERE OF BROWN FOREST SOIL

Ádám GYARMATI, Hosam E.A.F. BAYOUMI HAMUDA

[1]*Tomori Pál College, Budapest, Hungary,* [2]*Institute of Environmental Engineering and Natural Sciences, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Hungary, E-mail:* gyarmati.adam@uni-obuda.hu, **e-mail:* Bayoumi.hosam@uni-obuda.hu, *+36303900813*

Pesticides (herbicides, fungicides, zoocides, etc.) include all substances that reduce the harmful effects, or destroy pests that damage agricultural products or endanger humans in some way. Soil microbiotas produce countless enzymes, some of which can be induced or inhibited by certain chemical substances. Pesticides are made up of active ingredients, carriers and auxiliary substances. During their development, it is necessary to ensure that the active substance, which is the carrier of the biological activity, breaks down into biologically ineffective decomposition products after exerting the desired effect and does not have a harmful effect on the activity of the enzymes. In the present study, the pesticides used are: two herbicides (Ro-neet 6E, vernolat), two fungicides (fundazol 50 WP, Dithane M-45) and two zoocides (rogor L-40, phosphotion). Doses used during the study: (control; 1/2X, X (active ingredient: dose used in field) and 2X) of the active ingredient of each plant protection agent. After four weeks, the treated samples were analyzed in a controlled environment at 28°C and 45% soil moisture. The results showed the effect of different pesticides on the experiment, based on which it can be concluded that the order of toxicity was as follows: Dithane M-45 > vernolate > fundazol 50 WP > phosphotion > Ro-neet 6E > rogor L-40. The use of a double dose reduced the enzyme activity compared to the control. The use of the lowest concentration of pesticides showed a stimulating effect on the activity of the enzymes. Finally, it can be concluded that the used pesticides influenced the biological parameters of the examined brown forest soil in several ways, and these effects change the quality of the soil from different aspects. The plant protection agents used during the test must be chosen in such a way that they do not have a harmful effect on the biological functions of the soil. By analyzing the research, substances that have a positive or neutral effect on the biological functions of the soil can be used in agricultural practice.

Keywords*: pesticides, activity of enzymes, rhizosphere, brown forest soil*

Biography

Prof. Dr. Hosam Bayoumi Hamuda is working at Óbuda University. He is Environmental Microbiologist and Soil Biotechnologist dealing with the interactions between the microbiomes and the environment for increasing soil quality and saving the soil from pollutants in the agriculture. His investigations are on the role of waste management, soil quality, fertility, the crop production and environmental impacts related to the application of organic wastes; measurements soil microbial biomass and enzymatic activities in wastewater sludge amended soils; and roles of engineered metal oxide nanoparticles in biosphere. ***Research Interest****: Waste management; Biotechnology; Protection; Sustainable; PGPR; Microbial inoculants; gut microbiomes and human health and modern biology*

ISBN: 978-963-449-285-6

BIODIVESRSITY AND CONSERVATION

Adebayo Raimot ADEJUMOKE

Department of Biology Education, School of Science Education
Federal College of Education (Technical) Akoka- Yaba, Lagos State, Nigeria
Email: princess64raheemat@gmail.com, Tel: +2347030316062

This paper looked into biodiversity and conservation. The need to achieve substantial and improvement in any country is by integrating biodiversity and creating awareness on conservation into national policy for sustainable economic development and national transformation. The presentation involved meaning of biodiversity, types of biological variety, threat to Biodiversity in Nigeria, meaning of Conservation, groups of conservation, Need or Reasons for Conservation, Methods of conserving wildlife, water, forest, soil, air, mineral resources, Importance or Benefit of Conservation of Natural Resources, Benefits of water resource conservation, Benefits of Forest, soil, air and mineral resources conservation. Ways of ensuring the conservation of Natural Resources, Examples of agencies for conservation, some game reserves in Nigeria Problems and Difficulties Associated with Conservation, Some major challenges to Conservation Practices in Nigeria. Several recommended were made among which is that government should ratify the remaining convention and treaties in biodiversity conservation, the implementation of the millennium development goal with emphasis on poverty reduction which will reverse the degradation of the environment water and sanitation. Also, *government should create more awareness on benefit of conservation, and sponsor teachers on attending seminar , conference and workshop on conservation*

***Keywords**: Biodiversity, conservation*

Biography

Adebayo, Raimot Adejumoke working as lecturer, in Biology Education Department, School of Science Education Federal College of Education (Technical) Akoka-Yaba Lagos State, Nigeria. She has Master of Science in Botany (University of Lagos) and Nigeria Certificate in Education in Integrated Science/Biology (Federal College of Education Technical (Akoka), Yaba-Lagos State. She has attended many seminar, workshop, conferences in order to acquire more skills at both local and international level. Also published some work.

***HER VOLUNTEERING TASK: Her** educational desire for young scholar especially the youth and girl child education. A challenging position that offer me the opportunity to offer valuable contribution to the organization, thrive on imagination and passion. To be a good team player in an organization with either subordination role to effect changing for the development of an organization. Also, enriching my environment through creative thinking and innovative ideas.*

ROLE OF SOIL BIOLOGY IN LIFE: ACHIEVEMENTS AND CHALLENGES

Hosam E.A.F. BAYOUMI HAMUDA[1], Katalin Emese RAB GÁBORNÉ SERESS[2]

[1]Institute of Environmental Engineering and Natural Sciences, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Budapest, Hungary.
[2]CEE Web for Biodiversity, Green Project, Budapest, Hungary, E-mail: Bayoumi.hosam@uni-obuda.hu, E-mail_ ke.seress@gmail.com

Soil plays a vital role in sustaining life on the Earth. It is a non-renewable dynamic natural resource that is essential to life. Soil is a critical component of nearly every ecosystem provides a home for organisms. Soil biota plays an integral role in soil ecosystems by decomposing leaves, downed logs, and animals, and providing the primary nutrient source for vegetation. Soil biota includes both flora (plants) and fauna (animals). Soil flora includes organisms as small as diatoms and algae up to the size of tree roots. An important member of soil flora is mycorrhizae, fungi that form a symbiotic (mutually beneficial) relationship with plant roots. Most plants contain roots infected with mycorrhizal fungi. Mycorrhizae enhance water and nutrient absorption by increasing root surface area and accelerate mineral weathering which releases nutrients to the soil Water movement; water quality, land use, and vegetation productivity all have relationships with soil. Nearly all of the food that humans consume, except for what is harvested from marine environments, is grown in the Earth's soils. Other obvious functions that soils provide humans include fiber for paper and clothing, fuel-wood production, and foundations for roads and buildings. Less obvious functions that soils serve are providing a medium to attenuate pollutants and excess water, groundwater recharge, nutrient cycling, and habitat for microorganisms and biota. Soils have many secondary uses such as ingredients in confectionaries, insecticides, inks, paints, makeup, and medicines; uses of clays range from drilling muds, pottery, and artwork, to providing glossy finishes on various paper products. This study introduces many important soil concepts including development, classification, properties (physical, chemical, and biological), quality, and conservation. A general understanding of soil concepts and these interwoven relationships is essential to making sound land management decisions. Soil acts as the basis of the ecosystem foundation, as soil productivity determines what an ecosystem will look like in terms of the plant and animal life it can support. For example, in forest ecosystems, soils can determine species composition, timber productivity, and wildlife habitat, richness, and diversity. The role soil plays in forests is critical to maintaining water quality and long-term site productivity. In cultivated fields, soil quality plays a significant role in crop productivity since soil nutrients and soil physical properties can directly impact yields Collectively, soil biota carries out enzymatic and physical processes that decompose organic matter, build soil humus, and make nutrients available for plants. Decomposition is one of the most critical roles that soil biotas play in an ecosystem. Without efficient decomposition, organic material would accumulate on the soil surface and nutrients would be bound within the material. Decomposition is initiated immediately when a leaf, twig, or fruit hits the ground.

Keywords: *soil life, soil properties, soil microbiomes, soil biology*

Biography

Prof. Dr. Hosam Bayoumi Hamuda is working at Óbuda University. He is Environmental Microbiologist and Soil Biotechnologist dealing with the interactions between the microbiomes and the environment for increasing soil quality and saving the soil from pollutants. His investigations are on the role of waste management, soil quality, fertility, the crop production and environmental impacts related to the application of organic wastes; measurements soil microbial biomass and enzymatic activities in wastewater sludge amended soils; and roles of engineered metal oxide nanoparticles in biosphere. ***Research Interest****: Waste management; Biotechnology; Protection; Sustainable; PGPR; Microbial inoculants; gut microbiomes and human health and modern biology*

Poster Sessions

ISBN: 978-963-449-285-6

ASSESSMENT OF GROUNDWATER POLLUTION BY HEAVY METALS IN THE INDUSTRIAL ZONE OF SKIKDA

Amina HAFSI[1], Ahsene BOUREFIS[1], Farès KESSASRA[2], Abdellah BOUSHABA

[1]Affiliation Department of Geology and Environment, University les Fréres Mentouri, Constantine 1., [2]Laboratory of Geological Engineering, Team 3 "Geology", University of Jijel, Algeria, Department of Earth and Universe Sciences, University of Jijel, Central Campus, Algeria, [3]Department of Geology, Sidi Mohamed Benabdellah University, Fes, Morocco

Pumped groundwater volumes have been estimated at 52 hm^3 per year with 12hm^3 per year being abstracted from oil installation industry in Skikda city, situated in the north east of Algeria. Large industrial demands of groundwater have caused prejudicial effect on alluvial aquifer through aquifer depletion and moreover by contamination of aquatic ecosystems. An environmental assessment was carried out on water resources collected from boreholes and river, the aim was to assess heavy metal contamination in water close to our industrial area. Indeed, 20 water samples were collected in December 2021, including surface water and groundwater. results reveal that Safsaf river presents an alkaline pH (7.49), a high conductivity which reached 10620 us/cm exceeding the WHO limit fixed at 2500 us/cm , dissolved oxygen reaching up to 5.21 mg/l, and a maximum BOD$_5$ of 140 mg/l, this load exceeded WHO standards fixed at 25 mg/l. cadmium concentrations measured at 1.48mg/l as a maximum load which exceed WHO standards fixed at 0.05 mg/l, zinc concentrations show a large peak of 9.3 mg/l, when WHO standards limits it at 3 mg/l in water and arsenic was measured at 1.05 mg/l, greatly exceeding WHO standards fixed at 0.01mg/l. this high concentration of heavy metals may be of industrial origin, as the river flows through the industrial zone, or anthropic, as Safsaf passes through the entire city of Skikda. On the other hand, groundwater results indicate the presence of cadmium ranged from 0.005 to 5.09 mg/l and largely exceed WHO standards about only 0.003mg/l. high concentration could be due to anthropogenic and industrial discharge. And also the presence of a high concentration of Zn ranged from 0.325 to 7.21 mg/l and largely exceeds WHO standards about only 3 mg/l. and which has practically the same sources of pollution as surface water.

***Keywords**: groundwater, contamination, heavy metal, WHO*

Biography

Amina Hafsi I got my doctorate at the age of 26 years at the university of Mentouri brothers, Constantine 1.I got my master in georesource and environment of the university of Mohamed Saddik Benyahia, Jijel.I am in the field of environment, the transfer of heavy metals between soil and groundwater

ISBN: 978-963-449-285-6

COMPARISON OF DEEP ROOTING OF WILD BOAR ON SOIL PROPERTIES IN THE MÁTRA MOUNTAIN AND THE GÖDÖLLŐ HILLSIDE

Ádám FEHÉR[1], Csaba CENTERI[2*], Pari ALKHASOVA[2], Krisztián KATONA[2]

[1]*Independent Researcher, Apc, Hungary, e-mail: feher.adam.hun@gmail.com, [2]Institute for Wildlife Management and Nature Conservation, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary, e-mail: centeri.csaba@uni-mate.hu, alkhasovapari@gmail.com, katona.krisztian@uni-mate.hu*

Wild boar is known to create deep and shallow rooting in forests and this activity has a continuous disturbing effect on soil. There has been an ongoing discussion whether wild boar rooting can be considered as negative or also positive impact. Our hypotheses were that there are differences in the thickness of the humus-rich horizons between clayey and sandy soils and between rooted and control areas. Two sites were analysed, one in the Mátra Mountains (Apc) and the other in the Gödöllő Hillside (Babat-valley). Five deep rooting were investigated on both sites. The depths of the soil horizons and total soil depths were measured in the ring, in the rooting, and in a nearby control area to show the horizontal and vertical effects of wild boar rooting. We used a generalized linear mixed model to evaluate the thickness of the humus-rich A-horizon in the function of wild boar impact. Site effect and soil texture were additional explanatory variables. The differences between sites (Apc: 46±18 cm; Babat 48±21 cm) and disturbed vs. control plots (rooting: 46±16 cm; ring: 52±23 cm; control: 44±22 cm) were marginal. Therefore, the generalized mixed model has not confirmed any difference between sites, rootings or soil texture. Our preliminary results suggest that wild boar affects soils by local soil redistribution rather than expressing a significant impact on topsoil thickness.

***Keywords**: soil depth, vertical soil change, humus, clayey soils, sandy soils*

Biography

Csaba Centeri is an associate professor at the Dept. of Nature Conservation and Landscape Management at the Szent István Campus of the Hungarian University of Agriculture and Life Sciences in Gödöllő. He has published more than 21 papers in Q1 and Q2 journals and has been serving as a chief editor in the Hungarian Journal of Landscape Ecology, guest editor of special issues in the journal of Water, Sustainability, Forest and Remote Sensing. His main research interest is soil water erosion, soil erosion modelling, land-use change, ecosystem services, soil-plant, soil-wildlife and other soil-zoology interactions, with special emphasis on nature conservation and landscape-related issues.

FORGOTTEN PRESERVERS OF PROTECTED PLANTS: ORCHARD GRASSLANDS IN HUNGARIAN HILLY AREAS

Ákos MALATINSZKY

Department of Nature Conservation and Landscape Management, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary, Malatinszky.Akos@uni-mate.hu, +36-30-566-3869

Among the agricultural areas, orchard grasslands play an important role in the preservation of rare plant and animal species. Besides their conservation value, they are recognized as valuable landscape elements all over Europe (but especially in Central Europe). They are formed by fruit trees, usually belonging to traditional varieties and landraces, sparsely distributed on mowed (or grazed in some places) grassland. The old trees create habitats for bats, birds and saproxylic beetles. Although the grasslands underneath the trees are of secondary origin, their structure and species stock refer to close-to-natural conditions. Thus, besides serving the production of fruits without pesticide use, they host protected botanical values such as Anemone sylvestris, Centaurea triumfettii, Clematis integrifolia, Dianthus collinus, D. deltoides, Epipactis helleborine, Gentiana cruciata, Gymnadenia conopsea, Iris variegata, Lilium martagon, etc. Unfortunately, most of their stands have been abandoned during the past 50 years due to the lack of mowing (caused by lack of livestock, ageing local population, etc.), which caused scrub encroachment. However, those stands that open up without scrub infestation may give home for Aster amellus, Chamaecytisus albus, Orchis purpurea, O. tridentata, O. militaris, O. morio, O. ustulata, Polygala major, Ornithogalum pyramidale, Prunella grandiflora, etc.

***Keywords**: mowing, nature conservation, orchard floor, rare plant species, traditional fruit variety*

Biography

Ákos Malatinszky has completed his PhD at the age of 27 in 2006 from the Environmental Sciences Doctoral School at Szent István University, Hungary (previous MATE). He is habilitated associate professor and leader of the BSc course in nature conservation. He has published more than 70 papers in reputed journals and has been serving as an editorial board member of repute. Research interest: conservation management, adaptation to climate change, environmental education.

RISK ASSESSMENT OF HEAVY METALS IN THE COMPLEX TERMINAL AQUIFER DATA FROM BISKRA, SOUTH-EST ALGERIA

Reghais Azzeddine*, Drouiche Abdelmalek, Zahi Faouzi, Debeiche Taha-Hocine

*Geological Engineering Laboratory (Lgg), University Of Mohamed Seddik Benyahia - Jijel, Algeria, *E-Mail: Selmahadef18000@Gmail.Com, Phone: 0783 085-766, Corresponding Author: a.reghais@univ-Jijel.dz*

Due to its availability in arid regions, groundwater is increasingly used for drinking water supply and irrigation. Unfortunately, human activities such as agriculture have substantially impacted water quality, rendering it unsuitable in some cases. This study aims to evaluate the level of heavy metal contamination in the groundwater of the Terminal Complex in the region of Biskra (south-east Algeria), which is considered a region with a strong agricultural vocation. Six heavy metals (Mn, Fe, Cu, Zn, Cr, and Pb) were analyzed by atomic absorption spectrometry (AAS) in 45 water samples collected in April 2019. The results obtained show the existence of water contamination by lead and chromium, with levels well above the World Health Organization (WHO) standard for respectively 29 and 10 boreholes for each element. As for the other elements, most of the boreholes show levels below the standards. The heavy metal contamination index (HPI) indicates a high risk (average HPI = 550), which means the groundwater is unfit for human consumption. In contrast, the geo-accumulation index (Igeo) of the analyzed elements is in the following order: Pb > Mn > Cu > Zn > Cr > Fe, with an average level below the specified background level, except for Pb. Its average values for all elements analyzed range from -0.79 to 1.47, implying some borings were clean and others moderately contaminated. On the other hand, the Pb Igeo shows that 35.56% of the wells are not polluted, and 2% are highly contaminated. While the Igeo of the other elements (Fe, Cu, Zn, and Cr) oscillates between the uncontaminated and moderately contaminated classes.

***Keywords**: Heavy Metal Pollution Index (HPI), geo-accumulation index (Igeo), Water quality Heavy metal Complex Termail aquifer, Biskra*

Biography

Reghais Azzeddine is currently a fourth-year Ph.D. student in hydrogeology at the Geological Engineering Laboratory (LGG), Department of Earth and Universal Sciences, Faculty of Natural and Life Sciences, Mohamed Seddik Benyahia University - Jijel, Algeria, studying under the supervision of Pr. Debieche T-H.His and Dr. Drouiche Abdelmalek.His doctoral work focused on studying the hydrodynamic and hydrochemical functioning of the aquifer of the Terminal Complex in the Biskra region (South-East Algeria) . He has participated in Two international conferences in hydrogeology and hydrochemistry.

IMPACTS OF MOLE ACTIVITIES ON SOIL PROPERTIES

Csaba CENTERI[1*], Viktória VONA[2], Márton VONA[2], Zsolt BIRÓ[3]

[1]Department of Nature Conservation and Landscape Management, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary, Centeri.Csaba@uni-mate.hu, +36-30-202-7336, [2]Csernozjom Ltd., Nagykörű, Hungary, vona.viktoria@csernozjom.com, vona.marton@csernozjom.com, [3]Department of Wildlife Biology and Management, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary, biro.zsolt@uni-mate.hu*

Biological activity is one of the main actors of soil formation. The purpose of the present paper is to provide information on mole activities on soil properties. The hypothesis is that soil properties in molehills differ from the intact areas, serving as controls nearby these molehills. The question is what we can learn from these molehills in relation to one of the most important issues nowadays: soil organic carbon and its sequestration. The present paper is providing an additional explanatory view on wildlife impacts on soil in natural areas, supporting the former researches on wildboar rootings. The molehills and the nearby, intact, control areas were compared. The areas in question were forests and grasslands. The surface of the molehills and the nearby soils were measured with a Near Infrared Device of Agrocares Ltd. (Nl), measuring soil organic matter, pH, N, P, K, Ca, Al, Fe, clay and soil moisture. The results show that there are measurable differences in some of the soil parameters, e.g. on a forested sampling site the soil organic matter content is higher in the control areas (control 7,1%, molehill 4,9%), phosphorous content is higher in the molehill (32,83 mg/kg in the molehill, 19,96 mg/kg in the control), potentially mineralizable nitrogen content is higher in the control (95,53 g/kg in the molehill and 169,33 g/kg in the control). We can conclude that there are measurable effects of mole activities on the soils' parameters and these differences can further explain soil formation processes and vegetation as well.

***Keywords**: molehill, nutrients, pH, soil formation, wildlife effects*

Biography

Biography: Csaba Centeri is an associate professor at the Dept. of Nature Conservation and Landscape Management at the Szent István Campus of the Hungarian University of Agriculture and Life Sciences in Gödöllő. He has published more than 21 papers in Q1 and Q2 journals and has been serving as a chief editor in the Hungarian Journal of Landscape Ecology, guest editor of special issues in the journal of Water, Sustainability, Forest and Remote Sensing. His main research interest is soil water erosion, soil erosion modelling, land-use change, ecosystem services, soil-plant, soil-wildlife and other soil-zoology interactions, with special emphasis on nature conservation and landscape related issues.

ISBN: 978-963-449-285-6

ASSESSMENT OF SURFACE WATER QUALITY OF THE KEBIR-RHUMEL WADI (NORTH- EAST, ALGERIA)

***Fouzia* HIZIR[1], A. KRIKA[2], F. KESSASRA[1]**

[1]Geological Engineering Laboratory (LGG), University of Mohamed Seddik Benyahia, Jijel, Algeria, [2]Laboratory of Biotechnology, Environment and Health, University of Mohamed SeddikBenyahia, Jijel, Algeria, e-mail: aminajijel18000@gmail.com, Phone: 0790 18 14 56

Water quality is an important factor for health and safety issues associated with public health and also for aquatic life. The Kebir-Rhumel Wadi, one of the longest and most important Wadis in the east of Algeria and indiscriminate discharge of various types of effluents from different industries and domestic sewage entering this wadi leads to heavy pollution, which can produce detrimental effects on water quality, agriculture, and in the long run to human beings. During this study, the spatial variations of physico-chemical parameters of water such as : pH, EC, NO_3, NO_2, NH_4, DCO and DBO_5, were investigated to assess their effects on health of this aquatic ecosystem influenced by anthropogenic activities. Results show that there are significant variations of physico-chemical parameters of water among the sampling sites and the levels of all investigated parameters were above the limits specified by relevant regulation, except for pH, EC and NO_3, which were in accordance with the limits decreed by Algerian standard. The values of DCO/DBO_5 ratio ranged between 3.61 and 34.85 indicates a predominance of non-biodegradable organic matter, reflecting the influence of the wastewater discharges (industrial and agricultural) rejected directly, without prior treatment into the wadi

***Keywords**: Algeria, Kebir-Rhumelwadi, physico-chemical parameters, water quality.*

Biography

Hizir Fouzia is currently PhD student in hydrogeology at the Geological Engineering Laboratory (LGG), Department of Earth and Universal Sciences, Faculty of Natural and Life Sciences, Mohamed Seddik Benyahia University - Jijel (Algeria). My thesis topic is titled "Spatial and temporal characterization of water and sediments of the Kébir-Rhumel Wadi facing pollution problems" under the supervision of Dr. Krika A and Dr. Kessasra F.

ISBN: 978-963-449-285-6

CHANGES IN WET AND DRY HABITATS IN THE IPOLY VALLEY

Ildikó TURCSÁNYI-JÁRDI*, Eszter S.-FALUSI, Atilla FŰRÉSZ, Gergely PÁPAY, Gergő Péter KOVÁCS, Károly PENKSZA

Institute of Crop Production, Hungarian University of Agriculture and Life Sciences (MATE), Gödöllő, Hungary

Ipoly River in Hungary is slightly used by water management therefore it is prominent site in Europe that is formed variable habitats. The precipitation trend changed in the last few years. The General Habitat Category protocol was used for the habitat mapping, furthermore based on the Sentinel-2A satellite imagines were made vegetation indexes (NDVI, GNDVI) and different water indexes (NDWI, MNDWI) in for 5 years. The habitat mapping and the results of the satellite were compared and evaluation was the multivariate statistical method. The habitat categories separated well from each other, in the grass vegetations were significant different. The anthropogenic and the Phragmites australis dominant vegetation showed negative NDVI value. The actual vegetation activities showed better quality with the GNDVI. Note: The research was supported by the FEKUTSTRAT 2018 project and the OTKA K125423 application. SUPPORTED BY THE ÚNKP-21-4 NEW NATIONAL EXCELLENCE PROGRAM OF THE MINISTRY FOR INNOVATION AND TECHNOLOGY FROM THE SOURCE OF THE NATIONAL RESEARCH, DEVELOPMENT AND INNOVATION FUND.

***Keywords**: Sentinel-2A satellite, habitat mapping*

Biography

Ildikó T.-Járdi has working on her PhD thesis from Szent István University from School of Environmental Science, Gödöllő, Hungary. She has published more than 10 papers in journals. She is working on currently involved in the managament and conservation of domestic grasslands.

Abstract of the VIth.
International Symposium–2022
Theme: "Biosphere & Environmental Safety"

Biosphere and Environmental Safety
VI.th International Symposium-2022

May 5-6, 2022
Óbuda University,
Budapest, Hungary
ISBN: 978-963-449-285-6

THE EFFECT OF DIFFERENT LAND-USES ON SOIL ORGANIC MATTER CONTENT IN THE ZSELIC REGION, HUNGARY

Malihe MASOUDI[1], Csaba CENTERI[1], Gergely JAKAB[2,3], Zsolt BIRÓ[1], Lyndre NEL[1], Eszter KOVÁCS[1], Viola PROHASZKA[4]

[1]Institute for Wildlife Management and Nature Conservation, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary, e-mail: Masoudim65@gmail.com, centeri.csaba@uni-mate.hu, lyndrenel@gmail.com, kovacs.eszter@uni-mate.hu, [2]Geographical Institute, Research Centre for Astronomy and Earth Sciences, Budapest, Hungary, e-mail: jakab.gergely@csfk.org, [3]Institute of Geography and Earth Sciences, ELTE Eötvös Loránd University, Budapest, Hungary, [4]Doctoral School of Landscape Architecture and Landscape Ecology, Hungarian University of Agricultural and Life Sciences, Gödöllő, Hungary, e-mail: prohaszka.viola@gmail.com

There is a broad agreement that land-use change is a major driving force for soil organic carbon, thorough altering soil carbon turnovers, decomposition, and soil erosion. However, detailed land use dynamics on soil organic carbon remains an active research field. This study investigated the impact of different land-uses, including garden, orchard, forest, meadow/grassland, on soil organic matter content in the 0–30 cm layer. Our study is done in an area named Zselic in the south part of Hungary. 61 soil samples were analysed in a Hungarian accredited laboratory. The carbon determination is based on the Walkley-Black method. According to measured organic matter percentage, land use of forest showed the highest value (3.09%), followed by garden (2.64%), orchard and grassland (2.46-2.46 %), respectively. Based on the results, there were significant differences between the soil organic matter content of the different land uses (p=0.045). One-way ANOVA (Duncan range test) showed a significant difference between forest-orchard and forest-meadow/grassland, while the garden has an overlapping category between the two groups of grassland and forest.

***Keywords**: forest, orchard, grassland, garden, humus*

Biography

Malihe Masoudi has been a Ph.D. candidate with Stipendium Hungaricum scholarship in Environmental Sciences at the Institute for Wildlife Management and Nature Conservation, Hungarian University of Agriculture and Life Sciences in Hungary, since 2019. During the last 2 years, she has published papers in different journals and conferences, including 4 articles in ISI and national journals and around 9 articles in various conferences. She got her BSc and MSc in Environmental science, focusing on land use evaluation and planning using novel models. Currently, her research interests are studying land-use change and its effect on soil organic matter composition using remote sensing.

ISBN: 978-963-449-285-6

MODELLING AN ATMOSPHERIC DISPERSION OF METHANE AND HYDROGEN SULFIDE ORIGINATIG FROM LANDFILLS

Drakulovic VESNA*, Marko JOVANOV, Una MARCETA, Bogdana VUJIC

Technical faculty "Mihajlo Pupin" Zrenjanin, University of Novi Sad, Serbia e-mail: vesna.drakulovic2@gmail.com

This study was carried out to estimate methane and hydrogen sulfide emission from Zrenjanin's waste landfill, dispersion of these gases in the atmosphere, and their impact on the nearby population. Mathematical model used in this study, LandGem 3.02, requires data regarding the size and the duration of use of landfills, volume of deposited waste, etc. Simulation of dispersion and determination of concentration levels in specific vulnerable sites was performed using ADMS URBAN dispersion software. The results show that, in selected scenarios, methane (24,1 mg/dm3) and hydrogen sulfide (0.38 mg/dm3) concentrations are highest at the landfill site, while modeled concentrations based on meteorological conditions with predominant winds for the selected period indicate no significant impact on the neighboring population.

***Keywords**: landfill, emission, atmospheric modelling, methane, hydrogen sulfide*

Biography

ISBN: 978-963-449-285-6

NEXUS BETWEEN FOREIGN DIRECT INVESTMENT AND ECONOMIC GROWTH IN OIL EXPORTING COUNTRIES OF CIS

Dina MALGAZHDAROVA

Management and Organization Sciences/Hungarian University of Agricultures and Life Sciences, Kaposvar, Hungary, dina.malgazhdarova@gmail.com, +36205187845

In the current article, the impact of foreign direct investments (FDI) on economic growth in large oil exporter countries of CIS is analyzed. Meanwhile, for the purposes of the study, open statistical databases of the World Bank, the United Nations Conference, statistical agencies of the considered group of countries for the period 1991-2020 were used. According to the intensity of FDI in the oil and gas industries of the studied CIS countries their vital importance for economic growth was confirmed, at the same time denoting the dependence of some of the countries under consideration on this type of FDI. It was also noted that the COVID-19 pandemic having negatively affected the economy of the whole world, led to a sharp drop in investment activity in the CIS countries.

Keywords: *Foreign direct investments, FDI, CIS, oil exporters*

Biography

Dina Malgazhdarova has completed her Master's degree in Economic studies at the age of 30 in 2013 from the University of Quebec in Montreal (Canada) and currently is a PhD student of Hungarian University of Agricultures and Life Sciences. She is also a Lead Consultant of the Agency for Defense and Development of Competition of the Republic of Kazakhstan under President of the Republic of Kazakhstan, also has a work experience in local Investment policy division being responsible for communication with international bodies and enforcement of Investment climate in Kazakhstan. She has published 15 papers in reputed local journals as well as participated in publication of the textbook (namely the part that touched the questions of environmental and economic sustainability) for students of Military Institute of Radioelectronics and Communication in Almaty city of Kazakhstan. Has a strong interest in studying and promoting the environmental sustainability as well as finding the ways to raise the efficiency of State bodies in her motherland.

ISBN: 978-963-449-285-6

LIFE CYCLE ASSESSMENT OF RICE-PULSE PRODUCTION SYSTEM IN CAUVERY DELTAIC REGION OF TAMIL NADU, INDIA

P. SENTHILVALAVAN[1]., M.V. SRIRAMACHANDRASEKHARAN[1], R. MANIVANNAN[1], C. RAVIKUMAR[2]

[1]*Department of Soil Science and Agricultural Chemistry*
[2]*Department of Agronomy, Faculty of Agriculture, Annamalai University*
Annamalainagar, Tamilnadu, India
*Corresponding Author Email: senvalavan_m2002@yahoo.co.in

In this study, a life cycle assessment (LCA) method was used to examine the environmental impact of the rice pulse production system (RPPS) in Cauvery Deltaic Region (CDR), Tamil Nadu, India. The LCA considered the entire system required to produce 1 t of rice and 1 quintal of the pulse. The analysis included resource utilization and greenhouse gases emissions (GHGEs) under two different rice cultivation methods followed by a residual pulse crop. The result shows the significance of environmental impacts, followed by eutrophication, water depletion, global warming, and energy depletion. As such, reducing nitrogen (N) fertilizer intensity and increasing utilization efficiency are the key points to control the life cycle environmental impacts of rice and its fallow crops, which would decrease resource consumption and emissions in the upstream production stages. Streamlinig water management, particularly in the early growth stage, and reduction of rice field water discharge are also significant measures with which to minimize nitrogen and phosphorus runoff losses and control eutrophication and GHGEs so as to reduce life cycle environmental impacts of the rice-based cropping system.

Keywords: Eutrophication, Global warming, Greenhouse gases, Life cycle assessment, Rice-pulse

Biography

Dr. P. Senthilvalavan is an Assistant Professor in Department of Soil Science and Agricultural Chemistry, Faculty of Agriculture, Annamalai University, Tamilnadu, India. Twenty two years of research and 15 years of teaching experience. Published more than 90 papers in reputed journals attended and presented 85 research papers in national and international conferences and has been serving as editorial board member/reviewer of reputed Journals. Worked with radio-isotopes like ^{137}Cs, ^{131}I, ^{60}Co, ^{90}Sr related to phyto-extraction and transfer co-efficiency in different crops. Certain projects completed funded by IPNI, TENMA. Presently, working with Soil fertility & Biology, Soil-Water Pollution and Conservation, Nano fertilizers, Biochar, Carbon management, and Problem Soils (N, P & Zn nutrition).

ISBN: 978-963-449-285-6

SOIL-DEPENDENT IMPORTANCE OF SYMBIOTIC INTERACTIONS WITH THREE COVER CROPS

Sundoss KABALAN*, Katalin JUHOS, Nándor PRETTL, Priyo Adi NUGROHO, Borbála BIRÓ

Doctor's School of Horticulture, Hungarian University of Agriculture and Life Sciences (MATE), Budapest, Hungary, e-mails: kabasuzana@gmail.com; biro.borbala@gmail.com

Soil health views soil as a finite, non-renewable, and dynamic living resource and is a comprehensive concept that addresses the management and optimization of chemical, physical, and biological processes in soil that are critical to long-term productivity and environmental quality. Soil health refers to the observation that soil quality affects human and animal health through the quality of the crop. The use of cover crops are beneficial to soil quality; protects the soil from erosion, reduces weeds, maintains nitrogen cycling, and promotes the growth of nitrogen- and phosphorus-producing and/or solubilizing bacteria. Our examinations were carried out in pot experiments at MATE Buda Campus, in a heated greenhouse. The pot experiment was designed with three types of cover crops species (Brassica carinata, B.c.; Vicia faba, V.f.; Avena strigosa, A.s.) and two mixtures of (1: ray, wetch, pease), (2: oat, bean, mustard), placed in three different soils sandy soil (arenosol), loamy soil (chernozem) and luvisoil in plastic pots in 4 repetitions. We measured: the biological activity of the soil, which is the first step to healthy soils; soil salinity, and electrical conductivity (EC). Our results showed that bean and the mixture of all cover crops increased EC compared to the other cover crops. The growth of symbionts, such as arbuscular mycorrhizal (AM) fungi, can be promoted by growing cover crops. AM fungi can form a variety of interactions with different plants. The frequency of mycorrhizal infection was determined (F%). Bean as a double symbiont has the highest mycorrhizal activity and mustard as a non-symbiont has 0%. The percentage of mycorrhiza was good in all crops except the mustard, as non-symbiont. Oat responds positively to inoculation with AM fungi at all used soil types. The double symbiont crop of Vicia faba was less dependent on soils due to the presence of natural symbionts. Symbiosis is suggested to be considered at cover crop application.

Keywords: *soil health, cover crops, mycorrhiza symbiosis, sustainable agriculture*

Biography

Sundoss Kabalan Ph.D. student at MATE University completed a master's degree in Plant Biotechnology from Szent István University of Gödöllő in 2017 and a bachelor's degree in agricultural engineering in the section of soil and water management from Tishreen University (TU) in Latakia, Syria. Worked as an assistant young teacher at TU, besides working as a sales engineer at Bedar Ltd company, Preparing and delivering technical presentations that explain products or services to customers, helping in researching and developing new products. Participated in many courses like Sustainable Agricultural Land Management by the University of Florida and DNA Decoded and have published 3 papers. Worked at Computacenter company for 9 months in accounting payable position and presently at INNIO company as a part-time job in billing team in Budapest. Her Ph.D. is part of the Symbioses research, supervised by Prof. em. B. BIRÓ at Doctors' School of Horticulture (MATE University).

ISBN: 978-963-449-285-6

IMPACT OF FLOODS ON SOIL MICROBIAL BIOMASS AND ACTIVITY AT A FLOODPLAIN CONTAMINATED BY FORMER METAL MINING

Tibor SZILI-KOVÁCS*, Tünde TAKÁCS

Department of Soil Biology, Institute for Soil Sciences, Centre for Agricultural Research, Budapest, Hungary Szili-Kovács T., e-mail: szili-kovacs.tibor@atk.hu

Mining and metal industry are the main sources of soil contamination by adverse metals causing environmental risk to human health and ecosystem. River floodplains near to metal mines or industrial centers are frequently flooded with heavy metal containing sediment that may exhibit toxic effects towards soil biota. The objectives were to study a metal contaminated site if there are differences in soil microbial properties; and if there are significant relationships between soil biological and chemical properties. The study site was located near Gyöngyösoroszi village at the floodplain of the river which were contaminated by heavy metals. Soil samples were taken from willow and maize plantation. Soil basal respiration, substrate-induced respiration, soil microbial biomass carbon (MBC) and acid phosphatase activities were measured together with soil chemical properties. As, Pb, Zn, Cu, Cd and Ca content in soil was significantly higher at polluted, while phosphorus and potassium was significantly higher at unpolluted site. The substrate-induced respiration was in positive correlation with MBC and negative correlation with respiration quotient (qCO_2). MBC was in positive correlation with plasticity index and phosphorus, while negative correlation with total salt and Cd, Pb, Zn, As, and Cu content. Acid phosphomonoesterase activity was in negative correlation with plant available phosphorus content, and with MBC, while positive correlation with toxic elements (Cd, Pb, Zn, As, and Cu). A strong positive correlation was found between qCO_2 and toxic element content, showing that the respiration quotient is a sensitive indicator for metal pollution at floodplain soil.

***Keywords**: heavy metal, lead zinc mine, pollution gradient, microbial activity, phosphatase activity, soil respiration*

Biography

T. Szili-Kovács has completes his PhD at the age of 30 years from the University of Eötvös Loránd. He is working at the Institute for Soil Sciences, Centre of Agricultural Research, Hungary, head of department of Soil Biology. He has published 85 papers in reputed journals. Research interest is soil microbiology and carbon and nitrogen dynamics in soils.

ISBN: 978-963-449-285-6

PROMOTING PHYTOREMEDIATION BY ARBUSCULAR MYCORRHIZAL FUNGI

Tünde TAKÁCS *, Anna FÜZY

Department of Soil Biology, Institute for Soil Sciences, Centre for Agricultural Research, Budapest, Hungary Takács T., e-mail: takacs.tunde@atk.hu

Phytoremediation techniques are environmental-friendly methods for biological restoration. A small-plot field experiment was set up to examine the applicability of metal-tolerant arbuscular mycorrhizal fungi inoculants to improve the efficiency of phytostabilisation technologies. The experiments were performed on a field belonging to the Tatai Környezetvédelmi Zrt. (Environment Protection Company in Tata) using three different soil cover systems that were set up on the surface of red mud. The experiments were aimed at comparing the covering technique currently employed with possible alternative solutions. The vegetation was planted in four types of cover forming a 1 m layer on top of the red mud: I. compost, soil composite in a homogeneous order of layers; II. humified sewage sludge in a heterogeneous order of layers; III. soil cover (III/A without lignite and III/B with lignite). To test their effect maiden grass (Miscanthus sinensis 'Gracillimus') were planted with or without inoculation with selected AM fungi. There were no differences found in the element concentrations between the shoot of plants grown in plots I and II, while lower concentrations were recorded at plots III/A and III/B. The lignite had little influence on the plant element contents. Due to the substantial differences in toxic element content in the soils, the effect of AMF inoculation on element uptake exhibited different tendencies for each plot depending on the quantity and quality of the element in concern. The inoculation with selected AM fungi could be an efficient integrated technique for use on soils with high contents of toxic metals.

***Keywords**: heavy metal, phytostabilization, arbuscular mycorrhizal fungi, red mud, maiden grass*

Biography

Tünde Takács (PhD) started to research arbuscular mycorrhizal fungi (AMF) in 1994 at Faculty of Sciences of Eötvös Loránd University. She is working at Department of Soil Biology in Institute for Soil Sciences, Centre of Agricultural Research. She is the head of the plant-microbes interaction research group. The most important areas of her research are AMF spore isolation and strain production, infective and effective strain selection; AMF role in plant stress tolerance and soil health and services. She has published 70 papers in reputed journals.

MANUSCRIPTS OF ORAL PRESENTATIONS

Article submitted to the Proceedings Book of the VIth. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

HYGIEN AND SANITATION PROBLEMATIC IN PRIMARY SCHOOL OF ALLADA COMMUNE IN BENIN REPUBLIC (WEST AFRICA)

Léocadie ODOULAMI*, Grégoire A. BEWA

Pierre PAGNEY Laboratory, Climate, Water, Ecosystem and Development
LACEEDE/DGAT/FASHS/ University of Abomey-Calavi (UAC), 03BP:1122 Cotonou
2DGAT/FLASH/University of Parakou (UP), Republic of Benin (East Africa West);
leocadieo@yahoo.com

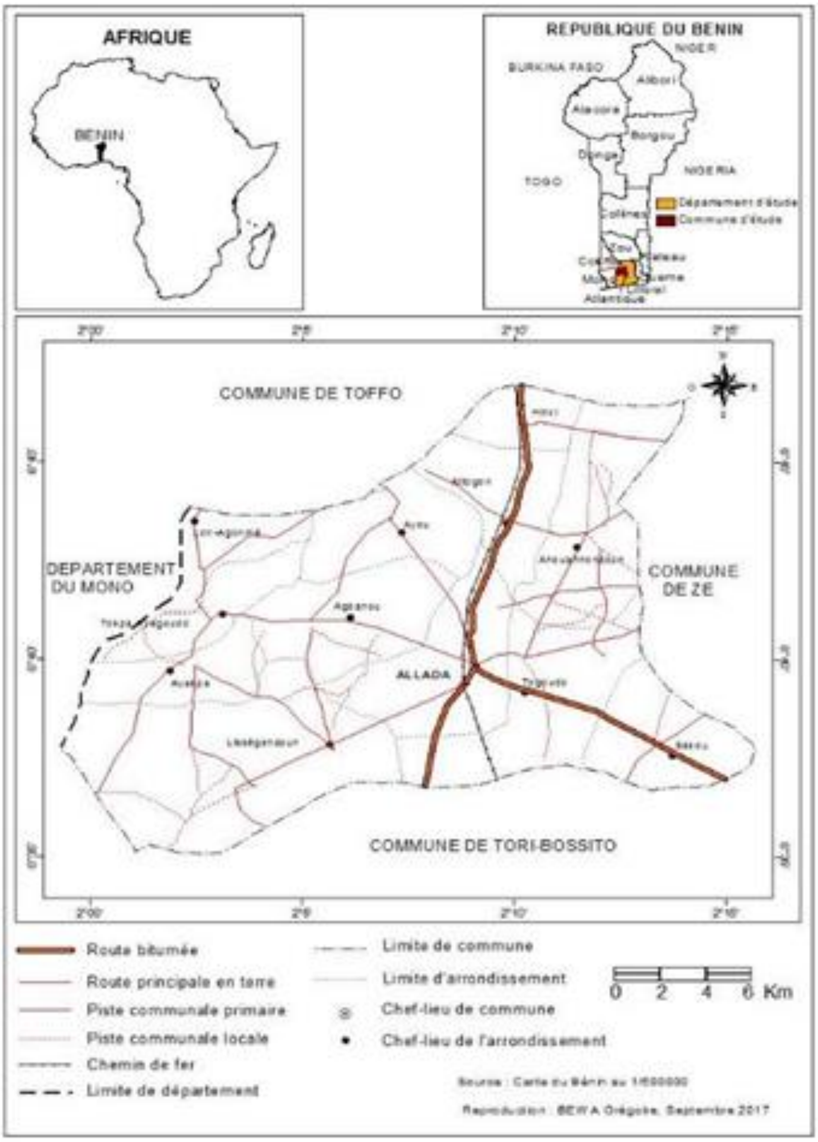
The insufficiency of hygiene and sanitation in the Allada commune particularly influence the health of schoolchildren. This research analyzed the effects of the precariousness of the basic hygiene and sanitation practices on the health of schoolchildren in this commune. For this research, 600 schoolchildren were selected by random cluster survey to observe their hygiene practices and especially to measure the prevalence of helminthiasis. Data were collected through documentary research, questionnaire surveys, observation and microbiological analyses of stool collected from schoolchildren. Statistical analyses were performed using Epi Info version 7 software. The analysis shows that diseases linked to poor hygiene and sanitation are acted severely in the Allada commune and affect the health of schoolchildren. In fact, cases of gastrointestinal disorders were found in 51.80% of these schoolchildren. The parasites identified are mainly protozoa, responsible for gastroenteritis diseases. Faced with this result, which gives rise to concerns, it is important for the communal and government authorities to provide the commune's schools with adequate sanitary infrastructure, to train educators in good hygiene and sanitation practices and to implement place school clubs for the promotion of hygiene and sanitation in order to reduce the vulnerability of the population of Allada commune.

Keywords*: Allada commune, Benin Republic (West Africa), Hygiene, sanitation, schoolchildren health*

INTRODUCTION

Most countries in the world are confronted with practices that do not comply with hygiene and sanitation standards. This represents a threat to human health. To remedy this situation, international (United Nations institutions) and national organizations are seeking to improve these hygiene and sanitation practices in order to secure global public health. Benin, like other nations, has made commitments that will be realized (Vissin *et al.*, 2012; Vigninou et al, 2012; G-EMERGENCY SARL, 2018). But approaches such as Community Led Total Sanitation (CLTS), Hygiene and Sanitation Promotion (HSP), Information, Education and Communication for Behavior Change (IEC/BC) and Sanitation Marketing are used especially in the North where 80% of the population practice opens defecation for lack of toilets. This has led the population to adopt hand washing techniques, preservation of drinking water quality, maintenance of the living environment,... Thus, 1315 localities have reached the status of End of Open Air Defecation (FDAL) and 600 localities are waiting for their pre-certification (MCDIPAPHYR, 2018). However, the entire country is not covered to limit infections related to uncleanliness due to the precariousness of household incomes that have difficult access to socio-sanitary structures in some localities of the country (Yadouléton, 2015). This is the source of vulnerability of some social strata in particular that of schoolchildren in the commune of Allada (Bêwa, 2018). Indeed, dubious hygiene and sanitation practices are observed among

schoolchildren in the commune of Allada who are the subject of this research. To do so, materials and methods are used to arrive at the results and discussion.
Located between 6°36' and 6°47' north latitude and between 1°58' and 2°15' east longitude, the commune of Allada is bordered to the north by the commune of Toffo, to the south by the commune of Tori-Bossito, to the east by the commune of Zè and to the west by the communes of Kpomassè and Bopa. It covers 85 villages and city districts spread over twelve (12) arrondissements (Map 1).



Map 1. Geographic location of the commune of Allada

MATERIALS AND METHODS

The study was conducted from March 2 to April 31, 2018. It is based on surveys conducted in schools and households and observation of hygiene practices of schoolchildren aged 6 to 13 years. The criteria of personal hygiene namely washing fruits before consumption, hand washing before meals and walking barefoot were observed. This phase was completed by sampling and analysis of the schoolchildren's stools in the laboratory. This target was chosen because the consequences of poor hygiene and inadequate sanitation primarily affect children. Cluster random sampling was adopted. The sample size was determined using Schwartz's formula:

n = sample size

E = confidence level derived from the confidence rate (1.96 for 95 %)
P = estimated prevalence of intestinal parasitosis among children in Benin (20%) (EDSB, 2011-2012)
I = Desired precision: 5 %.
Fc = Cluster effect correction factor = 2
A relative risk equal to 1.96 was chosen, i.e., a reduced variance equal to 1.96, a precision of 0.05 and a cluster effect correction factor equal to 2.
n = 491

In accordance with the number of samples accepted in this type of sampling, which should be greater than or equal to 30 clusters, the choice of clusters retained is 30. After dividing the sample size by the total number of clusters allowed, a total of about 16 students rounded up to 20 was obtained. Thus, the sample of schoolchildren in the community consists of 30 clusters of 20 students each. By multiplying the 20 students by the 30 clusters, we obtained a total of 600 students for the survey.

- Selection of survey schools
30 PPEs (clusters) were identified by random sampling out of 64 PPEs according to SNV BENIN / DNSP (2012)

- Selection of classes and students
The CE2 class was identified in the 30 PPEs because the majority of schoolchildren in this class are in the 6 to 13 age group. This age group was chosen as a criterion for selecting the schoolchildren, taking into account statistics from the school district of the commune of Allada (SNV BENIN/DNSP, 2012), which mention that the majority of schoolchildren in these classes are in this age group.
Each EPP is made up of 3 pedagogical groups of one CE2 class each. The three classes in each PPE were then enrolled in the survey process. A total of 90 third-grade classes were surveyed, with 20 students randomly assigned to each group. In total, 600 third-grade students were selected in the commune.
Also, the stools of the pupils were collected in a tube (transparent and hermetically sealed jar with a small spoon for collection) given to each pupil the day before the stool collection. The next morning, the tubes containing the stools were collected and sent directly to the hospital in Allada for analysis in the laboratory. This operation was repeated three times, with a two-day interval between each sample taken from each schoolchild surveyed. This frequency is justified because according to Ogouyèmi-Hounto et al, (2016), a single sampling is not sufficient to report on parasitic infestation. Subsequently, a direct microscopic examination or parasitology in physiological water and a concentration technique according to the Willis method were done on these collected stools.

- Direct examination
The stools are examined at 37°C immediately after their arrival in the laboratory in order to avoid the fragmentation of certain parasites which live naturally in the intestinal lumen and which disappear sometime after their emission. A fraction of each stool is homogenized with a drop of NaCl solution and mounted between slide and coverslip, then examined under a microscope at 240 or 400× magnification (objective 40×, eyepiece 6 or 10×). Liquid stools do not require this conditioning. This preparation must be transparent to facilitate reading the characters of a common printed text. The addition of lugol to this prepared solution highlights the cysts. Indeed, lugol stains the membranes, cytoplasmic and nuclear structures of the cysts and allows the identification of morphological characteristics.

- Willis concentration technique
This technique is relatively simple and increases the sensitivity of the search for cysts or eggs. It consists of mixing the stool with a concentrated solution of high density salt that promotes the floating of parasite eggs. This technique allows the collection of eggs on the surface.
The procedure consists of placing a piece of stool the size of a peanut seed in a "Peni" bottle, to which Willis' solution is added at a quarter of the bottle. The contents are then mixed with an applicator. The same solution is added again to fill the bottle. This vial is then slowly covered with a slide in order to avoid air bubbles.

The device is left to rest for 10 minutes; then the slide, carefully impregnated with a drop of the mixture, is carefully removed. It is then placed on a slide and examined immediately under the microscope to prevent the solution from drying out. Data and information collected were entered and processed in Epi Info version (7) software and others encoded in Excel 7 spread sheet and Word was used for text support. Descriptive statistics were used in the analysis of these processed data and information. The 95% confidence intervals were used in the estimation of the hygiene and sanitation indicators. Pearson's chi-square test and Ficher's exact test were used in the association between two categorical variables at the 5% level.

RESULTS AND DISCUSSION

The results are organized into two main areas:
- the hygiene practices of school children in the commune of Allada, and
- the effects of basic hygiene and sanitation practices on the health of these school children.

Hygiene of schoolchildren in the commune of Allada

Several factors determine the hygiene of schoolchildren in the commune of Allada in Benin. These include personal hygiene and the hygiene and sanitation of habitats.

Personal hygiene of schoolchildren

In the schools of the commune of Allada, personal hygiene is practiced differently by schoolchildren depending on their needs. Only 28 percent of students wash fruit before eating it, compared with 72 percent who do.
The high percentage of those who do not wash fruits before tasting them shows the deficit of hygiene education in schools. This is dangerous for the health of these school children.
In the same way, the washing of the hands after the emission of the stools, is not done by all the schoolboys. It is practiced randomly depending on where the need arises (Figure 1).

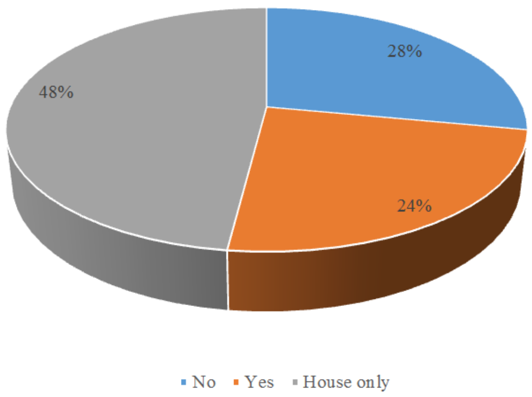


Figure 1. Hand washing after bowel movements of school children in Allada.
Source: Fieldwork, G.A. BEWA, November 2016

Figure 1 presents the places where hand washing is practiced or not practiced after bowel movements. It shows that 290 schoolchildren or 48% of schoolchildren practice handwashing after stools at home against 166 or 28% who do not do so at all. Only 144 students or 24% do so at school. The lack of handwashing among schoolchildren can be explained by the inadequacy of handwashing facilities and latrines in some schools and homes in the commune of Allada.
The number of schoolchildren who wash their hands after bowel movements at home indicates that these homes have toilets and handwashing facilities. Indeed, only 37.2% of householders have a latrine (G.A. Bêwa, 2018). This paltry rate in toilets does not facilitate the education of schoolchildren in the commune of Allada in personal hygiene. Also, the commune's drinking water service rate, which was only 37.1% (MEEM, 2017), also limits access to water and, by extension, handwashing

for schoolchildren. Indeed, only 39.59% of households have a high economic level compared to 14.04% low economic level households (G.A. Bêwa, 2018).
This socioeconomic disparity also makes it difficult to supply handwashing soap. This makes it difficult to observe proper hygiene. It is therefore necessary that schools are equipped with toilets and handwashing devices with soap sufficient to meet the needs of schoolchildren. Also, the maintenance of these facilities must be done regularly to interest the users who are mostly school children. This would be accompanied by continuous education of school children. Similarly, hand washing before meals, an indicator of personal hygiene, is observed among schoolchildren in the commune of Allada (Figure 2).

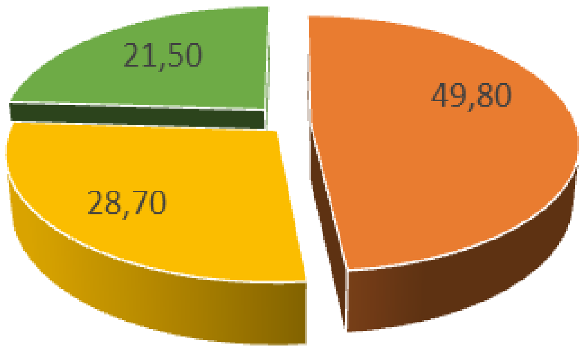


Figure 2. Handwashing before meals
Source**:** Fieldwork, G. A. BEWA, November 2016

Figure 2 presents the personal hygiene practices of school children. It shows that these practices are diversified depending on the location. Only 21.50% wash their hands and have a handwashing device at home. This facilitates their education in hygiene and sanitation techniques. Those who do it at school only are 28.70%. They can be considered as conformists to the personal hygiene education received at school. But, the largest one, 49.80%, seems to be uneducated in personal hygiene.
The IEC (Information, Education and Communication) approach should be used sufficiently to change these behaviors that are dangerous to their health. Indeed, handwashing decreases the number of deaths from infectious diseases in children (Vigninou et al., 2012). Schmidt et al (2009), in studying the determinants of handwashing practices, noted that out of a total of 5182 respondents in Kenya in 2009, only 25% practiced handwashing after bowel movements.
According to these authors, there is a strong relationship between socioeconomic status and handwashing. This finding is echoed by Sohounon (2017), who emphasizes the importance of having clean water at home for good household hygiene; also, Yalcin et al. (2004) conducted a study in 7 schools in Konya, Turkey in 2004 proving that 42.4% of respondents wash their hands before meals. This rate, higher than those who do so in the commune of Allada, is attributed to the presence of water and soap in some schools. Thus, water and soap are essential for good hygiene practice. This refers to the expenses that households will face if the socio-economic conditions allow it. The other indicator of personal hygiene and sanitation also observed among school children is walking barefoot.
It was found that 149 school children protect their feet with shoes before walking.
This means that these schoolchildren were informed of the dangers they would face if they did not protect their feet. In contrast, 451 students do not protect their feet. This large number of students proves that they are not sufficiently informed about the risks of walking barefoot. This includes the transcutaneous transmission of worms in the form of larvae found on the ground, such as anguillus and hookworms. It is necessary that school children are sufficiently informed about the health risks associated with walking barefoot. It is also important for understanding these behaviors to observe the hygiene and sanitation of the schoolchildren's homes.

Hygiene and sanitation in the home
A house requires basic facilities such as clean water, an adequate toilet and general hygiene. These criteria are used to classify the homes in the commune of Allada (Table 1).

Table 1. Results of surveys on household hygiene in the municipality of Allada

Variables	Absolute frequency	Percentage	IC 95%
Existence of home latrines			
No	378	63,00%	[59,00 - 66,90]
Yes	222	37,00%	[33,10 - 41,00]
Total	**600**	**100,00%**	**-**
Household water source			
Improved	417	69,50%	[65,60 - 73,10]
Unimproved	183	30,50%	[26,90 - 34,40]
Total	600	100,00%	-
General hygiene of the house			
Not satisfactory	335	55,90%	[51,80 - 59,90]
Satisfactory	264	44,10%	[40,10 - 48,20]
Total	**599**	**100,00%**	**-**

Source**:** Fieldwork, November, 2016

Table 2. Stool infections in schoolchildren in the commune of Allada

Variables	Absolute frequency	Percentage	IC 95%
Result of the stool analysis			
No	289	48,20%	[44,10 - 52,20]
Yes	311	51,80%	[47,80 - 55,90]
Total	600	100%	
Deworming			
less than 3 months	167	27,80%	[24,30 - 31,60]
more than 3 months	433	72,20%	[68,40 - 75,70]
Total	600	100%	
Type of parasites identified			
Ascaris lumbricoides	86	14,30%	[11,70 - 17,50]
Endolimax nana	7	1,20%	[0,50 - 2,50]
entamoeba coli	126	21,00%	[17,90 - 24,50]
Entamoeba histolytica	33	5,50%	[3,90 - 7,70]
Giardia intestinalis	59	9,80%	[7,60 - 12,60]
Negative	311	51,80%	[47,80 - 55,90]
Total	600	100%	
Digestive protozoa and helminths			
Amibes	166	27,70%	[24,20 - 31,50]
Flagellés	59	9,80%	[7,60 - 12,60]
Helminths	86	14,30%	[11,70 - 17,50]
Negative	289	48,20%	[44,10 - 52,20]
Total	600	100%	

Source**:** fieldwork, G.A. BEWA, November 2016.

On the other hand, compared to other studies conducted in Africa, this prevalence of 51.80 % is lower than that reported in the region of Kisangani in the Democratic Congo, whose rate is 62 % (Nimo Ngbabo, 2008). The latter value reflects poor hygiene, which favours infestation by ingestion of soiled food. The relatively high rate revealed in the schools of the commune of Allada can be explained by the poor hygiene and sanitation conditions of schoolchildren. Indeed, the high frequency of germs and parasites observed is related to the lack of regular deworming (Table 3).

Table 3. Stool examination results by deworming practice

	Results of the stool analysis		
	Negative	*Positive*	*Total*
Deworming			
No	177	256	433
Yes	112	55	167
Total	289	311	600

chi-square unadjusted and p=0.001, difference is significant
Source**:** Surveys, G.A. Bêwa, November 2016

Between stool examination and deworming practice, it appears that there is a link because out of a total of 167 subjects dewormed in the last three months prior to the surveys, only 55 have pathogenic germs and parasites and the proportion of dewormed subjects with a negative result is 112. Of 433 subjects not dewormed during this period, 256 had parasites in the stool. Therefore, deworming contributes to lowering the viral load in individuals.

CONCLUSION

Poor hygiene and sanitation practices have adverse effects on the health of the population, especially school children in the commune of Allada in Benin. Indeed, many of them are not used to washing their hands regularly after bowel movements or before meals and many walk barefoot. In addition, public and household hygiene and sanitation infrastructures remain insufficient for good hygiene and sanitation practices. This results in parasitic diseases that especially affect the health of school children. It is essential that the communal and governmental authorities, with the participation of the population, equip the commune of Allada with suitable hygiene and sanitation infrastructures and that the IEC (Information, Education and Communication) approach be used intensively for the appropriation of hygiene and sanitation techniques in the commune of Allada, in particular in schools and in Benin. Personal hygiene, which is generally neglected by schoolchildren and which has not been taken into account here, would be the subject of scientific research.

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ARTS AND NATURE: THE CONTRIBUTION OF ARTISTS TO UNDERSTANDING OF THE WORLD AND THE DEVELOPMENT OF NATURAL SCIENCES

Edit CSANÁK

Product Design Institute, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Budapest, Hungary, csanak.edit@rkk.uni-obuda.hu

This paper summarises the results based on the hypothesis that art had real and tangible merit in shaping man's more profound relationship with nature to understand the natural environment better. The paper summarises the basic facts gathered in the early stages of the research. It presents some illustrated examples of some artists and outstanding products of their creative careers that justify this assumption. ***Method****: Key method of the investigation was gathering information from the available literature.* ***Results****: The paper's main result is a unique topic; the facts carefully collected from the available sources are organised chronologically. The report summarises the basic facts gathered in the early stages of the research. It presents some illustrated examples of some artists and outstanding products of their creative careers that justify this assumption.* ***Conclusion****: The objective of this study was to review the available literature on the contribution of art to a better understanding of the world and its unique biosphere, to accurately map the extensive scientific interest in art and the lasting and irreplaceable work added to its development. Contrary to expectations, significantly less scientific research and writing were discovered in the study's first phase. However, the results so far also seem to support the hypothesis that there are verifiable facts and sources with which artists have contributed to scientific discoveries and a better understanding of the world. The author intends to continue the research.*

Keywords*: art history, scientific discoveries, environmental art, botanic art, human anatomy, medicine*

THE ROOTS OF ART IN THE REPRESENTATION OF THE NATURE

The earliest examples of artistic representations of the natural world historically recognised and respected within art societies are the Paleolithic Cave paintings of our ancestors, which depicted animals and human figures and other aspects of nature that are important to them. [2] Figure 1: (Left) Cave Paintings in Santillana del Mar, Cave of Altamira, Cantabria, Spain, c. 36,000 years ago: Bison, (right) Lascaux Cave Painting, France, Upper Palaeolithic. Figure 2: Cave paintings in the Chauvet Cave 30,000 to 32,000 years ago (Left) Group of rhinoceros (right) Cave hyena

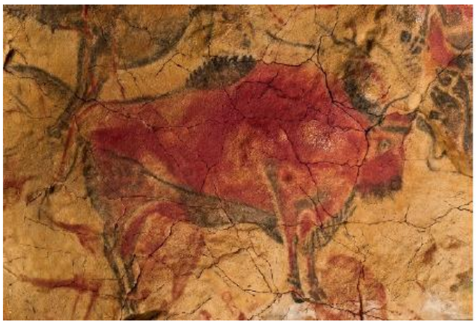

Figure 1. (Left) Cave Paintings in Santillana del Mar, Cave of Altamira, Cantabria, Spain, c. 36,000 years ago: Bison, (right) Lascaux Cave Painting, France, Upper Palaeolithic

Figure 2. Cave paintings in the Chauvet Cave 30,000 to 32,000 years ago (Left) Group of rhinoceros (right) Cave hyena

Early examples include the 'landscape frescoes' from the ancient Roman period. For example, the fresco in Painted Garden on which a lush garden full of numerous flowering plants, shrubs and trees was carefully represented. Plant species carefully depicted include oleanders, pomegranates, laurel, apples, palms, strawberries, myrtles, acanthus plants, umbrella pine, oak, red fir, quince, pomegranate, laurel, holm oak, boxwood, cypress and ivy, as well as roses, poppies, chrysanthemum, chamomile, fern, violet, and iris.
Numerous birds are perched on the trees, while others fly high in the blue sky along with the upper band. (Figure 3) [3]

INTEREST IN NATURE IN THE CENTURIES OF ART

The natural world has always inspired artists, both in the background and in the central focus, and its beauty gives it an ever-present sense of awe weaving through the centuries.

Figure 3. Painted Garden in the Villa of Livia Drusilla, (detail) Prima Porta, fresco, 30-20 B.C.

The Uomo Universale: Relationship of the Renaissance Man with the Nature

The European High Renaissance artists celebrated the harmony of nature in their artworks and searched to reiterate its balance. The cultural movement of Humanism, which weaved through the period, led artists to return to classical Roman and Greek philosophies about the Universal Man (Uomo Universale) and his place in the world.
Renaissance humanism blurs the line between art and science. Artists such as *Leonardo da Vinci*, *Michelangelo*, *Raphael* and architect *Donato Bramante* are undoubtedly the most remarkable legends of

the era, exemplifying the term ‘renaissance’ man by being proficient and mastered in several subjects and interests – especially in understanding the laws of nature.
Leonardo da Vinci, widely considered one of the greatest painters of all time, was the first prime exemplar of a "Renaissance man" – a person immersed in the comprehension and accomplishment of varied interests, represents that moment when the artist and the scientist became interdependent. His specific personal interests led to his mastery of multiple fields.
The use of *sfumato* on the Mona Lisa creates a sense of soft calmness and infuses the background landscape with a profound realism (Figure 4, left). But Leonardo’s natural science work and engineering studies are as impressive and innovative as his artistic work. One of Leonardo's works from his first Florentine period (1472–c. 1482) is a 1473 pen-and-ink study drawing *“Arno Valley Landscape”,* made in 1473. This study is essential because,
According to Vasari, the young Leonardo was the first to suggest making the Arno river a navigable channel between Florence and Pisa. [4] The purpose of making the *“Plan of Imola”* was to build a dam from the sea to Florence to provide a water supply to maintain the canal in all seasons.

Figure 4. (Left) Leonardo da Vinci: The Mona Lisa (*La Gioconda*), 1503. Louvre, Paris

Along with his groundbreaking and priceless research work on human anatomy. (Figure 5, right), Leonardo studied horses and wrote a treatise on horse anatomy. (Figure 5, left)

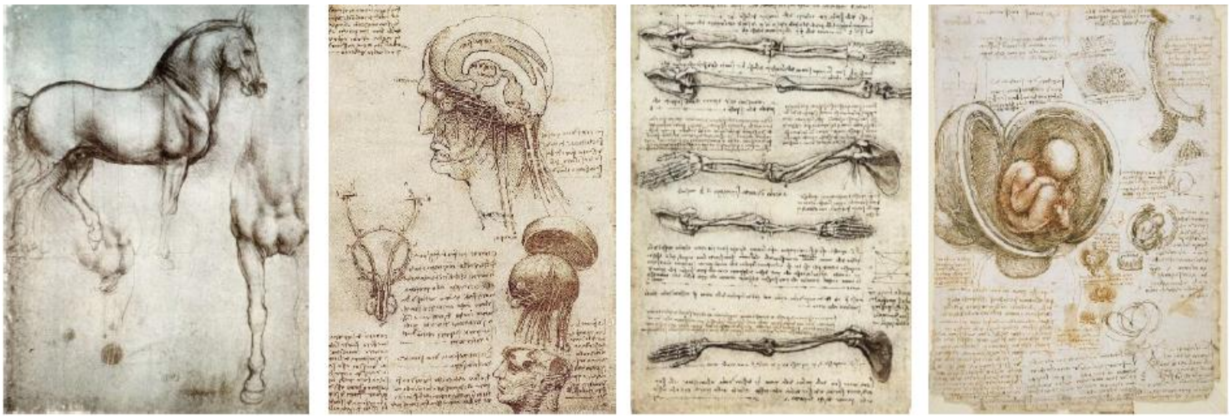

Figure 5. (Left) Leonardo da Vinci: study in silverpoint for The Horse, c. 1488, 1503. Louvre, Paris

Pharmacology, as an enhancer of scientific approach and realism of the artistic depictions
On the properties of herbs, the doctors used the meticulously and thoroughly compiled book *De Materia Medica*, published by Dioscorides in 77 B.C. It was copied and redrawn for fifteen hundred years until the 16th century, supplemented by poetic inserts and notes in different languages. With the beginning of the Renaissance, the book of Dioscorides did not lose its relevance. Still, the world changed drastically: Gutenberg invented the printing press. New continents and islands appeared on the Map of The World, along with the different plants and herbs that have unexpectedly proved to be a solution for the diseases.

The first authors of botanical illustrations were artists. Nearly every second page of Leonardo da Vinci and Albrecht Dürer's albums contained botanical sketches. The renaissance artists created their depictions by cognitive following the reality.
Leonardo was the first scientific illustrator who considered drawing a kind of visual thinking. *"Nature fascinated Leonardo as a mechanism and as an organism. (...) He made and accepted only those statements that he could prove through his eyes."* As a result, *"degree of likeness to reality never before received."* [8] Leonardo, the scientist, used his drawing skills to help him to see.

Figure 6. (Left) Leonardo da Vinci: Star of Bethlehem and other plants, 1505 and 1507. Royal Library, Windsor Castle, London; (middle) Botanical study, c. 1490; (right) Codex Atlanticus, c. 1478-1519

During the first decade of the sixteenth century, *Albrecht Dürer* (1471-1528) depicted plants in all his artworks with a new note of botanical correctness. In the age when the plant world was introduced to exotic oriental bulbs, and botany, as a subordinate discipline of science, broke away from medicine, he made several studies of the botanic and animal world. His watercolour painting entitled *The Great Piece of Turf* (Figure 7, left) depicts the plants precisely as sawn growing in the field. His observations would have a lasting influence on the interpretation of flowers in art well into the seventeenth century.

Figure 7. Albrecht Dürer: (Left) The Great Piece of Turf, 1503, Albertina, Vienna; (middle) Celandine, 1526; (right) Tuft of Cowslips, 1526, National Gallery of Art, Washington

Herbal art of the 16th-18th century

German herbalist and artist *Leonhart Fuchs* (1501-1566), with the publication of *The New Herbal* (1542), also became a noted and vital author, which took Fuchs over 30 years to be completed. He claimed: *"There is nothing in this life pleasanter and more delightful than to wander over woods, mountains, plains, garlanded and adorned with flowers and plants of various sorts, and most elegant to boot, and to gaze intently on them."*

Figure 8. (Images from left to right) Portrait of Leonard Fuchs; The botanical artists involved in creating images for the Great Herbal, History of Science Collections, University of Oklahoma Libraries; Mandragora (Mandrake) plant from 'De Historia"; Leonhart Fuchs: Lilium bulbiferum, 1543

In the 17th century, artists such as botanical and natural history artist *Maria Sibylla Merian* (1647-1717), Italian artist *Giovanna Garzoni (1600 – 1670)* and French artist *Nicolas Robert* (1614-1685), the number of recognised botanical artists emerged.

Figure 9. (Left) Two apples with a Gypsy Moth (crop) by Maria Sibylla Merian; (middle) Giovanna Garzoni: Plate with White Beans, ca. 1650–1662, Galleria Paletina, Florence; (right) Georg Ehret: Drawing of a Cedar

The 18th century was a period of excavation that brought the popularity of botanical illustration. Among them was the art of *Georg Dionysius Ehret* (1708-1770), one of the most influential botanical artists of all time and a prodigious artist. They produced many high-quality illustrations for various botanical publications and plant collectors to be highlighted. (Figure 9, right).
Other botanic artists of the period: *Franz Bauer* (1758 - 1840), the British *Elizabeth Blackwell* (1707 – 1758), Australian artists *Sydney Parkinson* (1745 - 1771) and *Ferdinand Bauer* (1760 - 1826), French artists *Pierre-Joseph Redouté* (1759 - 1840), *Claude Aubriet* (1665-1742) and ***Pierre Jean François Turpin (1775 – 1840),*** *Mary Delany* (1700-1788), and many more. [9]

Featured botanical art and natural illustration in Hungary
Vera Csapody (1890-1985) was a Hungarian botanist, author, and botanical illustrator known for studying and painting the flora of Hungary with Sándor Jávorka. Her over 11,000 illustrations held by the Hungarian Natural History Museum are among the most precious treasures of the Herbarium. Her watercolours are of high artistic and scientific value. (Figure 10) [10]
Other important botanical artists are *Gizella Gyurkó*, biologist, botanical illustrator, and botanical illustrator *Erika Urai* and *Magdolna Csépe* (Figure 11), whose work is also high quality and significant. [11] [12] [13]

Figure 10. Vera Csapody: Botanical illustrations for book Flowers of Forests and Fields, 1958 [14]

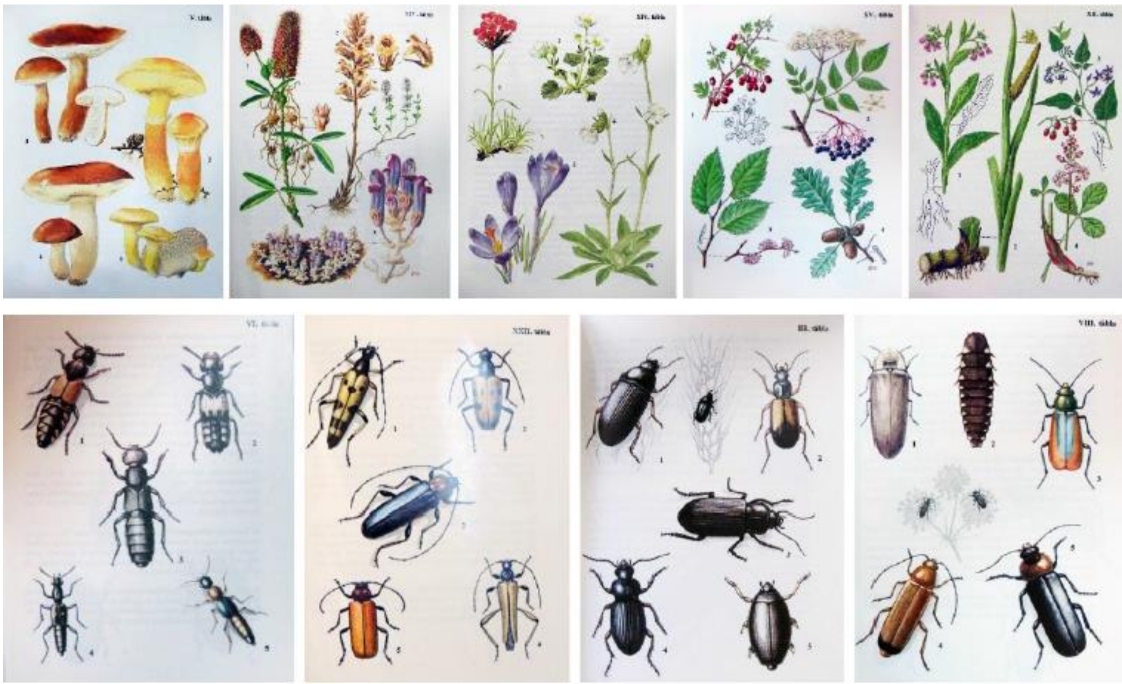

Figure 11. (top row) Botanical illustrations of Gizella Gyurkó; (bottom row) Insect illustrations of Erika Urai

Study of nature and atmospheric events: The Landscape Paintings of the 17th-19th century
The classical painter *Nicolas Poussin* (1594-1665) produced an essential painting in art history. He is notably the inventor of the "ideal landscape" where man is intimately linked to nature, portrayed

majestically and gloriously. In the 18th century Rococo period's romantic and poetic idealistic artworks depicting the beauty of the countryside landscapes, a great movement started toward the idealised representation of the beautifulness of nature.
The inhomogeneity of space on Earth manifests in the different intensities of landscapes, the complexity of places, the unevenness of terrain, vegetation and climate. (Figure 12, left) Rococo painter *Jean-Honoré Fragonard* (1732-1806) depicts nature as an idyllic setting.

Figure 12. (Left) Nicolas Poussin: Le printemps, 1660-64; (right) Jean-Honoré Fragonard: The Swing, 1767. Wallace Collection, London

English naturalist painter *John Constable* (1776-1837), best known for his natural landscapes and images that idealise living in connection with the land and nature, revolutionised landscape painting in the 19th century—moving away from the highly idealised landscapes to realistic depictions of the natural world created through close observation. English painters *John Constable* and *J.M.W. Turner*, German painter *Caspar David Friedric*h and the American *Thomas Cole* held a more grounded appreciation for the natural world and our human dependence upon its atmosphere and sheer power. In addition to the conditions perceived as constant, they perceive landscape as beautiful or majestic, depending on the weather, lighting, and atmosphere composition. They are concerned with capturing rare constellations and unusual interplay of atmosphere, water, and light, which man sees only once in his life. [15] Constable is most clearly remembered for his landscape oil paintings, famous for capturing the effects of fundamental change on the countryside. He was fascinated by changing patterns of clouds, weather and light. He sought to capture these moments in his artworks with large, loose brushstrokes that allowed him to create expressive depictions. (Figure 13)

Constable deepened his scientific knowledge of the weather by reading booklets published by meteorologists *Luke Howard* and *Thomas Forster*. [16] In collaboration with Howard, experiments with new aesthetic forms in response to the climate's challenges to representation were done. Efforts to stably depict England's climate are shaped in parallel with the polluted atmosphere of industrial, imperial London and the disciplining visuals of the modern state.

John Constable's fascination with weather and its ability to change a landscape greatly influenced his scientific approach to painting cloud formati. It was an open space with a vast expanse of sky. Constable upgraded his artwork by painting in the same place at different times of the day or in various weather conditions; he would be returned on numerous occasions to his favoured location. He quickly sketched the same landscape to demonstrate differing states' dramatic effects on light and colour. [17]
Constable's artistic practice highly influenced the art of his age. Painters from the French Barbizon School strove to represent real life in and amongst nature; the picture shown on Figure 14, left, was shown in an exhibition held in Paris in 1867 and was dedicated to *Théodore Rousseau* (1812-1867), a French painter of the Barbizon school.

Figure 14. (Left) Théodore Rousseau: A Morning in Early Summer in the Forest of Fontainebleau, 1861; (right) William Turner: Dutch Boats in a Gale, 1801, National Gallery, London

English Romantic painter *William Turner* (1775-1851) was known for his expressive colourisation of imaginative landscapes. Violent marine paintings have been campaigned by the leading English art critics, such as John Ruskin. (Figure 14, right)

Ideology, art and environmental consciousness of John Ruskin
The great Victorian writer, philosopher, artist and art critic of the Victorian era, *John Ruskin*, whose ideas shaped British attitudes to culture and nature in the 19th century, believed all beauty comes from the heart; the loveliest piece of art has its roots in the natural world. Ruskin argued that all architectural ornament should represent nature, and it is ugly, terrible and immoral to have an example of anything but nature. (Figure 15)
Ruskin is considered the first artist who paid attention to climate change and became an artist on the front line of global climate change; the aquarelle study he created was based on some of the first known alpine photographs taken by the nineteenth century's esteemed art critic. Using the early daguerreotype process, he captured more than forty views of Switzerland between 1849 and 1858. Even Ruskin feared that photography would negatively impact art; he appreciated its practical function. (Figure 16, left)

Figure 15. (Left) Portrait of John Ruskin, 1863; (middle) Study of a Kingfisher, 1871, Ashmolean Museum, Oxford; (right) Watercolor study of plants

His followers, such as Sir Richard Owen, founder of the Natural History Museum in London, believed that nature is God's work, making him a fierce opponent of Darwin. Artists began worshipping the greatness and beauty of nature, believing that humans should remain connected to it.
In the painting visible in Figure 16, left, Swedish painter Elias Martin wants to depict the power and beauty of nature. The rugged terrain forces the trees to grow in irregular patches of land and branch off in different directions. The height of the mountains reinforces the immense strength that nature has over man.

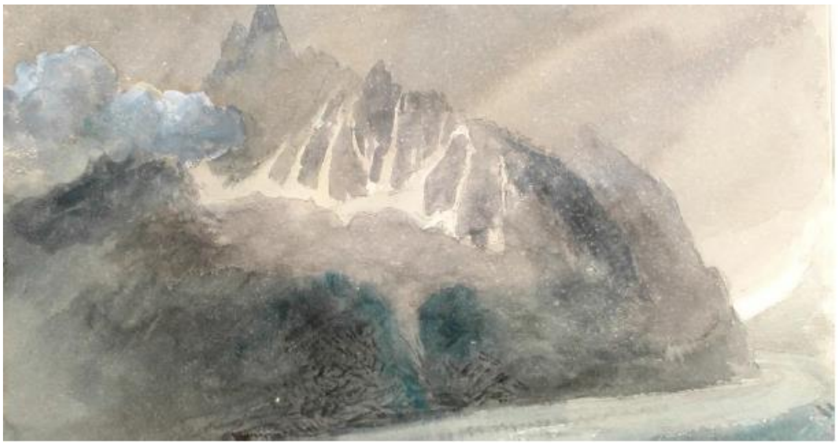

Figure 16. (Left) John Ruskin: Mer de Glace-Moonlight, 1863, Alpine Club Photo Library, London; (right) Elias Martin: Romantic Landscape with Spruce, 1768/1780, Nationalmuseum Sweden

The 19th-20th century art movements' contribution to understanding the nature

The nineteenth-century artists had great faith in the world of nature. In the 19th century, Impressionists (Claude Monet, Vincent Van Gogh, Pierre-Auguste Renoir, Edouard Manet, and Claude Monet) were challenged to capture snapshots of a moment. The *Plein air paintings* notably captured the artists' relationship with his immediate surroundings and the environment. The art was obsessed with the air and light, and one key goal was to understand momentary visual stimuli reaching the retina. (Figure 17)

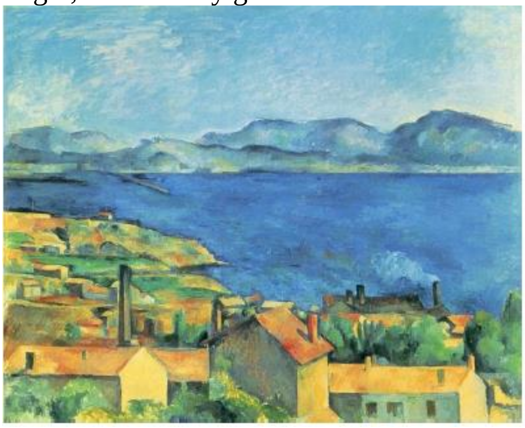

Figure 17. Paul Cézanne: L'Estque, (right): The Sea at L'Estaque, 1876, The national gallery, London

Art Nouveau artists went to nature as a significant source of inspiration and were often careful botany students. The French artist *Emile Gallé* (1846-194) studied natural science at the Lycée Imperial in Nancy. As an assistant to his father, he made floral designs and emblems for faience and glass. He became an accomplished botanist and wrote scientific articles on horticulture. He collected plants from

the region and made numerous drawings of plants, flowers, animals and insects, which became the main subjects of his art. (Figure 18).
Grasset realised the applications of plant study for the new 38 ornament, and Obrist started his career as a natural scientist. Ernst Haeckel, the German biologist and explorer who

Figure 18. Emile Gallé: (Left) Designs of two vases by Gallé, 1885, Musée d'Orsay; (right); Begonia rose flower cup, 1894, Musee d'Ecole de Nancy

ENVIRONMENTAL ART: DRAWING ATTENTION TO THE PROTECTION OF THE NATURAL ENVIRONMENT

Environmental art – also known as Ecological art, is a range of artistic practices encompassing the historical approach to nature in art and recent ecologically and politically motivated works. *Agnes Denes* (Dénes Ágnes), a Hungarian-born American conceptual artist, is one of the best-known Environmental artists, producing work that pushes the boundaries of art into disciplines such as activism. One of her most famous artwork is "Wheatfield - A Confrontation" (Fig 19, left), consisting of two acres of wheat planted and harvested in Manhattan's financial district, Battery Park landfill, downtown Manhattan, the year 1982. A masterpiece by British artist *Andy Goldsworthy* reverses the English agricultural tradition of building stone walls to demarcate areas. Its wall embraces and protects the trees instead of marking the space required by a man where they could otherwise be destroyed. (Figure 19, right)

Figure 19. (Left) Agnes Denes: Wheatfield - A Confrontation, 1982; (right) Andy Goldsworthy: Storm King Wall, 1997-98

Nature as a Work of Art

Today's anticultural civilisation has become alien to nature. Contemporary artworks from all around the world draw attention to the continuous connection between man and his environment. Art is looking to research the signs of life-giving nature in the world. Art explores the characters of life-giving nature in the world, and artists want to indicate that it is a living quality. So artists see the resource in their depiction of nature and want to draw attention to its rehabilitation and the need for healing. Artists draw attention to the rights of nature and the need for wildlife to survive; they indicate that it is a living quality as ancient as natural art is, and culture is given its name as a significant branch of the fine arts. Artis is related to the physical and environmental art that carries the work alone while also being open to other ideas. From the point of view of philosophy, the sciences meet the problems of cultures and the environment. In our age of hyper-technologies, we are fundamentally part of nature and the ecosystem. In *Yolanda Gutiérrez*'s (Mexico) artwork, the branch's shadow is significant because *"whatever has a shadow is alive"* – the shadow supports the living. *Ferenc Varg*a's artwork draws attention to the beauty of the trees and pays attention to them. [18]

Figure 20. (Left) Yolanda Gutiérrez: Prayer, 2016; (right) Ferenc Varga: Hundred thousand of leaves 2016

CONCLUSIONS

The objective of this study was to review the available literature on the contribution of art to a better understanding of the world and its unique biosphere to accurately map the extensive scientific interest in art and the lasting and irreplaceable work added to its development. Less scientific research and writing were discovered in the first phase of the investigation. However, the results so far also seem to support the hypothesis that there are verifiable facts and sources with which artists have contributed to scientific discoveries and a better understanding of the world. The author intends to continue the research.

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Article submitted to the Proceedings Book of the VIth. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

THE AGRICULTURAL PRODUCTION CONCERNING SUBSIDIES IN HUNGARY IN PERIOD OF 2008-2020

Sándor J. ZSARNÓCZAI,

National University of Public Service, Faculty of State Scientific and International Studies, Kálmán Széll State Finance Research Workshop, H-1083 Budapest, Ludovika tér 2.
Óbuda University, Rejtő Sándor Faculty of Light Industry and Environmental Engineering Institute of Environmental Engineering and Natural Sciences, Doberdó u. 6, H-1034 Budapest, Hungary, e-mail: zsarnoczai@yahoo.co.uk

Study focuses on influences of subsidies on agricultural production, as plant production, animal husbandry, output growing trend, and input growing trend and agricultural gross value added. Price conditions for input and producing price, as output price from agricultural producers paid by purchasers, manufacturing industries, whole traders, retailer traders or possible farmers sell their products directly on local markets – can create considerable influences on economic and marketing background for agricultural production including output growing, agricultural gross value added, gross fixed asset accumulation all. Subsidies accompanying with self-financial capacity of agricultural producers and credits financed by banks create basic financial issues for the agricultural basic material production conditions of producers. Plan production has share as 59-60% of all agricultural production and animal husbandry has share as 33-35%. The case-study uses statistical analyses as Special Program for Social Sciences. There is an import role of gross fixed asset accumulation all without recoverable value added taxes for agricultural production, because this has very strong correlations with gross value added by 0.941 and output growth by 0.934 and input growth by 0.803, also this one has strong correlation with producing price by 0.732. Subsidies should be provided for agricultural producers in order to obtain enough incomes to realize continuous basic agricultural production process, to develop advanced technology for their competitiveness on the markets and finally not to escape from the agricultural sector in order to ensure the supplying food for domestic consumers. Naturally subsidies cannot substitute self-financing capital force of producers.

Keywords: *Gross fixed asset, gross value added, innovation, input, output, producing price*

INTRODUCTION

In Hungary the agricultural production has been consisting of mostly plan production, which is proofed by its considerable share as 59-60% of all agricultural production as agricultural output and animal husbandry by its share as 33-35% and the other rest part was for agricultural and non-agricultural services for the researched period of 2008 and 2020 (Table 1; Table 2; HCSO 2021).
The plant production can be considerable for the Hungarian geographical conditions, providing the basic food-supply for consumers and feeding animals to obtain more value-added products over simple plant production as basic one. Both of plant production and animal husbandry are important to supply food demands of domestic market, to increase raw materials for the food manufacturing and light industries and the export capacity for obtaining more heavy currencies price incomes for the Hungarian economy. All of these conditions provide goal for this research. Also, the study focuses on the influences of the subsidies on the agricultural production, as plant production (Plant1), animal husbandry (Animal2), the output growing trend (OUTPUTG3), and input growing trend (INPUTG4) and agricultural gross value added (GVA7), on the basic price (OUTPUT-INPUT = GVA in agricultural sector).

The price conditions for input (INPUTPrice5) and producing price, as output price (PRODPrice6) from farmer and agricultural producers paid by purchasers even as manufacturing industries, whole traders, retailer traders or possible farmers sell their products directly on the local markets (PRODPrice6) – can create considerable influences on the economic and marketing background for agricultural production including output growing, agricultural gross value added, g*ross fixed asset accumulation all (GFAAcc9) without recoverable VAT = value added tax. The subsidies (Subsidies8) accompanying with self-financial capacity of agricultural producers and credits financed by banks create basic financial issues for the agricultural basic material production conditions of producers (Figure-1; Figure-2; HCSO 2021).*

Subsidies for holdings concerning Hungarian fiscal practice, which developed from it, built on the application of non-conventional instruments of active government regulation and fundamentally based on the Fundamental Law (Hungary's constitution) adopted in 2011, particularly its chapter on Public Finances and the cardinal laws pertaining to public finances (see more detailed in Lentner, 2020 and Lentner 2021).

In spite that conditions for providing subsidies are very strong and depending on the demands for agricultural production strategy at national economic level and production goals at level of farms and agricultural producers, these are very favourable financial situations for producers considered in the agricultural sector. The financial supports for producers focus on the developing gross fixed asset accumulation, and by these one to develop basic agricultural production in main two branches as plant production and animal husbandry by purchasing more advanced machines, improving soil conditions setting up new building for animals and stores for seeds, cereals, also, highly developed equipment for renewing irrigation system. Also, additionally to above mentioned supported fields sometimes the supports can provide for advanced plant and animal varieties, which can be used for many times of agricultural production, which can improve the agricultural technology for the production in this sector. This case study makes clear the correlations among these economic variables mentioned before, by showing out the importance of subsidies for developing agricultural production and its technology to strengthen the competitiveness of national agricultural producers either in domestic market, single EU common market and international markets accompanying with the following the sustainable agricultural development and environmental conservation from point of view of the agricultural sector.

The *hypotheses* can be summarised, which are as follows:

1- Animal husbandry (Animal2) has strong contradicted correlations with plant production (Plant1).
2- Strong influences and correlations of producing price level (PRODPrice6) on the agricultural branches in cases of plant production (Plant1) and animal husbandry (Animal2).
3- Influences of *subsides* (Subsidies8) from public finance on agricultural branches in order to increase investment gross fixed asset accumulation all (GFAAcc9), gross value added (GVA7) and output growth (OUTPUTG3).
4- The *gross fixed asset accumulation all* (GFAAcc9) has strong correlations with gross value added (GVA7) based on the output growth (OUTPUTG3) and input growth (INPUTG4) increasing.

Budgeting is the main tool supporting the management of an *innovative project* being realized by the presented enterprise. Body One of the priorities defined by the European Union Commission in the Europa 2020 strategy is *intelligent development* meaning economic development that is based on knowledge and innovation (Dyhdalewicz 2018; see in detailed in OECD 2015; and Veugelers - Del Rey 2014).

MATERIALS AND METHODS

The case-study uses statistical analyse as SPSS (Special Program for Social Sciences) based on the work of Sajtos-Mitev (2007). The very strong correlations are among economic variables, where the values are more than 0.800 till closed level of 1.000, and the strong correlation are between 0.500 and 0.800. From these value conditions the *subsidies (Subsidies8) have strong correlations* with g*ross fixed asset accumulation all (*GFAAcc9) *without recoverable VAT by 0.675 and* with gross value added (GVA=7) by 0.638 and with output growth (OUTPUTG3) by 0.583. From these conditions it can clearly be seen, how importance of the subsidies is for the agricultural production (see Table 2; Table 3; HCSO 2021).

STATISTICAL ANALYSIS AND GRAPHICAL PRESENTATION

The role of subsidies has more important than which the SPSS statistical analyse can show and emphasize in this study. Amount of subsidies measure comparably to volume of the gross value added (OUTPU-INPUT = GVA) was 45% in 2008 and increased to level of 40% as share of GVA in 2020.
Some economic variables have very strong correlations among themselves; producing price (PRODPrice6) has very strong correlations with input growth (INPUTG4) by 0,992 values, strong correlation with output growth (OUTPUTG3) by 0.737 and with plant production (Plant1) by 0.727.
The gross value added (GVA7) has very strong correlations with output growth (OUTPUTG3) by 0.989, input growth (INPUTG4) by 0,841 and strong correlations with producing price (PRODPrice6) by 0.783 and with plant production (Plant1) by 0.727.

Table 1. Abbreviation of economic variables

Variables Abbreviation	Variable names	Period	Source/Data base
Plant1	Share of plant and horticultural production in %	2008-2020	HCSO, 2021
Animal2	Share of animal production in %	2008-2020	HCSO, 2021
OUTPUTG3	Agricultural output growth	2008-2020	HCSO, 2021
INPUTG4	Agricultural input growth	2008-2020	HCSO, 2021
INPUTPrice5	Agricultural input price index	2008-2020	HCSO, 2021
PRODPrice6	Agricultural producing price index	2008-2020	HCSO, 2021
GVA7	**Gross value added on the basic price**	2008-2020	HCSO, 2021
Subsidies8	Subsidies, in Million HUF	2008-2020	HCSO, 2021
GFAAcc9	*Gross fixed asset accumulation all*	2008-2020	HCSO, 2021

Source:

- System of agricultural accounts at current basic prices, in %, in current basic price, in Million HUF, HCSO (Hungarian Central Statistical Office), 2021, Budapest, Hungary
- https://www.ksh.hu/stadat_files/mez/hu/mez0002.html
- https://www.ksh.hu/stadat_files/ara/hu/ara0051.html
- https://statinfo.ksh.hu/Statinfo/haViewer.jsp?wcf15eb7a36=x
- https://statinfo.ksh.hu/Statinfo/haDetails.jsp

Note:

NPUTPrice5 = Agricultural expenditure price indices [in the same period of the previous year]
Hosts selling products and services to farmers
PRODPrice6 = Farmer price index. Agricultural producer price index, 2015 = 100%, Organizations purchasing agricultural products and producer markets.
The prices paid to farmers for agricultural products purchased from farmers for further sale or processing and sold directly to the general public for consumption (on the market) show changes in the average prices of the base period. It does not include changes in the prices of animals sold for resale (breeding animals) between farmers.
The indices are calculated according to the Laspeyres formula.
GVA7= Output – Input = GVA in agricultural sector
GFAAcc9 = Without recoverable VAT (Value added tax)

Table 2. Changing rates of agricultural production and income conditions in Hungary between 2008-2020 in percent, Million HUF

	2008	2010	2012	2014	2016	2018	2020
Plant1	59	57	58	59	60	58	59
Animal2	33	35.5	35	34	32	35	34
OUTPUTG3	100	-15	110	124,5	131	136	149
INPUTG4	100	-21	-9	117	116	134	148
INPUTPrice5	100	104	102	100*	98,3	105	101
PRODPrice6	100	-5	-4	100*	104**	109.6	122.3
GVA7	100	-20	110	147	158	163	178
Subsidies8	100	117	143	164	137	147	158
GFAAcc9	100	-4	114.5	141	112	172	204

Source: System of agricultural accounts at current basic prices,
HCSO (Hungarian Central Statistical Office), 2021, Budapest, Hungary,
Note: * in 2015, ** in 2017, Estimated data for INPUTPrice5 and PRODPrice6 in 2010 and 2012

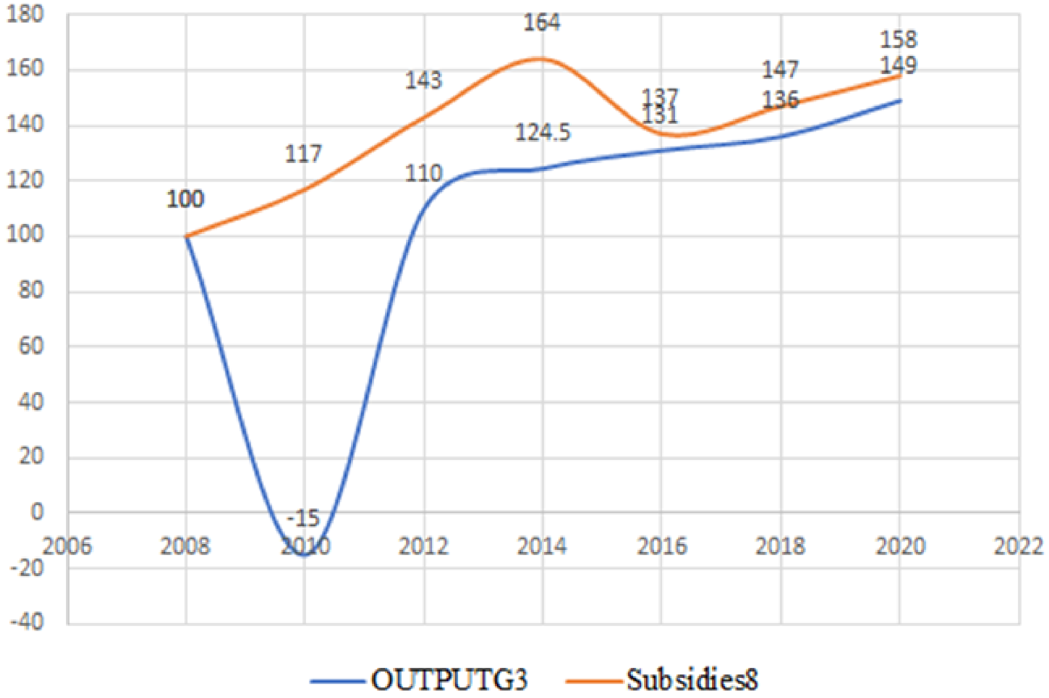

Figure 1. Changing rates of OUTPUT3 and Subsidies8 between 2008-2020 in percent in Million HUF
Source: System of agricultural accounts at current basic prices,
Hungarian Central Statistical Office, 2021, Budapest, Hungary

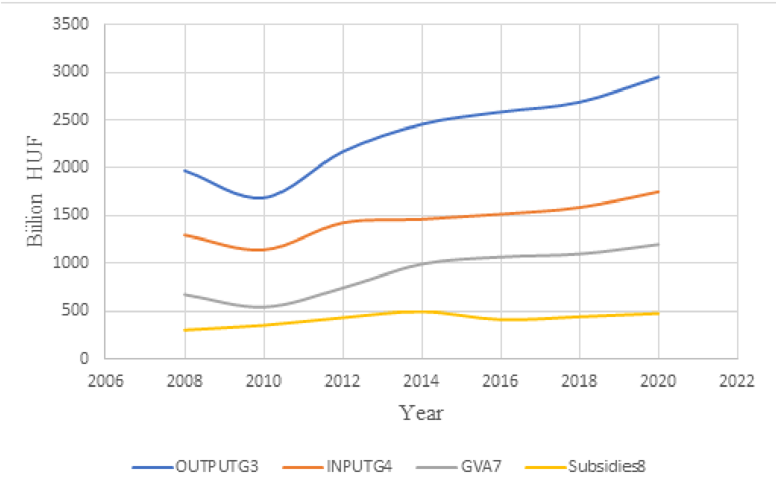

Figure 2. Changes of OUTPUT, INPUTG4, GVA7, Subsidies8 between 2008-2020 in Million HUF
Source: System of agricultural accounts at current basic prices

Note for abbreviations written in the text:

UAA = Utilised agricultural area.
Economic size: The *standard output* (SO) of an agricultural product (crop or livestock), abbreviated as SO, is the average monetary value of the agricultural output at *farm-gate price*, in euro per hectare or per head of livestock. There is a regional SO coefficient for each product, as an average value over a reference period (5 years, except for the SO 2004 coefficient calculated using the average of 3 years). The sum of the entire SO *per hectare of crop* and *per head of livestock* in a farm is a measure of its overall economic size, expressed in euro. *LSU* = Livestock units. One LSU is equivalent to a dairy cow. The number of animals (heads) is converted into LSU using a set of coefficients reflecting the feed requirements of the different animal categories.

Table 3. Correlation Matrix[a]

	Plant1	**Animal 2**	**OUTPUTG3**	**INPUTG4**	**INPUTPrice5**	**PRODPrice6**	**GVA7**	**Subsidies8**	**GFAAc c9**
Plant1	1.000	**-.935**	**.710**	**.706**	**-.885**	**.727**	**.715**	.204	.501
Animal 2		1.000	-.464	-.545	**.888**	**-.605**	-.462	.134	-.211
OUTPUTG3			1.000	.793	-.401	**.737**	**.989**	**.582**	**.934**
INPUTG4				1.000	-.351	**.992**	**.841**	.403	**.803**
INPUTPrice5					1.000	-.396	-.380	-.023	-.159
PRODPrice6						1.000	**.783**	.296	**.732**
GVA7							1.000	**.638**	**.941**
Subsidies8								1.000	**.675**
GFAAcc9									1.000

Source: Based on the System of agricultural accounts at current basic prices

Table 4. Total Variance Explained

Component	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.924	65.826	65.826	5.924	65.826	65.826	4.514	50.154	50.154
2	2.031	22.568	**88.394**	2.031	22..568	88.394	3.442	38.240	88.394

Extraction Method: Principal Component Analysis
Source: Based on the System of agricultural accounts at current basic prices

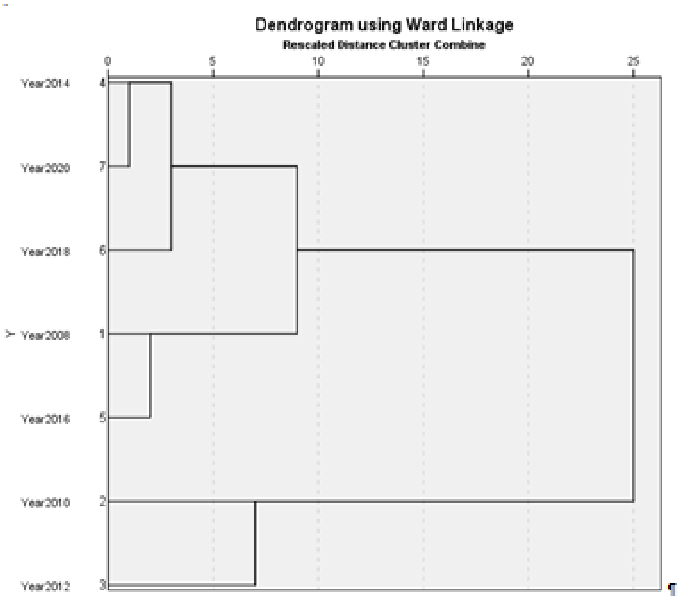

Figure 3. Dendrogram using Ward Linkage. Rescaled of distance cluster combine
Source: Based on the System of agricultural accounts at current basic prices

Table 5. Rotated Component Matrix[a]

	Component	
	1	2
GFAAcc9	**.970**	.114
GVA7	**.918**	.355
OUTPUTG3	**.885**	.367
INPUTG4	**.792**	.464
Subsidies8	**.789**	-.222
PRODPrice6	**.709**	.536
Animal2	-.112	**-.987**
INPUTPrice5	-.054	**-.916**
Plant1	.422	**.896**

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization, a = Rotation converged in 3 iterations.
Source: Based on the System of agricultural accounts at current basic prices

RESULTS AND DISCUSSION

Strategy trends of the agricultural industry and rural development

The most difficult condition for the agricultural production is the increase of the food and agricultural price level; because the input prices are increasing which press the output production conditions and the producing price level to be increasing trend. From this point of view the agricultural strategy should focus on the ensuring the possible moderate balance of supply-demand for food and agricultural products on the national market and increase the subsidies for the participant concerned the agricultural sector. The agricultural strategy includes some main aims of subsidies coming from public finance, which are as follows:

- *increase and strengthen agricultural production, food production and food-self-sufficiency as one kind of renewable energy resource;*
- *innovation process for technological development in agricultural industry;*
- *strengthen the integration process within the product channel of food and agricultural production and agrobusiness and food manufacturing industry from soil to table of consumers by vertical and horizontal levels;*
- *strengthen common purchasing input and common selling output from side of agricultural producers including family farms;*
- *ensure enough incomes for agricultural producers, farmers and employee in this sector based on the annual working unit system;*
- *strengthen capital force for producers of this sector by more income possibility, as self-financial force; favourable credit conditions accompanying with subsidies;*
- *strengthen the concentration for inputs used in the agricultural industry mostly in fields of land owned and land used, advanced mechanization technology, equipment;*
- *develop irrigation system accompanying with successful water management;*
- *improving the land use and land cultivation;*
- *extend the free of charge agricultural extension system including tax-calculation and planning of performance with participation of financial, law, mechanical engineering and veterinary experts for the agricultural producers;*
- *prepare network for extension structure coordinated by the Ministry of Rural Development, where one-one expert manages a fixed group of family farmers based on their performance-features until their retiring, beginning of pension period for them;*
- *extend the financial bases for agricultural producers in cases of crisis conditions either economic and natural-geographical;*
- *ensure enough genetic species for plant production and animal husbandry;*
- *extend the environment friendly technology for the agricultural production;*
- *help young farmers to start their performance in agricultural industry.*

Because of the main problems of agricultural producers mainly are lack of capital, land-use system based on the land separation, sometimes lack of knowledge and experiences even in field of adapting the new advanced technologies, therefore agricultural strategy should follow to solve these main problems.

From point of view of the farm structure of agricultural holdings, this means that the holdings less than 5 hectare had their share in 87% in 2010 and it decreased 81.4% by the end of 2016, while the share of holdings more than 100 hectare was 1.3% in 2010, which increased to 2.0% in 2016. *This means that the UAA (Used Agricultural Areas) per holding was only 8.1 hectare, while this increased to 11% in 2016.* (*Eurostat, ef_m_farmleg, June 2021; Table 3; Table 4; Table 5).*

The EU and Hungarian governmental offices also declared the new developing trend into sustainable development and biodiversity strategy. The European Commission declared about that putting our food systems on a *sustainable path* also brings new opportunities for operators in the food value chain.

New technologies and scientific discoveries, combined with increasing public awareness and demand for sustainable food, will benefit all stakeholders (EC 2021). The Farm to Fork Strategy aims to accelerate our transition to a *sustainable food system* that should:

- have a neutral or positive environmental impact
- help to mitigate climate change and adapt to its impacts
- reverse the loss of biodiversity
- ensure food security, nutrition and public health, making sure that everyone has access to sufficient, safe, nutritious, sustainable food
- preserve affordability of food while generating fairer economic returns, fostering competitiveness of the EU supply sector and promoting fair trade

To mitigate the market tensions caused by the overproduction of cereals, there can be five ways of facilitating restructuring: The production of bio-energy could provide a solution for the overproduction on two sides. On the production side, the plantation of fast-growing species decreases the land used for cereal production, while on the market side, the use of cereals for bioethanol production decreases the surplus what was produced (HG 2011, p25.)

There is an import role of g*ross fixed asset accumulation all (*GFAAcc9) *without recoverable VAT for agricultural production, because this has very strong correlations with gross value added (GVA7) by 0,941 and output growth (OUTPUTG3) by 0.934, and input growth (INPUTG4) by 0.803, also this one has strong correlation with producing price (PRODPrice6) by 0.732.*

Animal husbandry (Animal2) has a very strong contradict correlation with *plant production* (Plant1) by (Minus) 0.935, which means when animal husbandry increases the plant production decreases or opposite to this condition. This trend can be overviewed all over the researched period. Also, the animal husbandry has strong contradicted correlation with *producing price* (PRODPrice6) trends by (Minus) 0.605 in agricultural sector, which means that when the animal husbandry is increasing the producing price is decreasing based on the increasing supply of animal husbandry and animal products on the domestic market. But when *input price* (INPUTPrice5) increases the animal husbandry also increases, therefore, the correlation between two economic variables was by 0.888, as at level of very strong correlations. But when input price increases the *plant production* decreases based on the very strong correlation by (Minus) 0.885. This was resulted by increasing prices of such inputs used in plant production mostly fertilizer, pesticide and water irrigation equipment, soil degradation needing for coast soil improvement based on the water-wind erosion and increasing drought period in wide-side Europe and Hungary. Most of these kinds of costs degraded the efficiency of the plant production and not for animal husbandry. It does not mean that animal husbandry could not suffer from the global warming and its negative influences on this agricultural branch, but considerably less than the other plant branch. Also, the animal husbandry earlier – before the researched period – had less favourable conditions; therefore, the developing trend of the animal husbandry became better at present.

The data base shows that the change of plant production (Plant1) has grown by 48% for the period of 2008-2020 (2008= 100), while change of animal production (Animal2) has grown by 55.7%, therefore, the change of all agricultural production has grown by 49.5% for the same period. This can provide proof that plant production could be more efficient and income-able based on its producing price increase than production of animal husbandry, where the producing price level decrease (Table 3). In spite that the animal husbandry could result higher trend in its production, but it could not more profitable than the plant production, because the producing price level decreases the real income-able and profitability for the agricultural branches. Also, it is true that the plant and feed production has not increased as well as the animal husbandry needed for plant and feed yields for animal keeping.

From point of view of the development trend of the plant production, this branch has strong correlations with *output growth* (OUTPUTG3) by 0.710 and *input growth* (INPUTG4) by 0.706 and also with *gross value added* on the basic price (GVA7) by 0.715. This means that the *enough increase of the producing price level can ensure enough market price incomes for agricultural producers* to realise acceptable output and input growth resulting a *quite good gross value-added increase* and to make a satisfactory balance *against strong input price increase for plant producers*. When the input price increase was so higher the plant production decreased, but this decreasing was not considerable for longer time and was not general for all parts of the plant production (Table 3; HCSO 2021).

The Table 3 also shows that the *plant production* (Plant1) has considerable contradict very strong correlations with the *animal husbandry* (Animal2), which can be explained by the *less favourable economic conditions for the animal husbandry*. Because the animal husbandry was pressed by the *decreasing trends of the producing price level*, which enough cannot stimulate to increase of the gross value added (GVA7) based on the moderate decreasing output growth and input growth.

Fortunately, in case of animal husbandry not the considerable increase of the input price resulted the decrease of the gross value added, but the *unfavourable decrease of the producing price*. Probably the producing price level of animal husbandry was decreased by increasing production cost level and decreasing purchase power capacity based on the relatively larger supply side of animal husbandry on the domestic market.

The basic issue is *the producing price level for either plant production or animal husbandry*, because of the increasing producing price level of plant production and decreasing producing price level of the animal husbandry make sharply considerable contradict correlation by (Minus)0.935.
Sometime the *structure of the plant production cannot be satisfactory for the structure demand of the animal husbandry*, for example the feed production level. Also, many animal husbandry producers do not have enough production capacity for feeding their animal, therefore they have to purchase feed for animal from other producers by highly price level of feed. This can result more expansive animal products for the domestic market, which decreases market conditions for their selling.
Also, the input growth (INPUTG4) has closed to very strong correlations with output growth (OUTPUTG3) by 0.793 mostly closed to 0,800, which means that the increasing level of input can result more output volume based on more increasing producing price level leading to increasing more gross value added by 0.989 (Table 3; Table 4; HCSO 2021).
The Table-3 shows *88.394 values, as 88.4% according to the cumulative of initial Eigenvalues* for the total variance explained. This means that two components of this SPSS analyse are explained by 88.4%, which are more than 60%, therefore, the data base (HCSO 2021) are completely enough for statistical analysing correlations among economic variables.
The Table 5 (HCSO 2021) shows the rotated component matrix consisting of two main components based on the Extraction Method: Principal Component Analysis and Rotation Method: Varimax with Kaiser Normalization, where the *first component* includes GFAAcc9*, GVA7*, OUTPUTG3, INPUTG4, Subsidies8 and PRODPrice6, while the *second component* includes Animal2, INPUTPrice5 and Plant1. The values of the economic variables show the value of each economic variable as measure of its importance in this analyse. The Minus symbol means that the given variable has contradicted correlations with other economic variables, as well as these are shown by the Table 3 (HCSO 2021).
Figure 1 shows *changing rates of OUTPUT3 and Subsidies8* between 2008 and 2020 in percent, where 2008= 100. Figure 1 provides a scheme that the subsidies (Subsidies8) have somehow consequently increased by 58% since 2008, but there was a little decline in trends of subsidies from 64% in 2014 to the level of 37% of 2016, after 2014. Even subsidies have not become over the level of 2014 by the end of 2020. The output trend was unfavourable, because this declined very considerably by 15% and output of agriculture has been over the level of 2008 only by 10% by the end of 2012. Generally, it can be declared that the subsidies coming from public financial resources have consequently increased and become over the trend level of the output. This trend of the subsidies shows that the role of the subsidies had been considerable important for increasing the output of agricultural producers, which means that the increase of the output could ne be realised without subsidies of public financial resources (HCSO 2021).
Figure 2 (HCSO 2021*)* shows that the OUTPUTG3, INPUTG4, *GVA7 and* Subsidies8 in Billion HUF have mostly been changing in direction of prosperity since 2010, but value of output sharply changed from lowest level in 2010 after influence of the economic world-wide side crises. Value of output increased more than the other economic variables INPUTG4, *GVA7 and* Subsidies8. The difference became wider between output and input values in 2020 comparably to data of 2010 even in 2012. This means that the agricultural production in Hungary became more efficient by the end of the researched period than in 2012. In spite that the subsidies from public finance have not changed so much since 2012, the value of the gross value added (GVA7) little more increased than the value of the subsidies. Naturally the subsidies are needed for development agricultural production even for gross value added, but the unified subsidies could lead to more result in field of gross value added after 2014. These changes also show that the agricultural sector could come out from the crisis period resulted decline of the world economy in 2008. Figure 3 (HCSO 2021) shows the Dendrogram using Ward Linkage and Rescaled of distance cluster combine, which clustered the different years within the researched period into five clusters based on the results of agricultural production. Therefore, it can be seen that the results – even of which gross value added based on the subsidies of public finance – were closed to each-others in 2014 as well as in 2020.

CONCLUSIONS AND RECOMMENDATIONS

Sustainability development strategy to follow recycling production process according to the agricultural production and food manufacture in order to use by-products for the following production phases. This recycling method helps efficiently to manage using by-products, as raw materials. Also, the biodiversity in field of the agricultural production can stimulate the using more species of plants and animals, which can make structure of agricultural production be more flexible relevant to the structure of the agricultural and food consumption. Based on the results of the analyses it can be declared that animal husbandry (Animal2) has really strong contradicted correlations with plant production (Plant1). Also, there are strong influences and correlations of producing price level (PRODPrice6) on the agricultural branches in cases of plant production (Plant1) and animal husbandry (Animal2). It was proofed that influences of *subsides* (Subsidies8) from public finance on agricultural branches could increase investment in field of gross fixed asset accumulation all (GFAAcc9), gross value added (GVA7) and output growth (OUTPUTG3). Finally *gross fixed asset accumulation all* (GFAAcc9) has strong correlations with gross value added (GVA7) based on the output growth (OUTPUTG3) and input growth (INPUTG4) increasing. Also, the vertical integration provides possibility for participants concerned in product channel to produce, manufacture and sell final products from soil to the table of consumers. Also, the vertical integration strengthens agricultural producers / holdings to make wide-side cooperation to make the basic agricultural production and services are more efficient and profitable or income-able. *Gross fixed asset accumulation* based on increasing capital force of agricultural producers or holdings can ensure the further innovative production accompanying with using advanced technology, biodiversity and environmental conservation strategy. Also, this capital force of agricultural producers can be strengthened by the subsidies coming from public finance. The subsidies should be provided for agricultural producers in order to obtain *enough incomes* to realise continuous basic agricultural production process, to develop advanced technology for their competitiveness on the markets and finally not to escape from the agricultural sector in order to ensure the supplying food for domestic consumers. Naturally subsidies cannot substitute self-financing capital force of producers.

ACKNOWLEDGEMENTS

The study was supported by the Kálmán Széll State Finance Research Workshop, Faculty of State Scientific and International Studies, National University of Public Service.

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HEAVY METAL CONCENTRATIONS IN THE HAIR SAMPLES

Ágnes BÁLINT[1,4]*, Erika LÁSZLÓ[2], Csaba MÉSZÁROS[3]

[1]Institute of Environmental Engineering and Natural Sciences, Óbuda University, Budapest, Hungary, e-mail: balint.agnes@uni-obuda.hu, [2]Doctoral School of Public Administration Sciences, National University of Public Service, Budapest Hungary, e-mail: laszlo.erika@uni-nke.hu, [3]Institute of Mathematics and Basics of Natural Sciences, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary, Gödöllő, Hungary, [4]Hydro-Bio-Mechanical Systems Research Center, Budapest Hungary, e-mail: Meszaros.Csaba@uni-mate.hu

Since the industrial revolution, human activity has continued to cause significant pollution all over the world. Some of the various pollutants released into the environment take the form of heavy metals. These substances present a major threat to the biosphere by entering the food chain and causing toxic effects on living organisms. Our interest has been turned to the heavy metal exposure of Csepel residents in Budapest. Csepel is the site of the Weiss Manfred Steel and Metal Works, which has had various pollution problems over the years. In the present work, human hair was chosen as a tool to detect the above-mentioned heavy metal pollution. The concentrations of some heavy metals (copper, selenium, iron, zinc, cadmium, manganese) was measured in the hair of Csepel residents and compared them with the results of a control group, namely people living in "Erzsébet" district. It is a known fact, that hair testing is a good indicator of heavy metal pollution, because it is simple to perform without internal intervention and does not exposure the person being tested. The collected hair samples were cut into 2-3 mm pieces. The samples were washed, dried, digested and finally the heavy metal content was measured using a Unicam 923 QZ AA spectrometer. Statistical evaluation was done by SPSS 14.0. The results showed that the heavy metal concentrations of the Csepel hair samples were on average higher than the control samples for copper, iron, manganese, cadmium and selenium.

***Keywords**: biological indicator, environmental pollution, GFAAS, hair samples, heavy metals, SPSS*

INTRODUCTION

Since the industrial revolution, humans have continued to cause massive pollution. This pollution has a major impact on the biogeochemical processes taking place on Earth, which processes ensure the proper functioning of the Earth's ecosystem and climate. Some of the various pollutants released into the environment take the form of heavy metals. These substances pose a major threat to the biosphere by entering the food chain and causing toxic effects on living organisms.
This is why the role of environmental protection is becoming increasingly important today, both to minimize the release of these substances into the environment and to reduce the concentrations of those already released to the lowest possible levels through technical interventions.
Csepel is the site of the "Weiss Manfred" Steel and Metal Works, established in the early 20th century, which has faced various environmental pollution problems. In the years before the change of regime, the Ironworks, which operated with the technology of the time, paid huge fines in Budapest as the largest air polluter in Budapest [1].
Csepel Works was also the source of the large-scale pollution of galvanic sludge that caused a nationwide outcry. As a result, over the years, the Csepel Works area has been the source of various levels of heavy metal pollution into the environment and the bodies of Csepel residents, due to inadequate technologies and human negligence.

As it is known, the hair accumulates trace elements in the body over time as it grows, so testing can be used to assess the trace element status of the previous few months. Hair samples are easy to take and are safe to work with. When taking hair samples, the sampling site must be fixed, as different areas of the hair are not equally affected by environmental influences and cosmetics. After sampling, hair samples can be stored at room temperature, but some authors suggest that samples should be frozen, according to Pereira et al. [2], and collected hair samples should be placed in a polyethylene bag and kept at -20 °C until cutting.

For trace element analysis, samples are usually taken from the back of the head, which is relatively protected from contamination sources. For sampling, Manson and Zlotkin [3] recommended the use of a plastic or quartz cutting instrument to eliminate contamination, while Senofonte et al. [4] recommended the use of a titanium nitride-coated scalpel. However, these instruments are fragile, expensive and difficult to access. Storage may also contaminate the sample and therefore the storage vessels should previously be inspected to check whether the sample may leach contamination from the vessel or whether elements may bind to the vessel wall.

The next step in the preparation of the hair samples is washing, which is still an unresolved issue in hair analysis and the main source of error in results. The aim of washing is to remove as much as possible exogenous impurities from the surface of the hair fiber without affecting the endogenous composition of the sample. This is also complicated by the fact that different trace elements may accumulate in different forms of mobility or in different parts of the hair shaft. An inappropriate washing procedure may also alter the concentration of each trace element and their relative proportions to each other.

Several washing methods are described in the literature. The International Atomic Energy Agency recommends washing with acetone followed by washing with deionized water, both for at least 10 minutes with continuous stirring at room temperature. Senofonte et al. [4] recommended a washing procedure with diethyl ether-acetone (3:1), 5% EDTA solution followed by deionized water. The above examples illustrate the wide variation in washing operations, but most authors agree that a perfect washing method that has been shown to remove exogenous contamination and not affect the endogenous trace element composition has not yet been developed.

The next step in sample preparation is destructive washing. Humid atmospheric shredding and incineration are not suitable for trace element analysis due to the high risk of contamination and loss of certain trace elements. Today, the most commonly used method is microwave shredding, of which several variants are used. Koplík et al. [5] compared the microwave destructive method with cremation and found that out of a reference sample of about 500 mg of plant origin used, significant losses (10-75%) of most of the trace elements tested were found in the samples prepared by cremation, whereas the trace element composition of the samples prepared in a closed microwave system was in good agreement with the guaranteed values.

The methods used in the literature for the analysis of biological samples are very diverse. For the analysis of solid samples, non-destructive analytical methods such as neutron activation analysis (NAA) can be used. The advantage of these multi-element methods is that they do not require sample digestion.

Non-destructive methods are generally used for clinical research. Clayton and Wooller [6] and Tomza et al. [7] tested the hair of workers exposed to heavy metals in the workplace and obtained high concentrations of As, Cr, Co, Se, Zr and Cd. Zeng et al. [8], also examining hair samples from cancer patients, reported significant differences in Mn, Cu, Zn and As concentrations and Cu/Zn ratios between cancer patients and controls.

For the determination of trace element content in biological samples, non-destructive methods are much more widely used than destructive methods. It is commonly used being FAAS (Flame Atomic Absorption Spectrometry), ZAAS (Zeeman Atomic Absorption Spectrometry), ETAAS (Electrothermal Atomic Absorption Spectrometry), ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry), GFAAS (Graphite Furnace Atomic Absorption Spectrometry) and more recently ICP-MS (Inductively Coupled Plasma - Mass Spectrometry), ID-ICP-MS (Isotope Dilution - Inductively Coupled Plasma - Mass Spectrometry) and LC-ICP-MS (Liquid Chromatography-Inductively Coupled Plasma - Mass Spectrometry).

The results obtained are compared with reference ranges established from control samples. The results may be influenced by a number of factors other than health status, such as age and gender, while environmental factors include place of residence, occupation and lifestyle.

Zakrgynska-Fontaine et al. [9] studied the dependence of the composition of hair samples on sex and age and found that men's hair had higher concentrations of Fe and Pb, while women had higher concentrations of Ca, Mg, Zn and Cu. In hair samples collected from young people, Al, Ag, Cu and Co were found in higher concentrations, while Zn, Ca and Mg were found in higher concentrations in adults. Despite the problems encountered, trace element analytical methods are becoming increasingly common, not only to detect environmental effects, but also to test subjects suffering from various diseases.

The aim of these tests is to facilitate the early detection of diseases associated with changes in trace element status, preferably before the onset of clinical symptoms, and to investigate their biological and biochemical background and consequences.

Ely et al. [10] investigated the relationship between air pollutants and children's learning problems and found that although the hair of children with learning problems had a different trace element composition to that of controls, the differences were not due to air pollutants. Ryan et al. [11], analyzing hair samples from patients with multiple sclerosis, found that the concentration of V and Se in hair samples from patients was significantly higher, while the concentration of Cu, I, Mn and S was significantly lower than in control samples [12]. Keratin makes up 97% of the hair and the remaining 3% is water. Keratin is nothing more than the amino acid protein structure that makes up the horns.

The hair consists of three layers: the cortex, cuticle and medulla. The outer layer is made up of a series of overlapping plates, which are coated with hair oil produced by the sebaceous glands. The elasticity of the hair is ensured by a cortex of keratin fibers.

The hair is divided into two main parts, one is the living hair root in the scalp, the lower part of which is the hair follicle and the other is the lifeless hair shaft [13]. The lifelessness of the hair makes it a good choice for trace element analysis. Hair testing is much simpler and less inconvenient for the subjects than testing blood, urine, skin, plasma or other tissues. During the growth of hair, it continuously stores trace elements absorbed by the body, which allows the trace element content of the subject's body to be determined for several months, thus providing a good measure of the subject's heavy metal contamination [14].

Care should be taken during sample collection prior to testing to ensure that samples do not suffer from trace element loss or external contamination, as this may affect the measurement results later on. Due to the concentration of trace elements in $\mu g/dm^3$, a highly sensitive analytical method of analysis should be used. In our case, the residents of the study area were the residents of Csepel and the control sample were the residents of “Erzsébet”.

Due to its high sensitivity, the GFAAS (Graphite Furnace Atomic Absorption Spectrometry) method is often used for trace analysis of biological substances. We used this method for the analysis of the hair samples we obtained. The advantage of using this method is that by using a suitable heating program in the graphite furnace, the organic matter content of the sample can be destroyed before atomization, so that not only liquid but also solid samples can be analyzed [12].

In this article, human hair has been chosen as a tool to detect the above-mentioned heavy metal pollution. The concentration of some heavy metals (copper, zinc, selenium, iron, cadmium, and manganese) in the hair of Csepel residents was measured and compared with the results of a control group, namely persons living in “Erzsébet”.

An answer was sought to the question whether people living in Csepel were indeed exposed to higher levels of heavy metals compared to people living in the surrounding districts. It is a known fact that hair testing is a good indicator of heavy metal pollution; it is simple to perform without internal intervention and does not burden the person being tested.

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MATERIALS AND METHODS

Description of the sampling site

Csepel is located on the northern part of the island of Csepel, one of the southernmost districts of Budapest. Its population is 76 911 according to 2016 data. It covers an area of 25.75 km^2, of which 23.02 km^2 is internal [15].

It is bordered by the Danube to the west and the “Ráckeve”-Danube branch to the east, which is a NATURA 2000 site of "Nature of Special Importance for Nature Conservation". The only protected area in Csepel was the “Tamariska” hill in the King's Forest, which was protected from 1994. It became a Metropolitan Nature Reserve in 1999 and a National Nature Reserve in 2012 [16].

The area is named after the Tamarisk plant that grows here, and among the sandy plant and animal species, Red Book and Pannonian endemic species can also be found in this 5.2-hectare area. The first thing most people think of when they think of Csepel is not its natural values, but rather the “Weiss Manfred” Steel and Metal Works, founded in Csepel in 1892.

The name of the metalworks was changed in 1956 to Csepel Iron and Metal Works, a name that has remained to this day. Over the years, the factory site has been home to many different plants and industries. These included, for example, a munitions and ammunition plant, a metal foundry and metalworks, a power plant, a hydraulic press shop, a carpentry plant, a fine wire plant, a vehicle factory, an iron foundry, a steel foundry, a military vehicle plant, a gas generator plant, a bell foundry, a bicycle plant and many others [15].

These are all industries that have a high potential to pollute their environment with heavy metals, even today, let alone in the early 19th century, when there were no such strict or even no environmental standards for manufacturing technologies.

Indeed, the beginning of environmental protection can only be dated back to 1962, with the publication of Rachel Carson's Silent Spring. This work opened the eyes of intellectuals in time to the fact that what you do to your environment can have very serious consequences later on.

Since the early 1990s, the factories of the time have been slowly closing, fragmenting and transforming themselves as a result of the economic difficulties.

Today there are more than 200 companies operating in the Csepel Works area. The companies have acquired ownership of the buildings and have started to modernize and renovate them.

Waste water treatment plant in Csepel

Untreated wastewater can be one of the sources of heavy metals in soil, surface water and groundwater. Wastewater generally contains low concentrations of toxic metals, but they can enter the food chain during its passage into the biomass and accumulate in high concentrations once it reaches the human body [17].

With the construction of the Csepel wastewater treatment plant, this source of pollution seems to be decreasing. Wastewater from Budapest, and thus from Csepel, is now treated in a total of 4 treatment plants.

The largest of these is the Csepel wastewater treatment plant, built in 2009, which can treat an average of 350 000 m^3 of wastewater biologically. Together, the plants operated by North Pest, South Pest, Csepel and BKSZT Ltd. can treat 95% of Budapest's wastewater [18]. The contamination limits for heavy metals in wastewater and sludge are shown in Tables 1 and 2, based on the Government Decree 50/2001 (IV. 3.).

Table 1. Limit values for toxic elements and harmful substances in waste water for agricultural use

Name of materials	Limit value mg/dm^3

Zinc	**5.0**
Cadmium	**0.02**
Manganese	**5.0**
Copper	**2.0**
Iron	**20.0**

Table 2. Limit values for toxic elements and harmful substances in sludge for agricultural use

Name of materials	Limit value mg/kg dm.
Zinc	**5.0**
Cadmium	**0.02**
Manganese	**5.0**
Copper	**2.0**
Iron	**20.0**

Csepel drinking water base

Csepel is home to the second largest shore-filtered water base in Budapest. There are nearly 150 drinking water wells on the island, and the water extracted from these wells supplies 30% of the drinking water needs of the capital and the surrounding municipalities.

The quality of the drinking water from the Csepel Island area (Table 3) is heavily influenced by agriculture, waste management, sewage disposal and various industrial activities, as the drinking water bases are vulnerable. This is because there is no impermeable layer above the water storage medium to protect the vulnerable coastal filtered water from upstream contamination [19].

Fortunately, Csepel Works has so far not contaminated this vulnerable drinking water base, although the area adjacent to the Danube has sometimes polluted the Danube water to a greater or lesser extent.

Table 3. Limit values for harmful substances in drinking water

Description	Quantity	Limit value
Free active chlorine	0.34 mg/l	-
Chloride	34 mg/l	100 mg/l
Iron	46 μg/l	200 (μg/l)
Manganese	17 μg/l	50 (μg/l)
Nitrate	13.1 mg/l	50 mg/l
Nitrite	<0.03 mg/l	0.1 mg/l
Ammonium	<0.04 mg/l	0.2 mg/l
Conductivity	704 μS/cm	2500 (μS/cm)
pH	7.42	6.5-8.5

Sampling

Hair samples were obtained with the help of hairdressers from 3 different hairdressing salons in Csepel. The control samples were taken from 1 hairdresser in Erzsébet. A total of 30 hair samples were collected, of which unfortunately 2 were destroyed during the analysis. One was the control and one was from the tested group.

Thus, a total of 28 hair samples were tested. Hair samples were taken only from local residents and a short questionnaire was completed by them. The questionnaire contained the following questions:

- Gender
- Age
- Do you dye your hair? If yes, with what?
- Do you smoke? If yes, for how many years?
- Do you take medication regularly? If yes, what?

These questions were necessary because smoking, hair dyeing and taking certain medicines can affect the results of the measurements. For example, the control site was particularly interested to see if there was a measurable difference between the hair dyes they use and those used by other hairdressers. It was also important for them to know the quality of the hair dye packs their customers were receiving and to know what they were working with. Unfortunately, we did not get any valuable answers about their medication habits. Data for the Csepel study (A) and „Erzsébet" control (K) groups are shown in Tables 4 and 5.

Preparing the hair samples

After collection, the hair samples were stored in separate polyethylene bags together with the questionnaires until the start of the study. The first step was to cut the hair samples to 2-3 mm using stainless steel scissors [20].

After that, the cut hair samples were placed in beakers with hair sample code numbers. After the chopping, the hair samples were placed in an ultrasonic water bath first once in bidistilled water, then three times in diethyl ether, and then again in bidistilled water for 5-5 minutes for each washing phase. The washed samples were placed in coded petri dishes and placed in a drying chamber at 70 °C for 24 hours.

Table 4. Responses to the questions in the questionnaire from persons providing hair samples (A) living in Csepel

Code	Age	Gender	Smoking	Hair dyeing
A-01	57	Female	no	LK (lisap)
A-02	23	Female	yes (2-3 years)	HI Richesse (L'oreal)
A-03	80	Female	no	Regal Bes
A-04	60	Female	no	Regal Bes
A-05	32	Male	no	no
A-06	63	Female	yes (40 years)	Bes Regal
A-07	16	Male	no	no
A-08	84	Female	no	no
A-09	36	Female	no	no
A-10	40	Male	no	no
A-11	64	Male	no	no
A-12	57	Female	no	Regal Bes
A-13	50	Male	yes (35 years)	no
A-14	33	Male	no	no

Table 5. Responses to the questions in the questionnaire from people living in "Erzsébet" (K) who provided a hair sample

Code	Age	Gender	Smoking	Hair dyeing
K-01	43	Female	no	Joico
K-02	25	Female	yes (7 years)	Joico
K-03	47	Female	no	bleaching + dye
K-04	10	Male	no	no
K-05	19	Male	no	no
K-06	53	Male	no	no
K-07	18	Female	yes (6 years)	bleaching Kallos
K-08	46	Female	no	Joico
K-09	53	Female	no	Joico
K-10	33	Female	yes (15 years)	Joico
K-11	38	Male	yes (20 years)	no
K-12	38	Male	no	no

K-13	27	Female	no	Joico
K-14	44	Female	no	no

Digestion of samples
Digestion of samples was performed in a Milestone 1200 MEGA microwave oven (Table 6).
For digestion the samples 5 cm^3 of 65% nitric acid and 2 cm^3 of 30% hydrogen peroxide were used.

Table 6. The microwave hair digestion program was as follows

Number of steps	Time required (minutes)	Operation
1.	2	Digestion, 250 watts
2.	2	Ventilation
3.	6	Digestion, 250 watts
4.	5	Digestion, 400 watts
5.	5	Digestion, 600 watts
6.	5	Ventilation

RESULTS AND DISCUSSION

Changes in copper concentration values in hair samples
At the copper concentration (Figure 1), it can be seen that the concentration values in µg/g are higher for the control samples labelled "K" compared to the samples labelled "A". In particular, sample "K13" with a value of 39.70±0.34µg/g is outstanding. The lowest of these is sample "K12" with 1.70 ± 11.10µg/g. The average of the control samples is 12.37µg/g, while the average of the Csepel samples is only about half of 6.45 µg/g. Among these, the lowest was also sampling "A4" with 0.55µg/g, while the highest was also only 10.60µg/g, which was sample "A3".

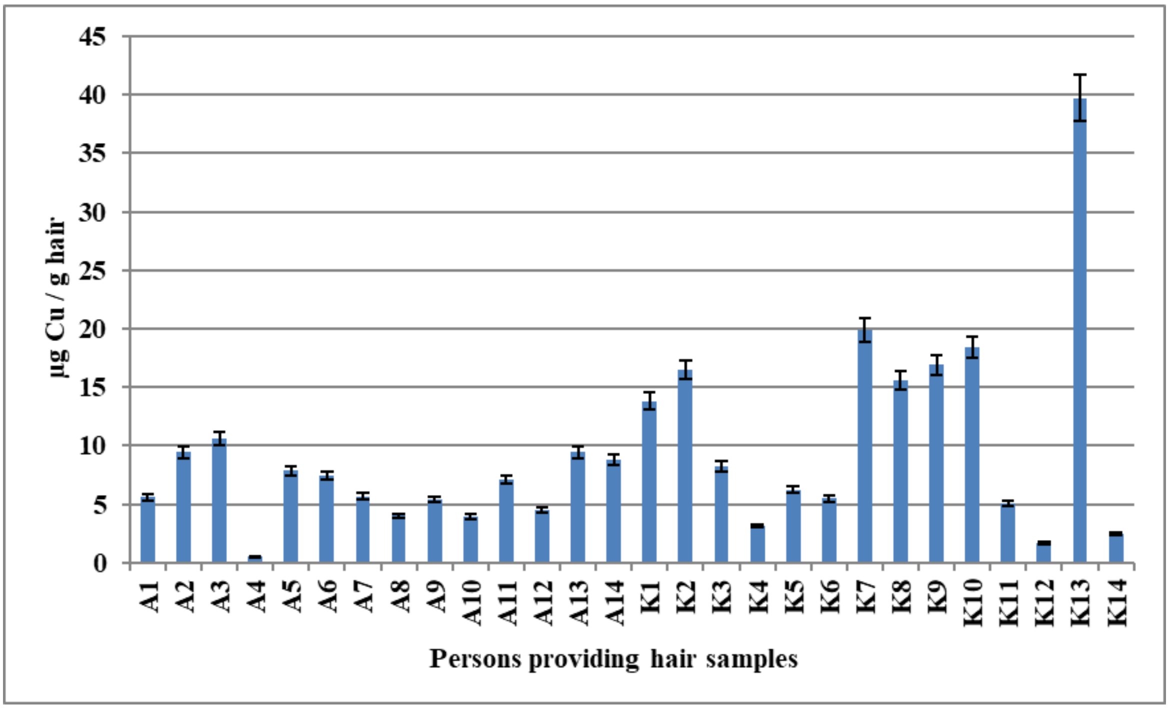

Figure 1. Cu concentration in hair samples

Statistical analysis (Table 7) showed that the Cu concentration of hair samples by residence (Figure 1) was significant ($LSD_{5\%}$= 4.36). On average, Cu concentration in hair of “Erzsébet” residents is significantly higher (A: 6.44μg/g hair; K: 12.63μg/g hair).

Table 7. Cu concentration variance table by residence

Factor	SQ	df	MQ	F	Sig.	$LSD_{0.5}$
Modell	507.589	2	253.795	4.111	0.022	
Correction Factor	4800.502	1	4800.502	77.753	0.000	
Residence	505.921	1	505.921	8.194	0.006	4.365
Repeat	3.029	1	3.029	0.049	0.826	
Error	3087.013	50	61.740			
Total	8485.368	53				
Corrected total	3594.603	52				

Table 8. Cu concentration variance table by gender

Factor	SQ	df	MQ	F	Sig.	$LSD_{0.5}$
Modell	432.468	2	216.234	3.419	0.041	
Correction Factor	3702.923	1	3702.923	58.551	0.000	
Residence	430.800	1	430.800	6.812	0.012	3.858
Repeat	8.190	1	8.190	0.130	0.720	
Error	3162.135	50	63.243			
Total	8485.368	53				
Corrected total	3594.603	52				

Statistical analysis (Table 8) showed that the Cu concentration in hair samples was significant ($LSD_{5\%}$= 3.86) according to the sex of the samplers (Figure 1).
On average, Cu concentration in hair of women is significantly higher than in hair of men (women: 11.72μg/g hair; men: 5.76μg/g hair).
Based on statistical analysis (Table 9), the Cu concentration in hair samples was not significant ($LSD_{5\%}$= 6.28) according to the smoking habits of the sampled individuals (Figure 1).

Table 9. Cu concentration variance table for smoking habit

Factor	SQ	df	MQ	F	Sig.	$LSD_{0.5}$
Modell	142.866	2	71.433	1.035	0.363	
Correction Factor	4509.091	1	4509.091	65.316	0.000	
Residence	141.198	1	141.198	2.045	0.159	6.282
Repeat	2.871	1	2.871	0.042	0.839	
Error	3451.737	50	69.035			
Total	8485.368	53				

Corrected total	3594.603	52				

Based on statistical analysis (Table 10), the concentration of Cu in hair samples according to the hair dyeing habits of the sampled individuals (Figure 1) is significant ($LSD_{5\%}$= 3.87).
The concentration of Cu in hair of hair dryers was significantly higher on average than that of men who did not dye their hair (hair dryers: 14.37µg/g hair; hair non-dyers: 4.97µg/g hair).
As the ladies were the overall proportion of people who dye their hair so the trend was similar for the ladies in the past.
Further investigation is needed to determine whether the ladies had higher Cu levels in their hair because they dyed their hair or whether the ladies had higher Cu concentrations by design.
The statistical analysis (Table 11) showed that the Cu concentration in hair samples was significant ($LSD_{5\%}$= 7.54) according to the age of the samplers (Figure 1).
The highest hair sample concentrations were found in those aged between 20 and 30 years (1: 8.75µg/g hair; 2: 21.89µg/g hair; 3: 7.42µg/g hair; 4: 10.04µg/g hair; 5: 7.24µg/g hair).

Table 10: Cu concentration variance table for hair dyeing

Factor	SQ	df	MQ	F	Sig.	$LSD_{0.5}$
Modell	1167.044	2	583.522	12.019	0.000	
Correction Factor	4938.803	1	4938.803	101.724	0.000	
Residence	1165.376	1	1165.376	24.003	0.000	3.866
Repeat	10.168	1	10.168	0.209	0.649	
Error	2427.559	50	48.551			
Total	8485.368	53				
Corrected total	3594.603	52				

Table 11. Cu concentration variance table by age

Factor	SQ	df	MQ	F	Sig.	$LSD_{0.5}$
Modell	1077.293	5	215.459	4.023	0.004	
Correction Factor	5531.923	1	5531.923	103.285	0.000	
Residence	1075.625	4	268.906	5.021	0.002	7.542
Repeat	4.874	1	4.874	0.091	0.764	
Error	2517.309	47	53.560			
Total	8485.368	53				
Corrected total	3594.603	52				

Changes in selenium concentration values in hair samples
Selenium concentrations (Figure 2) are relatively low in all except three samples from Csepel ("A1", "A2" and "A3"). A1 is 0.42 µg/g, A2 is the highest at 1.06 µg/g and A3 is 0.27 µg/g.
Apart from the three outliers, the average of the different samples labelled "A" is 0.059 µg/g. The overall average is 0.17 µg/g.
The control samples all show very low selenium concentrations with none of them reaching 0.2 µg/g. On average, 0.05 µg/g selenium is found in the "Erzsébet" hair samples.
Statistical analysis (Table 12) shows that the Se concentration in hair samples by residence (Figure 2) is significant ($LSD_{5\%}$= 0.117). Se concentrations in the hair of Csepel and Elisabeth residents are significant, on average (A: 0.186 µg/g hair; K: 0.056 µg/g hair).
Based on statistical analysis (Table 13), the Se concentration in hair samples was significant ($LSD_{5\%}$= 0.117) according to the sex of the samplers (Figure 2).

On average, Se concentration in hair of women is significantly higher than in hair of men (women: 0.150 µg/g hair; men: 0.065 µg/g hair).
Based on statistical analysis (Table 14), Se concentrations in hair samples were significant ($LSD_{5\%}$= 0.163) according to the smoking habits of the sampled individuals (Figure 2).

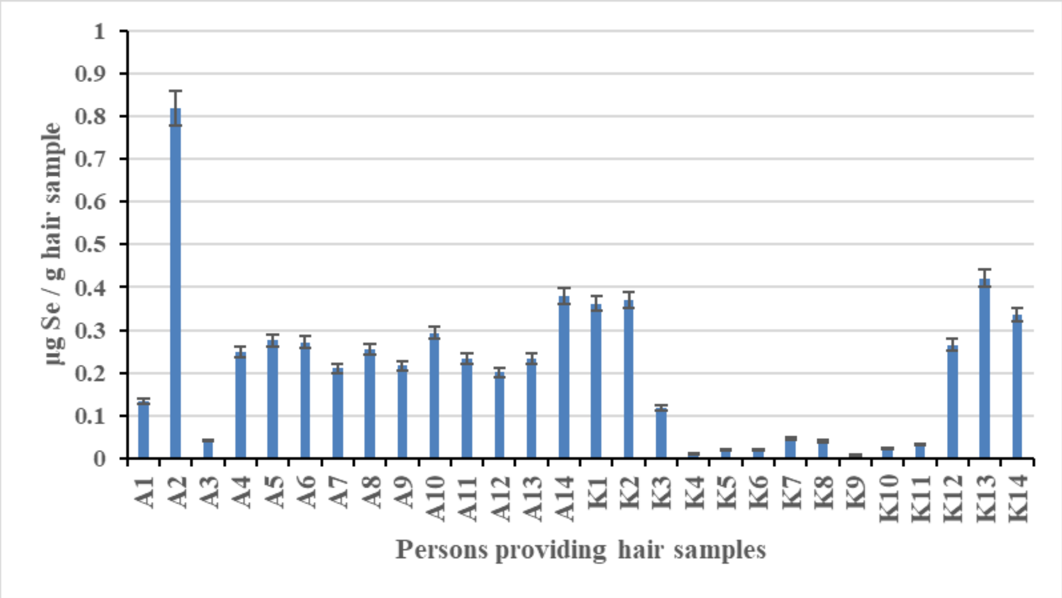

Figure 2. Se concentration changes in hair samples

Table 12. Se concentration variance table by residence

Factor	SQ	df	MQ	F	Sig.	$LSD_{5\%}$
Modell	0.226	2	0.113	2.565	0.087	
Correction Factor	0.774	1	0.774	17.578	0.000	
Residence	0.222	1	0.222	5.049	0.029	0.117
Repeat	0.005	1	0.005	0.109	0.742	
Error	2.203	50	0.044			
Total	3.184	53				
Corrected total	2.429	52				

Statistical analysis (Table 15) showed that the Se concentration in hair samples was significant ($LSD_{5\%}$= 0.119) according to the hair dyeing habits of the sampled individuals (Figure 2). The Se concentration in the hair of hair dryers is significantly higher on average than that of men who do not dye their hair (hair dryers: 0.172 µg/g hair; hair non-dyers: 0.069 µg/g hair).

Table 13. Se concentration variance table by gender

Factor	SQ	df	MQ	F	Sig.	$LSD_{5\%}$
Modell	0.092	2	0.046	0.982	0.381	
Correction Factor	0.561	1	0.561	11.996	0.001	
Residence	0.088	1	0.088	1.888	0.176	0.117
Repeat	0.001	1	0.001	0.030	0.864	
Error	2.337	50	0.047			
Total	3.184	53				

Corrected total	2.429	52				

Table 14. Se concentration variance table for smoking habit

Factor	**SQ**	**df**	**MQ**	**F**	**Sig.**	**$LSD_{5\%}$**
Modell	0.100	2	0.050	1.074	0.349	
Correction Factor	0.837	1	0.837	17.959	0.000	
Residence	0.096	1	0.096	2.071	0.156	0.163
Repeat	0.002	1	0.002	0.052	0.820	
Error	2.329	50	0.047			
Total	3.184	53				
Corrected total	2.429	52				

Statistical analysis (Table 16) showed that the Se concentration in hair samples was significant ($LSD_{5\%}$= 0.195) according to the age of the samplers (Figure 2). The highest hair sample concentrations were found in those aged between 20 and 30 years (1: 0.060 µg/g hair; 2: 0.417 µg/g hair; 3: 0.063 µg/g hair; 4: 0.040 µg/g hair; 5: 0.120 µg/g hair).

Table 15. Se concentration variance table for hair dyeing

Factor	**SQ**	**df**	**MQ**	**F**	**Sig.**	**$LSD_{5\%}$**
Modell	0.146	2	0.073	1.596	0.213	
Correction Factor	0.768	1	0.768	16.828	0.000	
Residence	0.142	1	0.142	3.112	0.084	0.119
Repeat	0.002	1	0.002	0.033	0.856	
Error	2.283	50	0.046			
Total	3.184	53				
Corrected total	2.429	52				

Table 16. Se concentration variances table by age

Factor	**SQ**	**df**	**MQ**	**F**	**Sig.**	**$LSD_{5\%}$**
Modell	0.651	5	0.130	3.439	0.010	
Correction Factor	0.887	1	0.887	23.445	0.000	
Residence	0.647	4	0.162	4.275	0.005	0.195
Repeat	0.002	1	0.002	0.052	0.820	
Error	1.778	47	0.038			
Total	3.184	53				
Corrected total	2.429	52				

Changes in iron concentration values in hair samples

The Figure of the iron concentration (Figure 3) shows that there is an exceptionally high value of around 980 ± 26.45µg/g among the hair samples from Csepel; this is sample "A13". The other samples from Csepel vary between 97µg/g and 6µg/g.

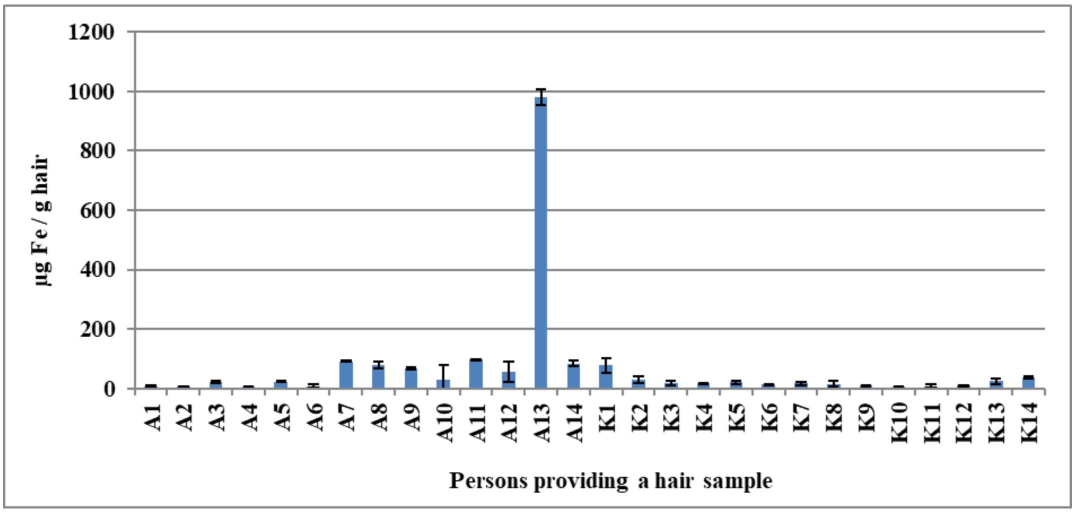

Figure 3. Changes in Fe concentration in hair samples

The average of these is 62.71µg/g, excluding the outlier. For the control samples, there is no outlier with the highest value being 77µg/g, the other values are all below this value, the lowest of which is 5µg/g. The average for the control samples is 22.05 µg/g. The statistical analysis (Table 17) shows that the Fe concentration in hair samples by residence (Figure 3) is not significant ($LSD_{5\%}$= 118.218). The Fe concentration in the hair of Csepel residents is higher than that of „Erzsébet" residents, on average (A: 137,040/g hair; K: 19,600µg/g hair).

Table 17. Table of variance of Fe concentration by residence

Factor	SQ	df	MQ	F	Sig.	$LSD_{5\%}$
Modell	160369.777	2	80184.888	2.204	.122	
Correction Factor	283943.173	1	283943.173	7.803	.008	
Residence	160191.399	1	160191.399	4.402	.042	118.218
Repeat	56.422	1	56.422	.002	.969	
Error	1601055.315	44	36387.621			
Total	2005094.027	47				
Corrected total	1761425.092	46				

Statistical analysis (Table 18) shows that the Fe concentration in hair samples is significant ($LSD_{5\%}$= 102.896) according to the gender of the samplers (Figure 3). The Fe concentration in women's hair is significantly lower on average than in men (women: 26.929µg/g hair; men: 138.415µg/g hair).
Based on statistical analysis (Table 19), the Fe concentration in hair samples was significant ($LSD_{5\%}$= 118.218) according to the smoking habits of the sampled individuals (Figure 3).
Based on statistical analysis (Table 20), the concentration of Fe in hair samples is significant ($LSD_{5\%}$= 120.496) according to the hair dyeing habits of the sampled individuals (Figure 3). The Fe concentration in the hair of non-dyers was significantly higher on average than that of men who dye their hair (hair dryers: 21.384µg/g hair; non-dyers: 113.190µg/g hair).
Based on statistical analysis (Table 21), the Fe concentration in hair samples was significant ($LSD_{5\%}$= 196.030) according to the age of the samplers (Figure 3). The highest concentration of Fe in hair

samples was found in those aged 50 years and over (1: 37.045μg/g hair; 2: 20.801μg/g hair; 3: 28.544μg/g hair; 4: 28.378μg/g hair; 5: 172.808μg/g hair)

Table 18. Table of variance of Fe concentration by gender

Factor	**SQ**	**df**	**MQ**	**F**	**Sig.**	**$LSD_{5\%}$**
Modell	142538.675	2	71269.337	1.937	0.156	
Correction Factor	311315.068	1	311315.068	8.461	0.006	
Residence	142360.297	1	142360.297	3.869	0.056	102.896
Repeat	1815.728	1	1815.728	0.049	0.825	
Error	1618886.417	44	36792.873			
Total	2005094.027	47				
Corrected total	1761425.092	46				

Table 19. Table of variance of Fe concentration by smoking habit

Factor	**SQ**	**df**	**MQ**	**F**	**Sig.**	**$LSD_{5\%}$**
Modell	160369.777	2	80184.888	2.204	0.122	
Correction Factor	283943.173	1	283943.173	7.803	0.008	
Residence	160191.399	1	160191.399	4.402	0.042	118.218
Repeat	56.422	1	56.422	0.002	0.969	
Error	1601055.315	44	36387.621			
Total	2005094.027	47				
Corrected total	1761425.092	46				

Table 20. Table of variance of Fe concentration for hair dyeing

Factor	**SQ**	**df**	**MQ**	**F**	**Sig.**	**$LSD_{5\%}$**
Modell	98071.317	2	49035.658	1.297	0.284	
Correction Factor	209579.049	1	209579.049	5.544	0.023	
Residence	97892.939	1	97892.939	2.590	0.115	120.496
Repeat	321.197	1	321.197	0.008	0.927	
Error	1663353.775	44	37803.495			
Total	2005094.027	47				
Corrected total	1761425.092	46				

Table 21. Table of variance of Fe concentration by age

Factor	**SQ**	**df**	**MQ**	**F**	**Sig.**	**$LSD_{5\%}$**
Modell	203569.754	5	40713.951	1.072	0.390	
Correction Factor	139850.264	1	139850.264	3.681	0.062	

Residence	203391.377	4	50847.844	1.338	0.272	196.030
Repeat	32.309	1	32.309	0.001	0.977	
Error	1557855.338	41	37996.472			
Total	2005094.027	47				
Corrected total	1761425.092	46				

Changes in cadmium content in hair samples

The samples from Csepel contained higher levels of cadmium than those from Erzsébet. The highest levels were found in samples "A1" and "A11", both above 0.15µg/g. The average for the Csepel samples was 0.07µg/g and for the Erzsébet samples 0.02µg/g. Among the “Erzsébet” samples, only one with the "K7" symbol is above 0.15 µg/g. Statistical analysis (Table 24) shows that the Cd concentration of hair samples by residence (Figure 9) is not significant (SD5%=0.044). On average, Cd concentrations are higher in the hair of „Erzsébet” residents (A: 0.068 µg/g hair; K: 0.022µg/g hair).

Statistical analysis (Table 22) showed that the Cd concentration in hair samples was significant ($LSD_{5\%}$=0.040) according to the gender of the sampled individuals (Figure 4). The Cd concentration in hair of women is significantly higher on average than in hair of men (women: 0.044 µg/g hair; men: 0.043 µg/g hair).

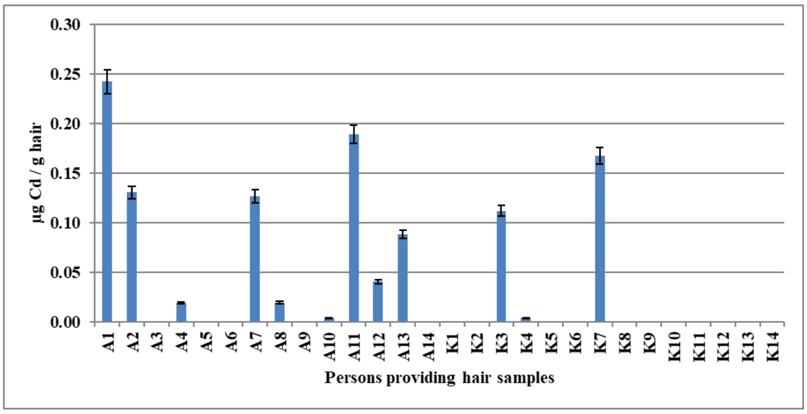

Figure 4. Changes in cadmium content in hair samples

Based on statistical analysis (Table 23), the Cd concentration in hair samples was significant ($LSD_{5\%}$= 0.062) according to the smoking habits of the sampled individuals (Figure 4). Smokers (0.058 µg/g, non-smokers (0.039µg/g). Based on statistical analysis (Table 24), Cd concentrations in hair samples according to hair dyeing habits of the sampled individuals (Figure 4) are significant ($LSD_{5\%}$= 0.046) in non-dyeing hair in men (hair dryers: 0.056 µg/g hair; non-dyers: 0.033 µg/g hair).

Extensive hair sampling was carried out in Beijing [21], using only samples of men and women with undyed hair. A common element in the studies conducted there was Cd. Comparing our results, we can say that the Cd content of the hair samples is of similar magnitude. We also came to almost similar conclusions in terms of age classification. Statistical analysis (Table 25) showed that the Cd concentration in hair samples was significant ($LSD_{5\%}$= 0.080) according to the age of the samplers (Figure 4). The highest hair sample concentrations were found in those aged between 20 and 30 years (1: 0.075 µg/g hair; 2: 0.038 µg/g hair; 3: 0.000026 µg/g hair; 4: 0.031 µg/g hair; 5: 0.065 µg/g hair).

Table 22. Cd concentration variance table by residence

Factor	**SQ**	**df**	**MQ**	**F**	**Sig.**	**$LSD_{5\%}$**
Modell	0.029	2	0.015	2.337	0.107	
Correction Factor	0.108	1	0.108	17.285	0.000	

Residence	0.029	1	0.029	4.672	0.035	0.044
Repeat	8.26E-005	1	8.26E-005	0.013	0.909	
Error	0.319	51	0.006			
Total	0.452	54				
Corrected total	0.348	53				

Changes in manganese content in hair samples

The average value of manganese content in the sample labelled "A" is 0.6788 µg/g and in the sample labelled "K" 0.1817 µg/g. The highest Mn concentration was measured in sample A4 with 2.6187 µg/g. Samples "A1" to "A3" also had values above 1 µg/g. "Samples 'A5' to 'A14' were all below 1 µg/g.

Table 23. Cd concentration variance table by gender

Factor	SQ	df	MQ	F	Sig.	$LSD_{5\%}$
Modell	3.57E-005	2	1.78E-005	0.003	0.997	
Correction Factor	0.096	1	0.096	14.065	0.000	
Residence	2.93E-005	1	2.93E-005	0.004	0.948	0.040
Repeat	5.07E-006	1	5.07E-006	0.001	0.978	
Error	0.348	51	0.007			
Total	0.452	54				
Corrected total	0.348	53				

Table 24. Cd concentration variance table for smoking habit

Factor	SQ	df	MQ	F	Sig.	$LSD_{5\%}$
Modell	0.004	2	0.002	0.272	0.763	
Correction Factor	0.097	1	0.097	14.397	0.000	
Residence	0.004	1	0.004	0.543	0.465	0.062
Repeat	1.41E-006	1	1.41E-006	0.000	0.989	
Error	0.345	51	0.007			
Total	0.452	54				
Corrected total	0.348	53				

Table 25. Cd concentration variance table for hair dyeing

Factor	SQ	df	MQ	F	Sig.	$LSD_{5\%}$
Modell	0.007	2	0.003	0.512	0.602	
Correction Factor	0.106	1	0.106	15.802	0.000	
Residence	0.007	1	0.007	1.023	0.316	0.046
Repeat	1.95E-007	1	1.95E-007	0.000	0.996	
Error	0.342	51	0.007			
Total	0.452	54				
Corrected total	0.348	53				

Table 26. Cd concentration variance table by age

Factor	SQ	df	MQ	F	Sig.	$LSD_{5\%}$
Modell	0.041	5	0.008	1.274	0.290	
Correction Factor	0.079	1	0.079	12.329	0.001	
Residence	0.041	4	0.010	1.593	0.191	0.080
Repeat	8.86E-005	1	8.86E-005	0.014	0.907	
Error	0.308	48	0.006			
Total	0.452	54				
Corrected total	0.348	53				

The concentration of Mn in the hair of women and men (women: 1.049 µg/g hair; men: 0.404 µg/g hair).

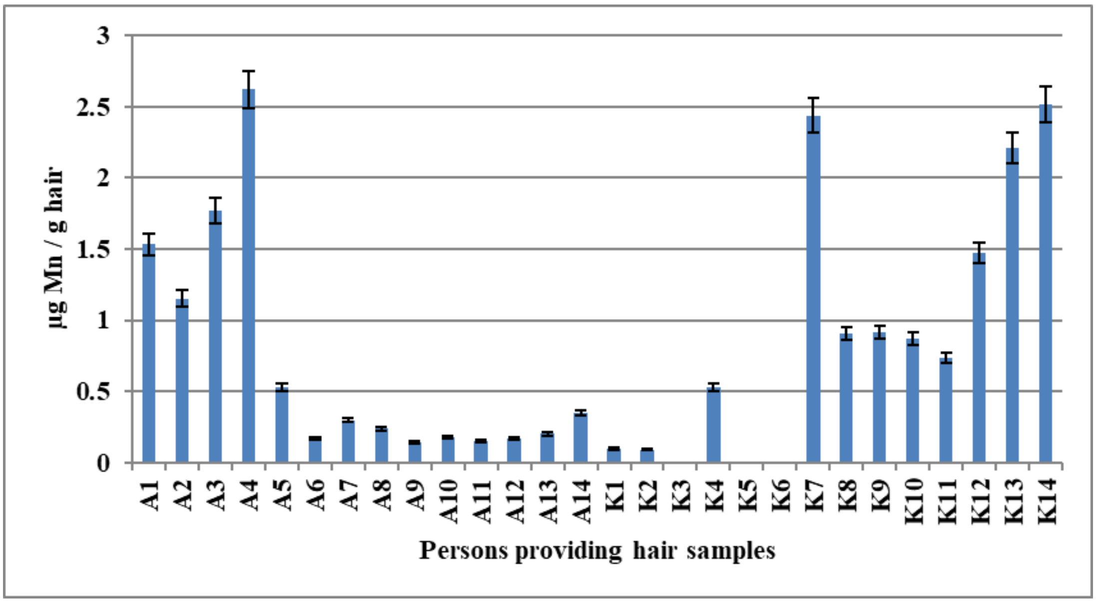

Figure 5. Changes in Mn concentration in hair samples

Table 27. Mn concentration variance table by residence

Factor	SQ	df	MQ	F	Sig.	$LSD_{5\%}$
Modell	0.767	2	0.383	0.422	0.658	
Correction Factor	35.433	1	35.433	39.045	0.000	
Residence	0.761	1	0.761	0.838	0.364	0.508
Repeat	0.006	1	0.006	0.007	0.935	
Error	48.097	53	0.907			
Total	84.296	56				
Corrected total	48.863	55				

Table 28. Mn concentration variance table by gender

Factor	SQ	df	MQ	F	Sig.	$LSD_{5\%}$
Modell	5.555	2	2.777	3.399	0.041	
Correction Factor	28.191	1	28.191	34.499	0.000	
Residence	5.549	1	5.549	6.790	0.012	0.622
Repeat	0.006	1	0.006	0.008	0.931	
Error	43.308	53	0.817			
Total	84.296	56				
Corrected total	48.863	55				

Based on statistical analysis (Table 29), the concentration of Mn in hair samples was significant ($LSD_{5\%}$=0.725) according to the smoking habits of the sampled individuals (Figure 5). Smokers (0.808 µg/g, non-smokers (0.791 µg/g). Based on statistical analysis (Table 30), Cd concentrations in hair samples according to hair dyeing habits of the sampled individuals (Figure 5) are significant ($LSD_{5\%}$= 0.526) in non-dyeing hair in men (hair dyers: 0.947 µg/g hair; non-dyers: 0.664 µg/g hair). Statistical analysis (Table 31) showed that the Cd concentration in hair samples was significant ($LSD_{5\%}$= 0.975) according to the age of the samplers (Figure 5). The highest hair sample concentrations were found in those aged between 20 and 30 years (1: 0.816 µg/g hair; 2: 1.150 µg/g hair; 3: 0.611 µg/g hair; 4: 0.878 µg/g hair; 5: 0.777 µg/g hair).

Table 29. Mn concentration variance table for smoking habit

Factor	SQ	df	MQ	F	Sig.	$LSD_{5\%}$
Modell	0.009	2	0.004	0.005	0.995	
Correction Factor	26.844	1	26.844	29.122	0.000	
Residence	0.003	1	0.003	0.003	0.957	0.725
Repeat	0.006	1	0.006	0.007	0.935	
Error	48.854	53	0.922			
Total	84.296	56				
Corrected total	48.863	55				

Table 30. Mn concentration variance table for hair dyeing

Factor	SQ	df	MQ	F	Sig.	$LSD_{5\%}$
Modell	1.127	2	0.563	0.625	0.539	
Correction Factor	36.155	1	36.155	40.142	0.000	
Residence	1.121	1	1.121	1.244	0.270	0.526
Repeat	0.006	1	0.006	0.007	0.935	
Error	47.737	53	0.901			
Total	84.296	56				

Corrected total	48.863	55				

Table 31. Mn concentration variance table by age

Factor	**SQ**	**df**	**MQ**	**F**	**Sig.**	**$LSD_{5\%}$**
Modell	1.302	5	0.260	0.274	0.925	
Correction Factor	33.288	1	33.288	34.994	0.000	
Residence	1.296	4	0.324	0.341	0.849	0.975
Repeat	0.006	1	0.006	0.006	0.936	
Error	47.561	50	0.951			
Total	84.296	56				
Corrected total	48.863	55				

CONCLUSIONS AND RECOMMENDATIONS

In the case of heavy metal contaminants analyzed from a residential point of view, all the substances analyzed were present in higher concentrations in the Csepel area than in the "Erzsébet" area, except for copper and manganese. These were selenium, iron and cadmium, shown in Tables 14, 19 and 24. This may be due to Csepel's history in the manufacturing industry. From the late 1800s onwards, there was extensive metal processing in the area, from which the people living here could have benefited.
In terms of age groups, most heavy metals accumulated in the bodies of people aged between 20 and 30. This may be due to unhealthy lifestyles or to the large-scale development of industry and transport.
When looking at the gender distribution, only iron concentrations were higher in men than in women. For men, this may be due to occupational pollution. For women, it is due to the high use of various cosmetics. Concentrations of manganese, cadmium and copper were compared with measurements in other literature. Their measurement results were of the same order of magnitude as ours. One of the articles is about the analysis of heavy metals accumulated in the bodies of people living in the environment of an electronic waste recycling area [22] The other one was about the accumulation in the occupational environment [23] Therefore, together with the measured results, we conclude that people living in the area of Csepel Works, including people living and working in Csepel, are more contaminated with heavy metals than people living in other cities. Studies by Salih and Aziz [24] also showed that workers in contaminated areas had higher concentrations of different heavy metals in their hair. Our suggestions are the next:

- Regular testing of soil and groundwater in Csepel.
- Investigate the heavy metal exposure of workers in the current Csepel Works area and reduce or eliminate the causes of exposure.

It would be advisable to carry out a future study of heavy metals in the Danube sludge surrounding the island of Csepel. This would show how much heavy metal has been released from the Csepel Works into the Danube over the years.

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Article submitted to the Proceedings Book of the VIth. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

ENVIRONMENTAL POLLUTION AND PUBLIC HEALTH

Hosam E.A.F. BAYOUMI HAMUDA

Institute of Environmental Engineering and Natural Sciences, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Budapest, Hungary. E-mail: bayoumi.hosam@uni-obuda.hu, Mobile: +36303900813

Pollution is one of the major problems persisting in our environment causing an increase in the morbidity and mortality, which ultimately affects the economic growth of a world. Therefore, environment quality sensing tools have become inevitable in everyday life. Environmental health concerns are a critical issue nowadays that needs joint efforts from multiple sectors to achieve better public health outcomes. The holistic approach, relevant to food safety and control of diseases (e.g. Covid-19) through usage of green technologies should be considered. The application of cleaner and effective technologies can be expanded to management and control pollution. The potential topics from the following research areas are expected: Global environmental health; environmentally friendly processes and their effects on human health; outdoor air quality, surface and ground water quality improvements; toxic substances and hazardous wastes reduction; environmental pollution, microbial degradation of pollutants, nanomaterials, nontoxicity and safety issues, food safety and agricultural products etc. Simultaneously, there is an increasing demand for natural bioproducts of therapeutic and industrial significance (in the areas of healthcare, environmental remediation, microbial biotechnology). Growing awareness and an increased attention on environmental issues such as climate change, energy use, and loss of non-renewable resources have carried out a superior quality for research that provides potential solutions to these problems. Emerging microbiome approaches potentially can significantly increase agriculture productivity and human healthcare and henceforth can contribute to meet several sustainable development goals. The aim of this study is to illustrate the novel research contributions on innovative approaches to manage, mitigate and valorize wastes produced by different sectors, with the aim of transforming our society towards a sustainable and circular bioeconomy. The present study discussed aspects including risk factors in atmospheric and water environment, public health improvement, changes of food trend, and living environment to elucidate the importance of environmental allergen

***Keywords**: environmental pollution, metal contamination, xenobiotic, clean technologies, public health*

INTRODUCTION

Environmental pollution resulting from agricultural practices and operations has become an issue of critical concern in recent years. Pollutant discharge from agricultural systems has been documented as one of the key non-point sources of pollution chiefly responsible for soil and water quality impairment in the worldwide. As major polluters, enterprises are expected to behave responsibly toward the natural environment. However, enterprises often do not pay enough attention to the environment and may even be environmentally irresponsible. Encouraging enterprises to actively accept environmental responsibility is the key to solving the problem of environmental pollution. Perhaps, nothing is more important today for businesses and societies than the management of the global and local environmental changes that are degrading all aspects of life—a trend at risk of worsening for future generations.
The main ambition of most nations in recent times is to reduce the environmental implications of greenhouse gas emissions which have resulted in global warming and climate change. Various chemical amendments have been effectively used to immobilize pollutants resulting from agroecosystems. Reduction in the mobility and solubility of contaminants such as P, Zn, Cu, Pd, Cd,

has been achieved by the use of various pure and industrialwaste materials, limiting the environmental toxicity of these pollutants. However, the continuous addition of most of these amendments and their associated impurities could in turn have a detrimental effect on soil and water quality.

To reduce production costs and pursue profit maximization, enterprises tend to overdevelop and generate excessive emissions, which creates shocking problems such as air pollution, water pollution, land pollution, and resource depletion. Nowadays, air pollution is a burning problem for every part of the globe. More than 100 pollutants which pollute air have been identified. They may be in the form of solids, liquids or gases. They differ significantly from place to place depending upon the particular complex of contaminant source and atmospheric conditions. The air pollutants emitted from both natural as well as anthropogenic sources.

A series of serious problems has been caused by environmental pollution, and corporate environmental responsibility has received increasing attention. Contaminants such as nitrogen, phosphorus, dissolved organic carbon, arsenic, heavy metals, and infectious pathogens are often associated with agroeco systems. The environment has become ever more hazardous due to industrialization for city development in many countries. This includes the sky and the soil where humans reside. Tiny particles from vehicles (e.g., diesel exhaust particles, particulate matters (PM)), dusts containing ultrafine particles (e.g., diameter below 0.1 μm), smoking (e.g., first- and second-hand smoke), chemicals from factories (e.g., coloring dyes, cotton, epoxy resins, isocyanates), and the emerging electromagnetic field (EMF) in telecommunications.

Tiny particles such as $PM_{2.5}$ and PM_{10} have diameter 2.5 μm and 10 μm, respectively or below can pass through and are trapped in our lung cells. The trapped PM affects breathing rate as it agglomerates into insoluble particles in the lungs that obstruct airway, thereby inducing breathing difficulties linked to chronic obstructive pulmonary disease. Tiny particles of chemical sources such as coloring dyes have been reported to be allergic to some people. Carmine (e.g., red), tartrazine (e.g., yellow), and annatto (e.g., orange or yellow) have been used in food coloring for meat, or peanuts, and many other types of foods. The common symptoms of allergic associated with food coloring include severe headache, itchy skin, breathing difficulty, and chest tightness.

Very small chemical particles such as coloring dyes have been reported to be allergic to some people. Carmine (e.g., red), tartrazine (e.g., yellow), and annatto (e.g., orange or yellow) have been used in food coloring for meat, or peanuts, and many other types of foods. Of the three coloring dyes, tartrazine has been mostly reported to be allergic and might cause pruritus and urticaria. The common symptoms of allergic associated with food coloring include severe headache, itchy skin, breathing difficulty, and chest tightness. Figure 1 summarize the allergen exposures

Air pollution is one of the biggest environmental health problems in the world; accumulative studies have shown that air pollution was closely related to metabolism disorders. HbA1c is a stable indicator for blood glucose level monitoring. However, studies on the impact of ambient air pollution on HbA1c have inconsistent conclusions. Inorganic gaseous pollutants (such as ozone, nitrogen dioxide, and sulfur dioxide) and volatile organic compounds (VOCs) have been the focus of attention in many studies in the literature because of their serious effects on human health and the ecosystem. Especially, ozone (O_3) is of primary interest because of its phytotoxicity at ambient concentrations and widespread existence in Europe, particularly in the Mediterranean area.

The study is going to explore the influence of ambient air pollution on HbA1c. By searching keywords, a systematic literature retrieval was carried out on PubMed, Cochrane Library, Web of Science, and Embase databases up to April 2022. Pooled percentage change (%-change) and 95% confidence intervals (95% CI) were estimated using random effect models for particulate matter (PM) and nitrogen dioxide (NO_2).

LASER, and most importantly, mobile phones. Power and phones range from 10^1 to 10^4 Hertz (Hz), radiowaves range from 10^4 to 10^9 Hz, and LASER communication is at 10^{14} Hz. Some reports on triggered sensitivity have been linked to mobile phones which lie in the 2–4 GHz. However, the future is 5 GHz with yet unknown effect on our health. Previous study reported that weak magnetic field shares similarity with chemical reactions from drug, indicating that magnetic field may affect humans at molecular level. Symptoms that have been reported include headache, nausea, and dermatological symptoms. However, the reported symptoms are yet to be medically diagnosed.

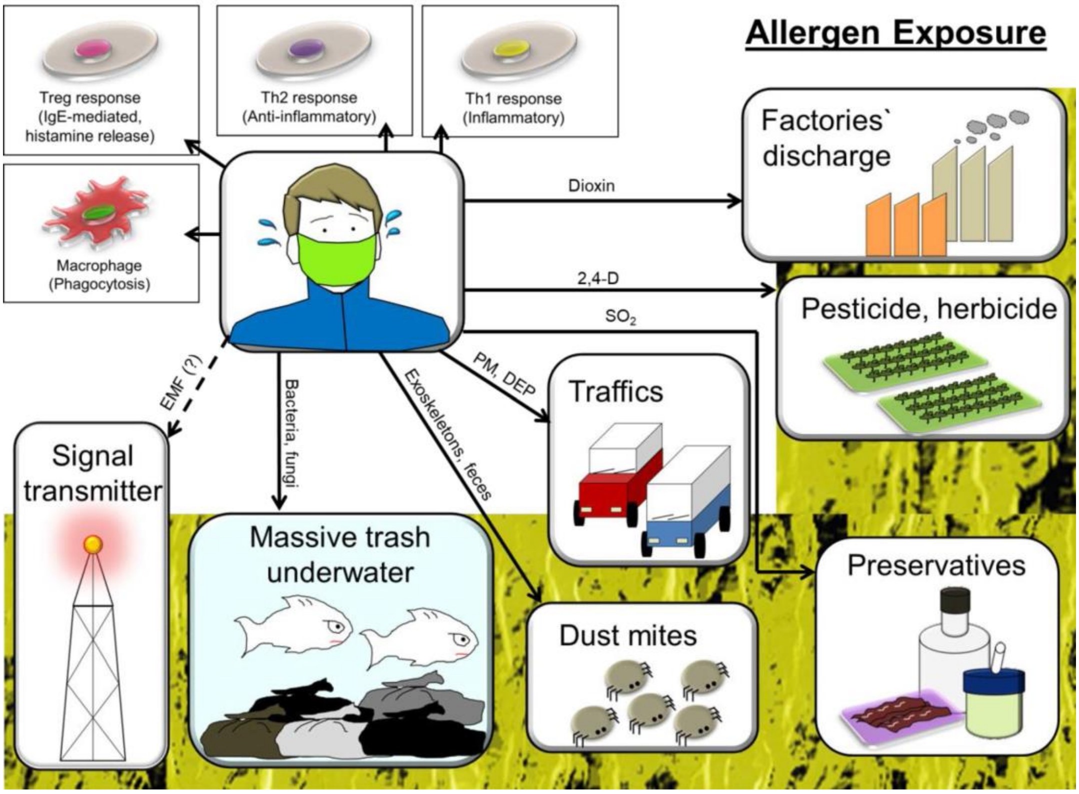

Figure 1. The currently known allergen exposures (Source: Yong et al., 2022[1])

HEAVY METALS IN THE ENVIRONMENT

Heavy metals generated by a variety of industiral practices can cause significant environmental harm if not efficiently eliminated from the wastes. These heavy metals adversely affect human health, the environment, and aquatic systems when they accumulate in living organisms at levels above the permitted limits.

Heavy metal accumulation in soil interrupts the normal functioning of soil ecosystems and plant growth [2,3]. Plants absorb various kinds of heavy metals when available in the soil or irrigation water [4]. Metals like manganese (Mn), magnesium (Mg), copper (Cu) and iron (Fe) is classified as plant essential metals. These metals are required in specific amount and their deficiency or elevated concentrations will result in toxic effects and reduce the plant productivity. For example, Mn is involved in splitting water molecules necessary for photosynthesis. Other metals like magnesium deficiency is responsible for cholorosis in plant leaves [5,6] and also induces oxidative stress [7]. Zinc (Zn) is essentially required for plants. However, too high concentrations can damage plants [5] and inhibit their growth. Zinc is responsible for chlorosis in leaves by reducing chlorophyll [8]. However, heavy metals including Cd and Pb are toxic metal and influence the plant growth adversely by affecting the leaves and root growth and inhibit enzymatic activities and resulted in reduce production [9,10]. Cadmium is considered as phytotoxic as it inhibits plant growth parameters including respiration, photosynthesis and water and nutrient uptake [11]. Further it reduces the rate of new cell production and root growth [12], inhibits the ant oxidative enzymes activities [13] and induces oxidative stress in cells [14]. Moreover, Cd induces changes in plants at all biochemical, physical and genetic levels, which are responsible for the reduction in the growth of plants [15], leaf chlorosis, and leaf or root necrosis [15] and ultimately plant death occurred [16]. Like Cd, Pb is also phytotoxic in nature. It affects the plants photosynthesis by reducing the chlorophyll content. This is because Pb reduces the uptake of chlorophyll-essential elements such as Mg and Fe, affecting chloroplast, changing essential enzymatic processes for photosynthesis and disturbing the closing of stomata [17]. Lead has significant impacts on seedling dry mass, root and shoot length, and weight [18,19]. It adversely affects the process of respiration and metabolism of plants [20]. Soils are contaminated in the environment with a number of heavy metals by natural (weathering and erosion of parent rock material or ore deposits) or artificial (wastewater irrigation, mining activities) sources. The presence of one contaminant can increase or decrease the impacts of others. To date, majority of studies have focused or investigated the effects of a single metal on plant species [21–23]. However, the study of plant to a mixture of heavy metals requires more attention throughout the world.

POLLUTION AND HUMAN HEALTH

Human exposure via the oral pathway (*i.e.*, eating food) is one the major routes for heavy metal exposure [24]. *Spinacia oleracea* is a member of the Caryophyllales order, comprising broad, green and leafy vegetables possessing large surface areas, relatively high growth rates and rather elevated heavy metal absorption rates. Recently, due to these unique characteristics, *S. oleracea* and other members of the Caryophyllales order have been researched in a number of scientific studies to observe their growth and toxicity responses to heavy metal contaminations [25–28]. *Spinacia oleracea* has an imperative position in the order due to large and expanded leafs, fast growth and by being a common part of the human diet. Nevertheless, there is a lack of information regarding growth behavior, metal accumulation, total protein content, fiber characteristics, moisture content and inorganic nutrients response to individual and combined heavy metals with respect to this plant. Therefore, it is necessary to unravel the response of *S. oleracea* to a range of individual and combined heavy metals.

Heavy metal contamination in soils is the cumulative results of intensive smelting and mining activities [29]. For instance, Liu et al. [30] reported that the concentrations of As, Cu, Pb, and Zn in four sampling regions of a typical Chinese smelting assembly greatly exceeded the nation limits of Soil Environmental Quality Standard. Zhao et al. [31] also reported that the average concentrations of Cd, Cu, Pb, and Zn in mining and smelting–impacted soils from Baiyin district exceeded the background values of Gansu province. Previous studies have shown that about 40–70% of anthropogenic metals were emitted from smelters into the environment, including soils (Pacyna and Pacyna, [32]). It must be emphasized that Pb/Zn mineral deposits are widely distributed in China, and Pb/Zn smelting activities are responsible for the enrichment of heavy metals such as As, Cd, Cu, Pb, and Zn in soils [33].

As a consequence, the environmental impacts of smelter operations on the soils need to be identified and better quantified for the risk management and remediation of smelter–contaminated sites. At present, mineralogy studies have been successfully applied in the areas of pollution identification and risk assessment for soils, dusts, and slags in mining and smelting areas. Bari et al. [34] have revealed that the main As hosting minerals were identified as tooeleite, arsenopyrite, scorodite, and arsenolite. Palmer et al. [35] confirmed that As–rich minerals (arsenic trioxide) were generated from roaster stack emissions. Berryman and Paktunc [36] have indicated that Cr (VI) was closely related to the Ca– and Mg–rich micro–spherules in ferrochrome smelter dusts. Similarly, Ettler et al., [37] found that the high bioaccessibility of V, Pb, and Zn was mainly caused by the solubility of metal–rich Mn oxides, slag glass, hemimorphite, and carbonates. Despite the extensive global studies reported for heavy metal contamination in soils around smelters, limited literatures address the soil mineralogy as the potential control that influences element geochemistry in soils around smelters [38]. In addition, there remained poorly understood about the relationship between the metal hosting phases and the environmental behavior of heavy metals in smelter–impacted soils.

Among the heavy metal ions, e.g., Pb^{2+} and Co^{2+} represent a greater hazard to human health. Acute Pb^{2+} exposure, e.g., can result in newborn brain harm and nervous system, kidney, as well as vascular system disorders. Removing these harmful metals from polluted water is critical for both human health and environmental conservation. Associations between environmental pollutants such as heavy metals and harmful chemicals and adverse human health effects have emerged recently, but the links among environmental metals and respiratory diseases need more studies.

Cadmium is considered as one of the most toxic non-essential heavy metals that can cause negative impacts due to exposure in humans and other living organisms. It is occurring as pollutant in the environment resulting from industrial and agricultural procedures. Primary Cd^{2+} exposure routes include consumption of contaminated food and water, and inhalation from smoking. Studies show that exposure to Cd^{2+} has been linked with kidney, lung, breast, pancreas, prostate, and nasopharynx cancers. Pollution from plastic toys is one of the most important potential routes of exposure to toxic metals such as Cd^{2+} and Pb^{2+}.Regarding Pb^{2+}, the toxic effects of this metal in children have been associated with learning difficulties, attention deficit, low intelligence quotient (IQ), and antisocial behavior. Lead pollution can occur during the food production process through specific migration from packaging into the foods contained. With regard to Cd^{2+}, the main toxicological effects include renal damage, hypertension, emphysema, malformation, and impaired reproductive function. Exposure to Cd^{2+} can take place through occupational activities involving contact with the meta and by ingesting foods contaminated by this metal. Childern exposure to these heavy metals is a worldwide health problem, where children are especially vulnerable both because of their hand-to-mouth behavior and the fact their gastrointestinal and nervous systems are undergoing development.

ENVIRONMENTAL POLLUTION

Chemical pollution arising from heavy metals and metalloids is a growing global concern and a major cause of pollutionrelated diseases in the world today, especially in low- and middle-income countries.
Environmental pollution has become more diversified in recent years as technologies for urbanization is increasingly more advanced. Several environmental factors such as air and water pollutants have been linked to allergic symptoms. For instance, because of industrialization for city development in many countries, polluted soil or tiny particles in the air could result in an even more hazardous environment for people to reside. Aside from the aspects of environmental issues, other newly emerging factors such as the electromagnetic field (EMF) also require further investigation. Issues regarding environmental factors in the influence of immune system have become clinically critical.
The pollution does not stop in the atmosphere, but continues in the hydrosphere. Since a decade ago, global warming has become a concern for health and environment. On the lands, human civilizations thrive as new products along with heat-trapping air pollutants. To solve the heat trap in atmosphere, some countries have used aerosols. The amount of wastes include plastics, heavy metals, alloys, and chemicals (e.g., pesticides from farmland), nuclear materials (e.g., uranium-238 (half-life of 4.47 billion years), hydrogen-3 (half-life of 12.3 years), and carbon-14 (half-life of 5,730 years)), and various other materials are increasing quickly. However, for some of the wastes such as plastics, burning could potentially cause severe influence on the environment and thus could not be fully relied on [39]. Some of the wastes such as heavy metals are not decomposed [40]. To save the lands from being drowned by massive trash, the trash are in fact submerged in water [41]. The atmospheric pollution and the wastes that are kept underwater help breed bacteria, fungi, and other microorganisms that are yet to be discovered. The health concern due to sea pollution arises from the fact that fishes are being consumed worldwide. In some nations, aquatic lives are staple foods; in other nations, people live on the water as a lifestyle. The metals foundbreed bacteria, fungi, and other microorganisms that are yet to be discovered [42]. The health concern due to sea pollution arises from the fact that fishes are being consumed worldwide. In some nations, aquatic lives are staple foods; in other nations, people live on the water as a lifestyle. The metals found in contaminated water such as chromium, mercury, and tin are consumed by fish at the top of food chain [43]. In addition, fish contaminated with heavy metals has been associated with eczema in children [44]. However, one of the most toxic by-products from industrial waste is dioxin which is manufactured during paper bleaching, metal refining, and incineration. According to the US Environmental Protection Agency, dioxin can be found in the drinking water from factories discharge and waste incineration, and has been associated with allergy [45].

HYGIENE IMPROVEMENT

As modernization rapidly grows worldwide, an increased ways of sanitation which results to improved hygiene in personal and public environment. The applications of bactericidal agents, pesticides, as well as angenies have reduced bacterial and parasitic and other microbial infections. Reduction in microbial infections reflects the fact that less microbe's invasion in our immune system. An immune system that experiences reduced or no foreign invasion might be unable to act rapidly against foreign pathogen while being attacked the second time [46]. However, previous study suggested that the gut microbiota is linked to an IgE-mediated food allergy, rather than microbial infection [47].

The adaptive human immune system can be modulated by T helper 1 (Th1) (e.g., fighting against intracellular invaders such as virus and bacteria) or Th2 cells (e.g., triggered by extracellular invaders). The Th1 response activates macrophages to kill the invaders. Th1 cells secrete interferongamma (IFN-γ) to trigger Th1 development and suppress Th2 response. The Th2 is known as a humoral response which produces antibodies to generate isotype switch to fight against foreign pathogens. While Th1 cells secrete IFN-γ, Th2 cells secrete interleukin-10 (IL-10) to trigger Th2 response while inhibiting Th1 development. Since the antibodies are triggered from a humoral response, the immune system can store a memory of the pathogens that have been encountered in an earlier period, such that identical pathogens can be killed efficiently upon the second encounter. Evidence has shown that reduced microorganism infection can affect the Th1/Th2 response. If the Th2 response is less triggered, the immune system has reduced ability to fight various pathogens, the immune system is inclined to Th1 response, causing an autoimmune response [48].

CHANGES IN FOOD TREND

Globally, manufacturing of food products has become modernized in many ways. To prolong storage period, or to make foods taste better, foods are chemically processed Preservatives such as antioxidants (e.g., sulfur dioxide, sodium benzoate, and nitrates) are added in meat products and beverages to prevent bacterial infection. The beer and wines, sausages, meat patties for burgers, and even pickled vegetables can be preserved with sulfur dioxide to restrict oxidation. Unfortunately, some people are allergic to the added antioxidant.

To grow foods more efficiently, seedlings are cultivated with herbicides (e.g., 2,4-dichlorophenoxyacetic acid and glyphosate) or pesticides (e.g., rodenticide warfarin, permethrin, and carbaryl). The 2,4-dichlorophenoxyacetic acid (2,4-D) is an active ingredient in herbicides for removing unwanted vegetation. The 2,4-D has been linked to allergic wheezes as it is widely used in public parks, playground, and crops [49]. The pesticide warfarin is widely being used to kill rats. Since the 1970s, even stronger type of warfarin was being developed to overcome rats that were resistant to warfarin which was then called "Superwarfarin." The molecule brodifacoum is found in the superwarfarin which restricts the function of vitamin K by stabilizing the inactive form of vitamin K, vitamin K epoxide (Card et al., [50]). Furthermore, warfarin was found to induce skin conditions such as dermatitis, urticaria, purpura, hemorrhagic necrosis, and purple toe syndrome (Kwong et al., [51]). In addition to food making, plasticizers are used in various cooking utensils, plastics, which can be dissolved after a period of time and be mixed in the lipids of foods during cooking. Phthalate ester is a plasticizer commonly used for increasing flexibility in plastics and has been associated with atopic dermatitis (Takano and Inoue, [45]). As a result, human consumes various types of molecules apart from the original foods themselves.

RESIDENTIAL ENVIRONMENT

Dust mites are prevalent in residential areas worldwide regardless of geographical locations. The factors that determine mites prevalence are dependent on their need to humidity and to avoid light. The prevalences of dust mites are added on by pets inside the residential areas. In addition to pets, the use of air conditions can stabilize humidity in the living environment. Clinical symptoms for dust miteassociated allergy include wheezing and breathing difficulty. *Dermatophagoides farinae*, *Dermatophagoides pteronyssinus*, *Euroglyphus maynei*, and *Blomia tropicalis* belong to the arachnid class. Components from the mites (e.g., exoskeletons, feaces) can affect skin through proteolytic effect on epithelial cells (Erban et al., [51]). The dust mites can activate the pattern recognition receptors which recognize conserved pathogen associated molecular patterns (PAMPs) to induce innate immune system. Clinical symptoms from dust mites include rhinitis, asthma, and atopic dermatitis.

POTENTIAL PREVENTION AND PUBLIC HEALTH APPROACHES OF HUMAN HEALTH

In prevention of respiratory diseases aroused by air pollution, approaches could be applied in the aspects of environmental policy and personal prevention (Pfeffer et al., [52]). As for personal prevention, avoidance of places with high risk of allergen exposure could be effective in lowering the adverse influence in respiratory system. Moreover, antioxidants could also serve as feasible option as pharmacotherapies for allergen-associated allergic reaction prevention (Pfeffer et al., [52]). For instance, in a previous translational study, vitamin D was reported to play a protective role in the pathogenesis of pollutant-induced inflammation (Pfeffer et al., [53]).

Other substances or medications such as vitamin C, vitamin E, N-acetylcysteine, and sulforaphane could also provide similar effect on antioxidant response (Pfeffer et al. [52]). However, given that there were many risk factors regarding the development of allergic diseases, it is important to consider the effect of confounders while setting allergic diseases as observational outcomes in studies (Paller et al. [54]). Therefore, while considering the preventive effect to pollutant-induced allergic reaction, potential influence of confounding biases should be noticed in studies. To further clarify the interaction between public health and allergens, future studies should focus on the effectiveness of different policy implement and the influence on environmental toxicant-associated pediatric allergic diseases.

As a conclusion, different environmental allergens pose various extent of risk in people. The influence does not only limit in respiratory system but also could potentially lead to systemic influence and changes in the comorbidity status (Gau et al. [55]). Identifying potential interaction between environmental pollution effects and allergy could be protective for future allergic statuses. Clarifying interactions between allergens, pollutions, and microbiomes could be effective in understanding the influence to the severity and onset time of allergic diseases (Burbank et al. [56]). The Global Burden of Disease study showed that air pollution is the fourth leading cause of death and disability [57]. More than 92% of the world's population lives in places with $PM_{2.5}$ concentrations higher than 10 $\mu g/m^3$, on the basis of an air quality standard announced by the World Health Organization (WHO) in 2005 (WHO [58, 59])

Accumulative studies have shown that ambient air pollution (including diameter ≤ 10 (PM_{10}) and ≤ 2.5 μm ($PM_{2.5}$), NO_2, ozone (O_3), etc.) is the biggest environmental problem caused by industrialization, increasing the risk of metabolic disorders (such as insulin resistance) and related diseases (such as type 2 diabetes) (Eze et al. [60,61]). In order to improve global air quality, a series of policies have been adopted to improve energy efficiency and reduce energy pollution, but the protective benefits of improving air quality are largely offset by harmful factors caused by aging population, economic polarization, climate change, and other factors (Geng et al. [62]). Meanwhile, health hazards can still be observed in Europe and America where air quality levels reach those of the WHO air quality guideline in 2005 (Strak et al. [63]), suggesting that the health effects of air pollution have been seriously underestimated.

HbA1c (HbA1c is a combination of hemoglobin and glucose with a slow, nonenzymatic reaction in red blood cells; the levels of HbA1c in the blood remain relatively stable for 2–3 months until the red blood cells are metabolized and was normally measured using a high-performance liquid chromatography throughout the blood sample (Riant et al. [64]) is a stable biomarker, which can reflect the average blood glucose level, and this meta-analysis showed that higher levels of HbA1c were significantly associated with the exposure to PM_{10}, $PM_{2.5}$, and NO_2. The subgroup analysis showed that exposure period, sample size, and Body Mass Index were associated with HbA1c in response to air pollution. Public awareness of the health impact of air pollution should be enhanced and the mechanism of the air pollution's effect on metabolism needs further exploration. According to Lauri [65], China's CO_2 effusions increased by approximately 1.7% per year on average from 2015 to 2020. Irrespective of the economic consequences of the COVID-19 pandemic, the country's CO_2 exudates continued to surge by about 1.5% in 2020..

Nowadays, the world is experiencing carbon emission and climate change which knock down the environment and the economy, so all the countries raise their concern towards green technology innovation to restore the environmental degradation without compromising the growth and development. Environmental regulation plays a crucial role in attaining sustainable development as it improves energy efficiency and reduces pollution emissions.

Exposure to environmental chemicals and metals causing adverse health effects is a major concern leading to numerous conditions including hypertension, cardiovascular disease, sleep disorders, decrease in cognitive function, and allergies (Rahman et al., [66-72]). Exposure to heavy metals has been associated with chronic diseases likely due to oxidative stress and inflammation in the lungs causing tissue destruction [73]. Among occupational respiratory diseases, there has been a shift from exposure to mineral dust such as coal and silica in the 20th century to low-dose allergens and irritants. This has led to a change in respiratory diseases from pneumonoconiosis to occupational asthma. Approximately 15% of all chronic obstructive pulmonary disease (COPD) cases in western societies have been attributed to dust, fumes, vapor, or gas (De Matteis et al. [74]).

In 2018, it was found that pollution was responsible for 9 million deaths worldwide. And it was corresponded to 16% of the total global deaths, and to 21% of all deaths from cardiovascular disease, 26% of deaths due to ischaemic heart disease, 23% of deaths due to stroke, 51% of deaths due to chronic obstructive pulmonary disease, and 43% of deaths due to lung cancer" (Landrigan et al. [75].

HEALTH RISKS: INFECTIOUS DISEASES CLIMATIC CHANGES

Climate change is now becoming a critical public health challenge by increasing exposure to rising temperature, extreme weather, declined air quality, and new pests and pathogens. Actions can be taken to lessen the effects of climate change and to build resilience to reduce the impact on human health.

A multidisciplinary and collaborative effort from the scientific community is needed to establish a comprehensive understanding of these topics. Several studies explored some interesting topics on the relationship between climate change and human health. the direct and indirect effects of carbon emissions on public health; when the average temperature of the year exceeds 17.75°C, an increase in greenhouse gas emissions will have a more significant negative impact on public health. However, the climate change and environmental pollution problems induced by rapid economic development has caused a great threat to our human lives (Watts et al. [76]).

DISPOSAL OF HEALTHCARE WASTE

Globally, disposal of healthcare waste is a key issue of environmental sustainability. The amount of healthcare waste is increasing every day, and it is necessary to adequately dispose of this kind of waste. There are various treatments for healthcare waste disposal, of which incineration of healthcare waste is one of the solutions. Waste generated in healthcare institutions is classified into three main groups: municipal waste, healthcare wasteH and hazardous waste. At the same time, Healthcare waste represents very big challenges for public authorities Healthcare waste raises high levels of concern about public health and the environment. Improper management of healthcare waste can cause significant environmental pollution (Kumar, et al., [77]) and health problems in terms of the spread of diseases caused by viruses and microorganisms and can generate groundwater pollution as a result of continuous disposal of untreated medical waste in municipal landfills (Lu, et al., [78]). Healthcare waste directly and indirectly affects health and the environment risking more risks (Geetha, et al., [79]).

Healthcare institutions do not have a different approach to healthcare waste which is often mixed with municipal waste (Lee, et al., [80]) which further has consequences for human health and the environment. HCW waste must be disposed of properly. There are different ways of treating healthcare waste such as: incineration, autoclaves, chemical disinfection, disposal in the ground, and deep burial (Geetha, et al., [79]). Process of selection of the best and most effective healthcare waste treatment technology has been the subject of huge research interest (Shi, et al., [81]), especially because of great environmental and financial effects. When choosing treatments for HCW management, it is necessary to provide a reliable and environmentally friendly healthcare waste management system that is, according to Aung, et al. [82], one of the most important topics on the agenda for health institutions and local communities.

However, healthcare waste incinerators have a role in increasing environmental air pollution (Datta, et al., [83]). Sometimes, there are conflicting criteria existing in the selection process; thus, the problem of incinerator selection can be done by applying the method of multi-criteria analysis which is a very useful tool for analyzing complex real-world problems.

ENVIRONMENTAL PERSISTENCE AND HEALTH IMPACTS

Recent research suggests a definite distinction between indoor and outdoor microplastics. However, knowledge of different microplastic kinds and relative exposure via inhalation to humans in outdoor and indoor locations is lacking. Notably, microplastics formed from various plastic types could have distinct features, and the relative health risk varies by environment. For example, outdoor polyethylene goods have recently become more popular. These products are generally of poor structure and recycled material, making them more susceptible to decay.
Particularly in the outdoor environment, the constant exposure to an open-air environment increases the risk of fragmentation and atmospheric mixing and thus facilitates microplastic's availability. It is reasonable to assume that breathable microplastics in indoor outdoor environments are more harmful than inhalable microplastics, whereas exposure to indoor breathable polyethylene - microplastics could be highly hazardous (Figure 2).

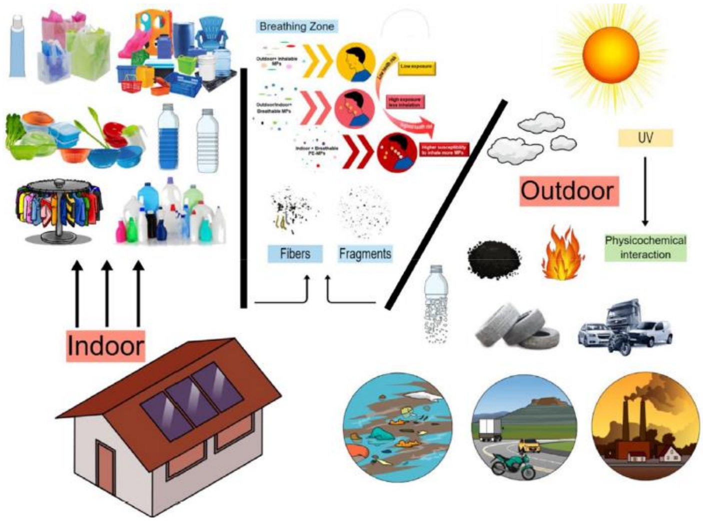

Figure 2. Occurrence, human exposure, and risk of microplastics in indoor and outdoor environments (Source: Mehmood et al., [83])

Exposure to these microplastics from the environment may pose a severe health risk to humans (Goodman et al. [84]). The size and shape of airborne microplastics determine their ability to be inhaled and their fate in the human body. Smaller, angular particles, for example, pass through membrane barriers more quickly than those with longer edges or irregular surfaces (Mehmood and Peng, [85]).
Those coarse microplastics (size: ≤ 10 μm) that can reach the human respiratory system and deposit in the upper airways or enter the intrathoracic cavity (≤ 10 μm) are called inhalable particles. On the other hand, fine microplastics (size: ≤ 10 μm) are called breathable particles and can reach and deposit in the deep lung (gas exchange zone in lungs) (Liao et al., [86]).
Mainly microplastics concentration, distribution, and transport are explained by anthropogenic and climatological factors, leaving physicochemical interaction with environmental attributes like ultraviolet (UV) radiation, oxygen, and other pollutants. Likewise, the variability of different microplastics and their corresponding levels in contrasting environments such as indoor and outdoor is also unclear (Mehmood and Peng, [85]). Several studies suggested that atmospheric microplastics contain a substantial concentration of polyethylene (Mehmood and Peng, [85]).
Subsequently, Zhang et al. [87] reviewed the intake of microplastics in humans and reported that the estimated range of daily microplastics intake of the individual is 0 to 5.7×10^3 items ・ m^{-3} (Liu et al., [88]), which was higher in indoor ($1.9 \times 10^3 - 1.0 \times 10^5$) than outdoor ($0–3.0 \times 10^7$).
In the case of polyethylene - microplastics, the dominant sources are (1) disintegration of outdoor plastic trash polluting cities (Zhou et al., [89]), (2) wind-driven microplastics mobility and fiber release from drying of cloths (Liu et al. [90]), (3) synthetic material cutting or grinding (Dilara and Briassoulis, [91]), (4) tires, (5) incomplete burning of plastic trash (Liu et al., [92]), (6) cyanobacterial and algal biodegradation, (7) surface water bubble bursting (Sarmah and Rout, [93]), and (8) polyethylene sheets

(which are extensively used in farmland for mulching and greenhouse cover) that have been identified as critical agricultural microplastics (Wang et al., [94]).
Since most polyethylene - microplastics) emission sources are linked to the outdoor environment and considering the role of UV radiation in fragment formation of polyethylene, it can be concluded that atmospheric polyethylene - microplastics are mainly released from outdoor polyethylene sources, which is in reasonably good agreement with the findings of Gaston et al., [95]) who reported that polyethylene - microplastics concentration (12.6 ± 8.0 fragments per m^3) were twice in outdoor compared to indoor (5.6 ± 3.2 fragments per m^3) concentration, indicating higher polyethylene - microplastics level in outdoor. Moreover, Liu et al., [92] found that polyethylene - microplastics were higher in the breathing zone than in dust and upper atmosphere (above 83 m). Hence limited use of polyethylene -based products substantially reduces adverse health impacts such as respiratory and lung disorders.
In brief, a detailed health risk assessment of microplastics requires more work and needs to look at a wide range of microplastics for their toxicity and persistence in the breathing zone, relative exposure intensity, and tendency to reach the deeper respiratory tract. Indeed, it consumes a lot of effort and resources, but it is necessary.
Meanwhile, switching to or correcting outdoor use of polyethylene products could cut exposure to atmospheric microplastics by up to 50% in some cities worldwide. In addition, indoor microplastics concentrations are mainly influenced by direct emissions from indoor sources (toys, clothing, mats, curtains, kitchen tools, furniture, mattresses, and so forth) from outdoor sources by ventilation supplies. Besides, indoor environments may also influence transformation processes in pollutants (e.g., inter-zonal transport, mixing, coagulation, re-suspension, and phase change). Therefore, physicochemical changes attributed to microplastics transportation between indoor and outdoor environments may also be important to assess the corresponding changes in microplastics and associated chemical species.

CONCLUSIONS

The current article provided current evidences regarding the association between various pollutants and the potential diseases that could be induced. For people with high skin exposure to air pollutants such as PM2.5, PM10, or sulfur dioxide, potential onset of dermatological allergic events should be alerted. The detailed immunological mechanisms and clinical implications could potentially provide readers with clearer view to the interaction between allergic status and pollutants. For personal prevention, avoidance of contacting potential pollutant and consuming antioxidants could be possible approaches. It is also conculated that critical public health implications because increasing and widespread exposure to environmental heavy metals and their mixtures may be a key contributor to human health conditions. The management of HCW gets increasing importance due to the increasing amount of waste that occurs during the operation of healthcare institutions. There are different types of HCW that can be treated in different ways.

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Article submitted to the Proceedings Book of the VI^th^. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

THE PERMEABILITY VARIABLES OF GRANULAR MATTER

Emőke IMRE[1]*, Zsombor ILLÉS[2], Ágnes BÁLINT[3,9], Henry GONZALES[3], Levente RÉPÁSSY[3], Dang Thi Quynh HUONG[3], Lamas Lopez LIZETH[3], Daniel BARRETO[4], Giulia GUIDA[9], Maria DATCHEVA[5], Wiebke BAILLE[6], Vijay P. SHINGH[7]

[1]Óbuda University, Bánki Donát Faculty, and Hydro-Bio-Mechanical Systems Research Center, Budapest, Hungary, e-mail: imre.emoke@uni-obuda.hu, mobile: +36202892656, [2]Department of Engineering Geology and Geotechnics, Budapest University of Technology and Economics, Budapest, Hungary, e-mail: zsombor.illes@epito.bme.hu, phone: +36 1 463 3004;[3]Institute of Environmental Engineering and Natural Sciences, Óbuda University, Budapest, Hungary, e-mail: balint.agnes@rkk.uni-obuda.hu, mobile: +36303721342,, [4]Edinburgh Napier University, U.K., e-mail:D.Barreto@napier.ac.uk , [5]Institute of Information and Communication Technologies, Bulgarian Academy of Sciences, Bulgaria [6]Ruhr University Bochum, Germany.[5]Università di Roma Tor Vergata, [7] Department of Biological and Agricultural Engineering, Texas A&M University, USA, [9]Hydro-Bio-Mechanical Systems Research Center, Budapest Hungary,

No "unique" relation between soil parameters and grading curves of granular matter can be elaborated. In case some statistics are used (e.g., d_{10}), then infinite many grading curves may be related to the same value of it. Moreover, several densities can be related to the same grading curve, and different permeability values are measured at different densities. A model discrimination study was started to be made to suggest a saturated water permeability k – grading curve – density relation using some new measurements. The following model variables were tested: (i) various grading curve statistics, (ii) combined variables of harmonic mean diameter and density like specific surface are or hydraulic radius, (iii) density parameters like void ratio or the newly applied relative density. Two newly measured data sets were used with identical soil composition and different density (in more dense and less dense states). Both data sets consisted of 3 series of optimal 2-fraction granular soils, the fractions were: 0.25 to 0.5 mm, 0.5 to 1 mm, 1 to 2 mm and 2 to 4 mm. Each series consisted of 5 mixtures with the same, fixed relative base entropy A values (i.e., mean log d values). In addition, some earlier data sets were used to test the extension of the relations. According to the results, the regression for the new data was acceptable if extra density parameters were applied with either the (i) or the (ii) type parameters. The addition of earlier data bases increased the regression coefficient R^2.

***Keywords**: entropy, grading curve, model discrimination, permeability, relative density, specific surface area*

INTRODUCTION

Permeability (*k*) is a measure of the ability of a porous material (typically, a rock or soil material) to transmit fluids (liquid or gas). Permeability is a function of the porosity, the particle diameter distribution and internal structure of the solid medium and the physical properties of the permeating fluid, and so, any measured value is specific to a particular combination of a porous medium and a permeating fluid.
It depends on the intrinsic permeability of the material and on the degree of saturation. Saturated water permeability describes water movement through saturated media (ms^{-1}).

Permeability variables

A particle size distribution curve is a compendium of much quantitative data, and it is difficult to define well and poorly graded soils in terms of a single basic data value from this curve. To overcome

this difficulty, a few derived quantities are defined in terms of the basic particle size distribution curve data. These are the d_{10}, d_{60}, the coefficient of uniformity C_U, given by d_{60}/d_{10}.
Early research established that the hydraulic conductivity may be related to other standard PSD descriptors such as d_{10}, d_{60}, C_U well as the void ratio e [1 to 4]. Recently the grading entropy theory is started to be used ([5, 6]) and the density [7], moreover the specific surface concepts ([8, 9, 10]).

Table 1. Definition and properties of fraction *j*.

j	**1**		**23**	**24**
Limits in d_0	1 to 2		2^{22} to 2^{23}	2^{23} to 2^{24}
S_{0j} [-]	1		23	24

The base entropy S_0 and the normalized form *A* read:

$$S_0 = \sum x_i S_{0i} \tag{1}$$

$$A = \frac{S_o - S_{omin}}{S_{omax} - S_{omin}} \tag{2}$$

where x_i is the relative frequency of fraction *i*, $S_{0i} = i$ is the *i*-th fraction entropy Table 1). The entropy increment ΔS and the normalized version *B*:

$$\Delta S = -\frac{1}{\ln 2} \sum_{xi \neq 0} x_i \ln x_i \tag{3}$$

$$B = \frac{\Delta S}{\ln N} \tag{4}$$

The harmonic mean diameter is:

$$\sum \frac{x_i}{d_i} \tag{5}$$

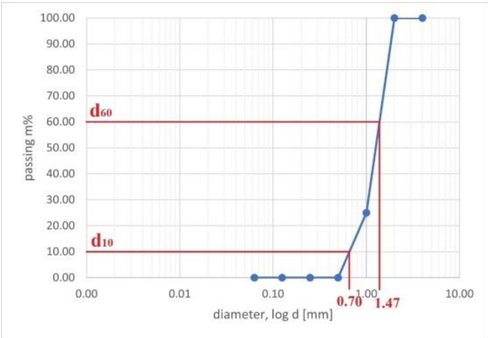
The harmonic mean diameter, d_h is a kind of equivalent grain diameter, being equal to the diameter of the sphere which has the same ratio of volume / surface area as the solid phase in soil. The specific surface area per mass / volume of a soil is the total surface area to the unit mass/ unit volume of grains. The specific surface area per mass of a single sphere and the soil is defined as:

$$S_m = 6/(1+e)/\rho_d/d_h \tag{6}$$

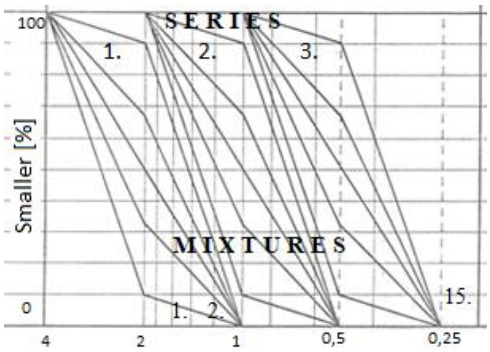
The particle surface area is a value in square metre, and the mass is grams, volume in cubic meters so the units are m^2/g/ and 1/m. The specific surface area per volume is the ratio of the total surface area (m^2) to the volume of the soil (m^3) so it has a unit of m^{-1}. The specific surface area per volume of a single sphere and for the soil is defined as:

$$S_{sV} = 6/(1+e)/d_h \tag{7}$$

In an earlier study of [8], among specific surface per volume parameter (containing density information), harmonic mean d_h and d_{10}, it was found that the best regression explanation (higher R^2) was related to the specific surface variable.
In this work, the following variables were tested: (i) various grading curve parameters, (ii) specific surface area, (iii) void ratio and relative density [7]. Two new measured data sets were used with identical soil composition and different density.



(a)



(b)

Figure 1. (a) Simple grading curve parameters. (b) The grading curve series 1, 2 and 3. These were numbered from 1 to 15.

MATERIALS AND METHODS

Earlier data bases

In Nagy data base [4] the artificial mixtures of natural soil mixtures were prepared from fluvial soil mixtures for permeability testing. The d_{10} or 10% diameter value of the measurement series were as follows:
series of measurements d_{10} = 0.004-0.006 mm,
measuring series d_{10} = 0.006-0.010 mm
measuring series d_{10} = 0.010-0.014 mm, and
measuring series d_{10} = 0.014-0.016 mm.
In Feng database (series V, [6]) d_{10} = 0.72 to 5.82 mm. In Pap database (series VI, [3]) d_{10} = 0.002 to 0.216. These are re-analyzed in this research [8].

New data

15 optimal 2-fraction soils, with fractal gradings were tested by means of constant head permeability tests. The composition of each series was: 25%, 33%, 50%, 67%, 75 % finer, *A*=0.75, *A*=0.67, *A*=0.5, *A*=0.33, *A*=0.25. Two different sample preparation techniques were used resulting in loose state (15 samples) and dense state (45 samples, 3 repeats) was tested (Figs. 1 to 3). The four fractions were: 0.25-0.5 mm, 0.5-1 mm, 1-2 mm and 2-4 mm. The tests with denser samples were repeated in 3 times.

Models

The models were as follows. The simplest relationship among the base entropy parameter S_0, the entropy increment ΔS and *k* [cm/s] in the equivalent forms are as follows:
In addition, the relationship among the base entropy parameter S_0, the entropy increment ΔS, *k* and *e* was determined in the following form.

$$k = \exp C_3 \Delta S^{C_1} S_0^{C_2} \tag{8}$$

$$\ln k = C_3 + C_1 \ln \Delta S + C_2 \ln S_0 \tag{9}$$

$$k = \exp C_4 \Delta S^{C_1} S_0^{C_2} e^{C_3} \tag{10}$$

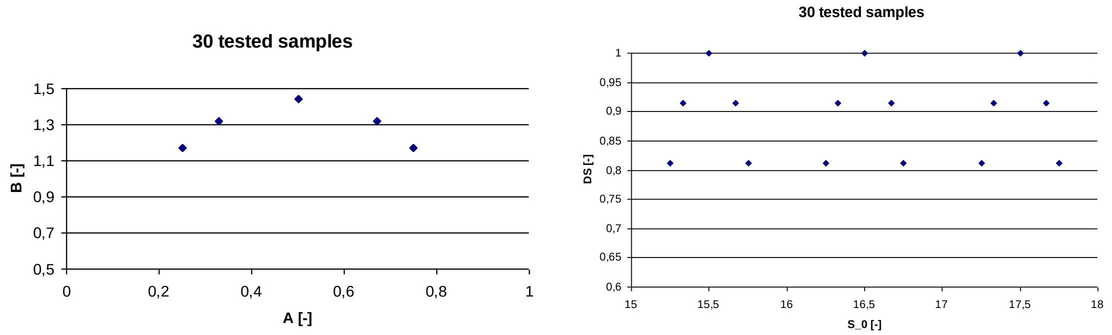
In the equation some other soil variables *p* were written instead of e, like specific surface area per unit volume or relative density:

$$k = \exp C_4 \Delta S^{C_1} S_0^{C_2} p^{C_3} \tag{11}$$

In the relationships the base entropy parameter S_0, the entropy increment ΔS were interchanged. In case of the most recent specific surface area approaches, the void ratio is generally included as extra variable. Using Ren & Santamarina (2018) [10], the following was suggested:

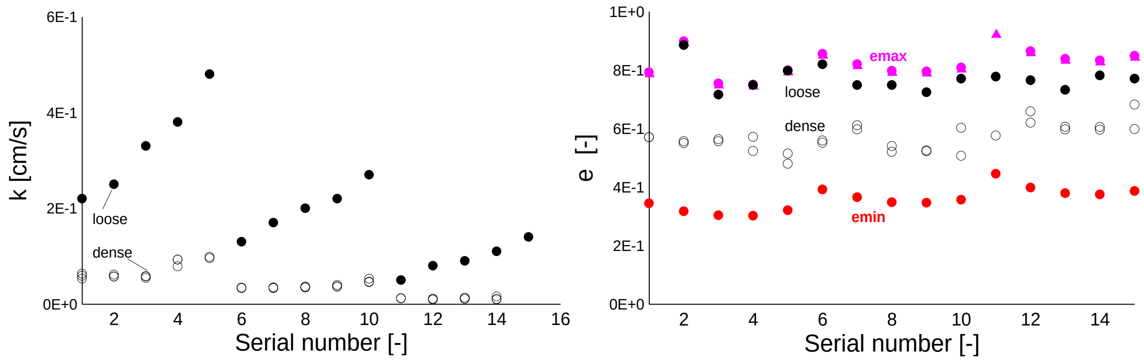
$$k \sim C\ S_S^{-2}\ e^D \tag{12}$$

where S_S is the specific surface area per unit volume or mass, the parameters may be obtained from a fitted power relation.



(a) (b)

Figure 2. The tested 30 mixtures in terms of entropy coordinates (a) Normalised entropy coordinates. (b) Non-normalised entropy coordinates. Due to the coincidences, any relations based on purely entropy coordinates are not suggested.



(a) (b)

Figure 3. (a) The permeability *k* in terms of serial number for tested grading curve series 1, 2 and 3. (b) The void ratios in terms of serial number for tested grading curve series 1, 2 and 3.

The parameters were determined by the Gauss Normal Equations [11]. The least-squares fitting process produces a value – r-squared (R^2) – which is 1 minus the ratio of the variance of the residuals to the variance of the dependent variable. It says what fraction of the variance of the data is explained by the fitted trend line.

RESULTS

New data

Results are shown in Figures 2 to 7 and Table 2. The tested 30 mixtures plot 5 points in terms of normalised entropy coordinates, and 15 points in terms of non-normalised entropy coordinates. The void ratio data were represented with maximum and minimum void ratios, assessed from earlier research, where e_{max} was minimal at A=2/3 in each series (Figure 3), according to measurement of Lőrincz [3]. The minimum void ratio e_{min} was estimated from that [5]. The k -relative density data - relation indicated large difference in k for the two data sets with smaller and larger density (Figure 4).

Model fitting

In this work it was found that the newly measured data separated considerably in terms of entropy coordinates – k and d_{10} – k for loose and dense samples (Figure 5). With extra density parameters, Eqs (10, 11) showed better the R^2 (void ratio e, specific surface area per volume S_{sv} or relative density R_d). The entropy parameters could have been substituted in Eqs (10,11) by d_{10} and Cu. The best the R^2 results were found with relative density. In case of Ren & Santamarina (2018) based relation Eq 12 - the R^2 was larger than in case of the specific surface variable alone. In case of the enriching of the newly measured data, when the Eqs (10, 11, 12) were fitted including the two additional data bases (with series III and V) and with different k range, the R^2 increased. Similar result was found for the case when specific surface area per unit volume parameter is used alone, the two additional data bases with different k range gave increased R^2.

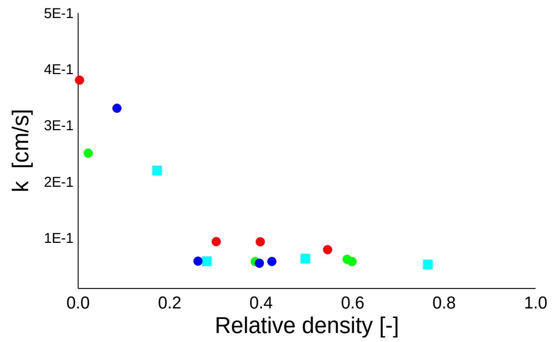


Figure 4. The permeability k in terms of relative density for tested grading curve series 1.

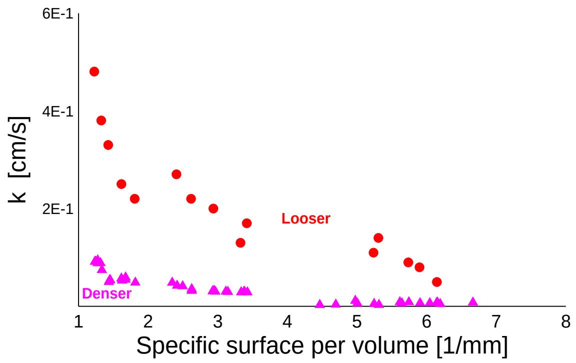


Figure 5. The measured permeability k in terms of specific surface area per unit volume, series 1 to 3, loose and dense samples.

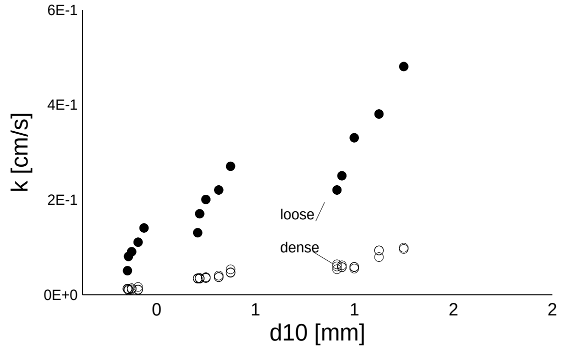


Figure 6. The measured permeability k in terms of terms of d_{10} for tested grading curve series 1, 2 and 3, loose and dense samples.

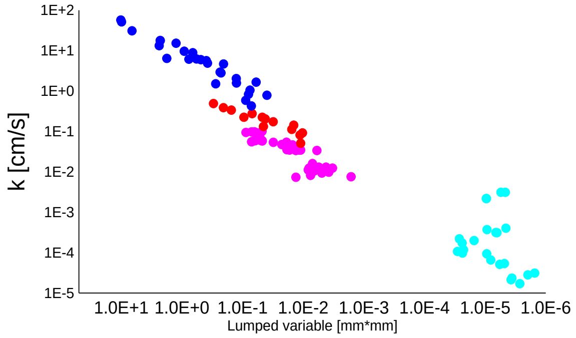


Figure 7. The *Ren & Santamarina* [10] based relation (R^2 = 0,8986). Red and pink: dense and loose data from newly tested series 1 to 3. Blue: database V. Light blue: database III.

Table 2. New 2-fraction mixtures data, R^2 values

extra density variable	R^2
Eq 8, no extra variable	0,4790
Eq 10, with void ratio, e	0,7701
Eq 11, with specific surface area per unit volume	0,7476
Eq 11, with relative density	0,8847
Eq 12, the *Ren & Santamarina* [10] based relation	0,7362

DISCUSSION

Multiple data bases

The Eq 8 type regression was used to visualize the results in the entropy diagram for large *k* ranges, using all previous data I to VI ([8], see Figure 8). The permeability zones of [6] are in accordance with the level lines presented by [8].
The relative density – entropy coordinate models can be extended and used for the entropy diagram representation purpose. The relative density variable may give a good normalisation since the e_{max} is dependent on the internal structure and on entropy coordinate *A* [12].

Fractal gradings and density

The optimal or finite fractal grading curves [12] are mean grading curves of all grading curves with fixed normalized base entropy parameter *A*, for a given fraction number *N* and given smallest fraction ([10,12]). Therefore, these are the best to be used to study the relation of permeability, relative density and grading curves.

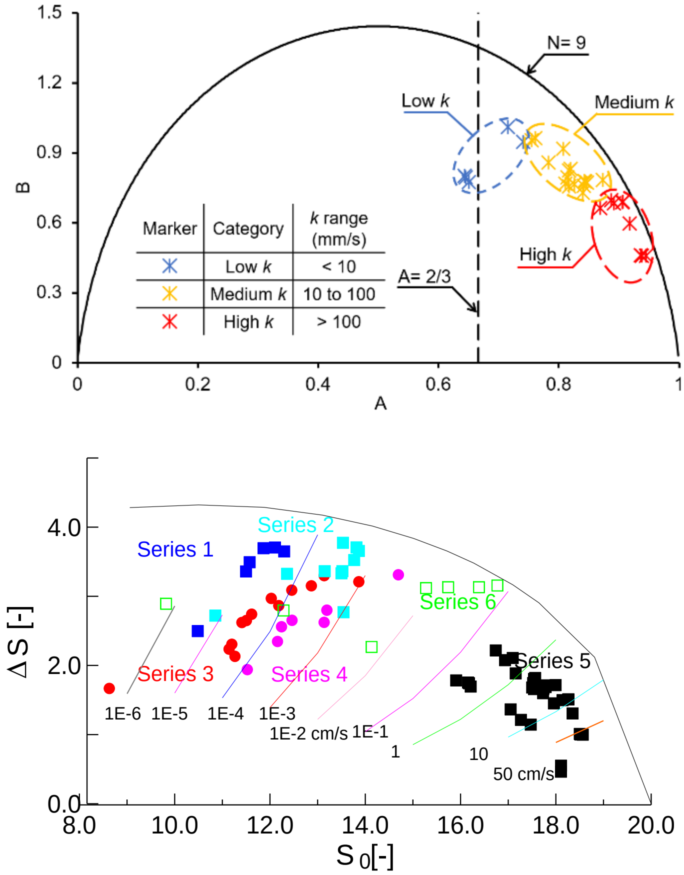


Figure 8. (a) Identified permeability zones shown on the normalized entropy diagram (adapted from Feng et al, 2019a) (b) The level lines determined for Eq. 8, using data bases of 1 to 6

CONCLUSION

The permeability relations can be based either on grading curve statistics like the non-normalised entropy coordinates, or on a specific surface area type variable. In this work it was found that the in each case some additional parameter for the density is needed. The relative density - a newly tested parameter - provided the largest R2 values. The relative density gave a good normalisation in terms of density since - for fractal (or mean) gradings -, the e_{max} is dependent on the entropy coordinate *A*. In further research, the model discrimination study is suggested to be continued, including sensitivity analyses of the various models. Some additional measurements are suggested on the variation of the saturated *k* in terms of relative density. The relative density – entropy coordinate models are suggested to be extended and used for the entropy diagram representation.

ACKNOWLEDGMENTS

M. Datcheva acknowledges the partial support by Grant No BG05M2OP001-1.001-0003-C01 financed by the Science and Education for Smart Growth Operational Program (2014-2020) and co-financed by the European Union through the European Structural and Investment funds.

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Article submitted to the Proceedings Book of the VIth. International Symposium–2022, *Theme: “Biosphere & Environmental Safety”*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

ASSESSMENT OF GROUNDWATER POLLUTION BY HEAVY METALS IN THE INDUSTRIAL ZONE OF SKIKDA

Amina HAFSI[1], Ahsene BOUREFIS[1] , Farès KESSASRA[2,*], Abdellah BOUSHABA[3]

[1]Affiliation Department of Geology and Environment, University les Fréres Mentouri, Constantine 1., [2]Laboratory of Geological Engineering (LGG), Team 3 "Geology", University of Jijel, Algeria.
** Department of Earth and Universe Sciences, University of Jijel, Central Campus, Algeria.*
[3] Department of Geology, Sidi Mohamed Benabdellah University, Fes, Morocco

Pumped groundwater volumes have been estimated at 52 hm^3 per year with 12hm^3 per year being abstracted from oil installation industry in Skikda city, situated in the north east of Algeria. Large industrial demands of groundwater have caused prejudicial effect on alluvial aquifer through aquifer depletion and moreover by contamination of aquatic ecosystems. An environmental assessment was carried out on water resources collected from boreholes and river, the aim was to assess heavy metal contamination in water close to our industrial area. Indeed, 20 water samples were collected in December 2021, including surface water and groundwater. results reveal that Safsaf river presents an alkaline pH (7.49), a high conductivity which reached 10620 us/cm exceeding the WHO limit fixed at 2500 us/cm, dissolved oxygen reaching up to 5.21 mg/l, and a maximum BOD$_5$ of 140 mg/l, this load exceeded WHO standards fixed at 25 mg/l. cadmium concentrations measured at 1.48mg/l as a maximum load which exceed WHO standards fixed at 0.05 mg/l, zinc concentrations show a large peak of 9.3 mg/l, when WHO standards limits it at 3 mg/l in water and arsenic was measured at 1.05 mg/l*, greatly exceeding WHO standards fixed at 0.01mg/l. this high concentration of heavy metals may be of industrial origin, as the river flows through the industrial zone, or anthropic, as Safsaf passes through the entire city of Skikda. On the other hand, groundwater results indicate the presence of cadmium ranged from 0.005 to 5.09 mg/l and largely exceed WHO standards about only 0.003 mg/l.* high concentration could be due to anthropogenic and industrial discharge. *Also, presence of a high concentration of Zn ranged from 0.325 to 7.21 mg/l and largely exceed WHO standards about only 3 mg/l. and which has practically the same sources of pollution as surface water*

Keywords: *groundwater, contamination, Skikda, heavy metal, WHO.*

INTRODUCTION

Any increase in production activity results in an increase in waste, and if there is no destruction, recycling, there is pollution (Faurie et al., 2003).The problem of water pollution undoubtedly represents one of the most worrying aspects of environmental degradation by contemporary technological civilisation (Ramade, 2005). Pollutant discharges can profoundly modify the physico-chemical components of the receiving aquatic environments as well as the biocenoses populating these environments (Pesson, 1980).

Our work consists in carrying out an evaluation of water pollution by heavy metals in the industrial zone of Skikda, which is located in a region that receives daily sewage, domestic waste and effluents from the zone.

Our objective is therefore to determine the degree of contamination and the fate of heavy metals (As, Zn, Cd) in these waters.

MATERIALS AND METHODS

In July 2018 to March 2022, three water sampling campaigns were carried out in the surroundings and inside the industrial zone of Skikda (25) stations were selected, (10) samples from the surroundings of the zone, (3) samples from inside the zone, (4) samples from the refinery effluents, and one sample from the sea water. The pH, electrical conductivity (δ), temperature (T) and dissolved oxygen (DO) were measured *in situ* using a multi-parameter suitcase. All water samples were stored in a cooler, transported to the laboratory. However, prior to storage, these samples were filtered and then stored in a refrigerator at a temperature not exceeding 4°C. Samples for the determination of heavy metals were acidified until their pH was below 2 and then stored in a refrigerator until the day of the ICP reading. The determination of calcium, magnesium and chloride ions was done by the titrimetric method. Sulphates and nitrates were determined by spectrophotometry, sodium and potassium by flame photometry (Rodier, 1996).

STATISTICAL ANALYSIS AND GRAPHICAL PRESENTATION

The temperature values of the water vary between 21.2 and 14.8°C; they are not dependent on the season. The pH values of the stations vary between 7.42 and 9.2; these values exceed the irrigation standard according to FAO (6.50<pH<8.40), and from 6.5 to 8 for the WHO standard. In fact, the pH of the site is alkaline; this alkalinity is related to the lithology of the region which is presented by the predominance of carbonate formations. The electrical conductivity ranging between 334 and 62200 µs/cm, whose minimum content is recorded downstream of Wadi Safsaf (O1), while the highest value is recorded at the level of the P9 All the values measured exceed the WHO irrigation standard (70-300 µs/cm), as well as the FAO standard (700µs/cm). Dissolved oxygen levels vary from a minimum value of 5% to a maximum value of 30%. These values generally exceed the irrigation standards defined by the FAO and the WHO standards, which range from 70 to 90%, but the E2 effluent is extremely low in oxygen, at 4.2%, due to the high pollution load it carries.
From Table 1, it can be seen that calcium ions are in close concentration in the different stations, with calcium contents varying between 250 and 421 mg/l. These contents are classified in the range of 0.5 to 0.5 mg/l. These levels exceed the FAO irrigation standard (200 mg /l). Magnesium contents vary between 13.44 and 40.22 mg/l, with the lowest content recorded in the middle of oued Safsaf (P5) while the highest value is recorded at the upstream end of the wadi (P4).

Table1: physico-chemical parameters analysed in the water

	$N0_3$	NO_2	NH_4	SO_4
p1	0,558	0	0	11,62
p2	2,659	0	0	236,33
p3	3,7	0,01	0,02	294,62
p4	1,6	0,02	0,06	187,59
p5	0,3	0	0	186,5
p6	0,809	0	0,07	268,92
p7	1,52	0	0,16	88,11
p8	2,987	0	0,67	382,88
p9	2,77	0	0,16	294,5
p10	3	0,01	0,02	279,39
p11	1,09	0	0,13	172,49
p12	6,58	0,01	0,37	258
p13	0,79	0	0,13	271,7
p14	9,12	0,01	0,37	325,84

p15	0,79	0,01	0,07	256,66
p16	1,55	0,02	0	173,74
p17	2,25	0,08	0	13,96
p18	2,6	0,15	0	97
p19	3,3	1,02	0,08	193,5
p20	0,8	1,14	0	133,28

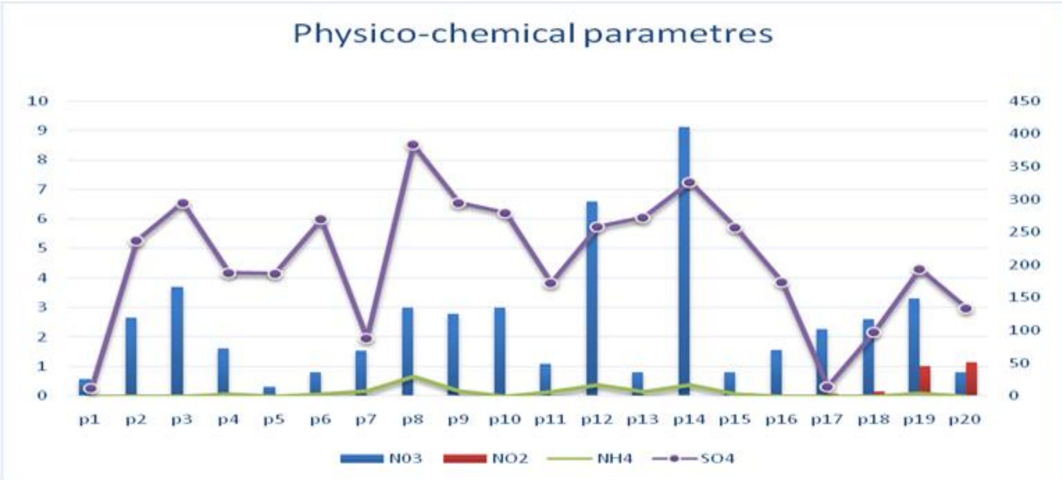

Figure 1. Graph of physic-chemical parameters

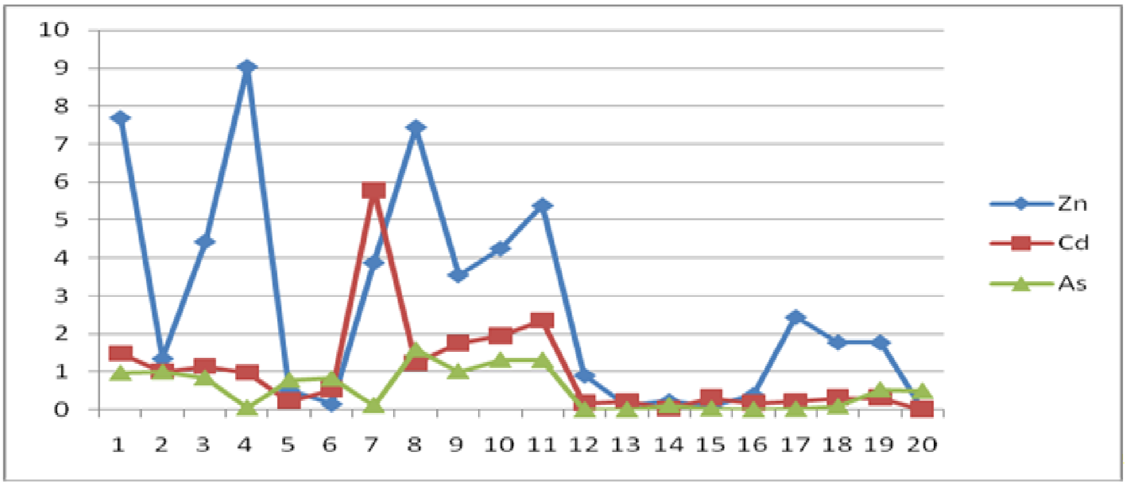

Figure 2. Graph of heavy metal parameters

RESULTS AND DISCUSSION

All points sampled show concentrations above the FAO standard (150 mg/l). The Ca+2 and Mg+2 ions come mainly from the dissolution of carbonate formations (limestone, dolomite, magnesite, etc.). The sodium and potassium contents show a great difference from one station to another; an average sodium concentration is around 200 mg/l.

The potassium content of the three stations studied ranges from 12 to 236 mg/l. The distribution of chloride concentrations in the water of Wadi Safsaf varies between 50 mg/l at station P6 and 380 mg/l at station P1. The totality of the measured water points have concentrations higher than the irrigation standard fixed by the FAO at 350mg/l, and 250 mg/l according to the WHO.

The levels of sulphates found in the water of Wadi Safsaf oscillate between 20mg/l at the station (P5) and (P9) and 792 at the station (P12). The values obtained for nitrates are 12mg/l and 299mg/l respectively for station (P7) and station (P11).
Copper levels in the different stations of oued safsaf vary between a minimum value of 2.3 mg/L recorded in the effluent station (O1) and the maximum value of 8.7 mg/L at the station (P3). Cadmium levels are above the European (0.150 mg/L) and WHO (3 mg/L) standards. The minimum value of zinc is recorded in the station (P12) downstream of the wadi of the order of 0.12mg/L.
Generally, zinc and copper levels are low in the natural surface waters of Wadi Safsaf because the aquatic environment is dynamic and the mobility of chemical elements and heavy metals is greater. In addition, the high rainfall recorded in the region, on average 1000 mm/year, contributes to the dilution process of the concentrations in the water. It should be noted that as the pH of the water is mostly alkaline (above 9), this alkaline environment favours the hydrolysis of Zn^{2+} and therefore, the decrease of its content in the aqueous phase (Burnol et al.2006). The threshold of toxicity of this trace element in irrigation water of the WHO is fixed at 10 μg/L. In our study, the surface waters of oued safsaf in the Skikda region have concentrations ranging from 125.8 μg/L to 160.2 μg/L. These concentrations are quite high and exceed the above-mentioned standards. Cadmium can be released into water through natural weathering processes, discharges from industrial facilities or wastewater treatment plants, atmospheric deposition, leaching from landfills or soil or phosphate fertilizers (ATSDR, 2012). At the study site, these high concentrations could be due either to geogenic factors that favour the release of cadmium into water, related to the geological nature of the terrain, mainly the presence of carbonate formations and probably basement formations, or to anthropogenic discharges. On the site of the industrial estate, the combustion of fossil fuels and road transport may contribute small amounts of cadmium.

CONCLUSIONS AND RECOMMENDATIONS

Spatial variations of physico-chemical parameters, major elements and heavy metals in groundwater in the different sampling stations showed that: Wadi Safsaf water has an alkaline pH, a very high conductivity. A high concentration of heavy metals (Zn, Cd, As) in wadi water, as well as groundwater seems to be affected, except that we report a high contamination of these waters by cadmium which is found concentrated and exceeds the required standards, However, it has been established that for all the sampling TMEs carried out, a metallic contamination in the soil (Cd, Zn and As). Our results may lead to consider the contamination status of surface and groundwater. A temporal follow-up is recommended, other compartments (sediments, atmosphere) and other MTE such as iron, lead, mercury should complete our impact study.

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Article submitted to the Proceedings Book of the VIth. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

STUDY AND EVALUATION OF THE POLLUTION IN ETM IN THE VALLEY OF OUED SAF -SAF AND OUED ZERAMNA, SKIKDA, NORTH-EAST OF ALGERIA

Amina **BOUSSELIOU[1*], I. BOUDRAA[2,3], S. CHELLAT[1], H. BELAIDI[1]**

[1]*Geology and Environment Laboratory, University of Constantine 1, Road Ain El Bey Zouaghi Slimane Constantine 25,000, Algeria,* [2]*Constantine 1 University, Department of Chemistry, Pollution and Water Treatment Laboratory, Constantine1, Algeria,* [3]*Environmental Molecular and Structural Chemistry Research University Constantine1, Algeria,* *corresponding author:hydrgeo23@gmail.com,

The city of Skikda is ranked third nationally after Algiers and Ouargla; in terms of volume of different waste discharged without treatment it exceeds 250,000 m^3/d. Thus, according to a recent study by the Ministry of Environment, the coastal area Skikda is mined by 29 discharge points. This situation forced the establishment of a wastewater treatment and treatment plant (WWTP). The WWTP located in Bantous treats wastewater from the three municipalities of Skikda, Hammadi Krouma and El Hadaïek. This makes it possible to improve the quality of wastewater before its reuse, but there are still other wild discharges that require control and monitoring in order to minimize its pollutants, a solid and liquid sample has been taken to measure the degree of pollution of possible heavy metals in Oeud Safsaf and Oued Zeramna. The results of the atomic adsorption analyses show a high percentage of ETM pollutants in liquid and solid samples show an iron level that varies from 0.2 mg/l to 0.6 mg/l, copper between 0.02 mg/l and 0.03 mg/l, arsenic reaches 0.9 mg/l, cadmium varies between 0.02 mg/l and 0.05 mg/l. Those rates exceed all standards, Algerian, WHO, AFNOR.

Keywords: *pollution, waste discharge, coastal area, Skikda, wastewater treatmen, WHO.*

INTRODUCTION

The environment considers everything that surrounds humans from living and non-living materials, but humans have always been at the root of the world's environmental problems. Population and industrial growth in the world has led to several types of pollution, including liquid discharges (urban and industrial discharges) and the use of oceans and seas as dumping grounds can lead to high levels of pollution [4].

In Algeria, population and industry are concentrated in the north of Algeria and overlook the Mediterranean Sea, which has become a direct or indirect discharge through the valleys for untreated or STEP-treated industrial wastewater and liquid discharges, which may contain TMEs that are often present. Not treated at WWTP level. The city of Skikda is ranked third nationally after Algiers and Ouargla [3], In terms of volume of different wastes discharged without treatment it exceeds 250,000 m^3/d, Which contain a treatment plant located in Bantous de Hammadi Krouma [3] and whose capacity is not sufficient to cover the whole city Therefore large quantities of domestic and industrial wastewater, which contain various pollutants (heavy metals, organic pollutants, etc.) are discharged into Oued Saf Saf and Oued Zeramna, which flow into the sea, resulting in a deterioration in the quality of the aquatic environment.

This observation has raised questions about the content of chemical elements in the coastal waters of Skikda, in particular heavy metals, if we know that these metals are not biodegradable and can have harmful effects on aquatic flora, fishery resources and human beings. However, to our knowledge, no study on metallic pollution of water and sediments has been carried out to diagnose the quality of the environment. The objective of this study is to determine the concentration profiles of metallic trace elements (Cd, Cr, Cu, Co, Ni, Pb and Zn) in sediments in areas presumed to be contaminated by wastewater discharges in the city of Skikda and to assess their quality [3]. Indeed, contaminated sediments are potential sources of pollution.

STUDY AREA SETTINGS

The region of Skikda is located in the North-East of Algeria on the entire between longitude 6°50' E and latitude 36°35' N. It occupies a strategic position on the northern coast of the Mediterranean [4].The largest basin in the region is the basin of Oued Saf which is located in the center of the wilaya. it begins in the south in the mountains of Constantine, North-South direction its length is 53.19 km, its main tributaries are Oued Zeramna [5]

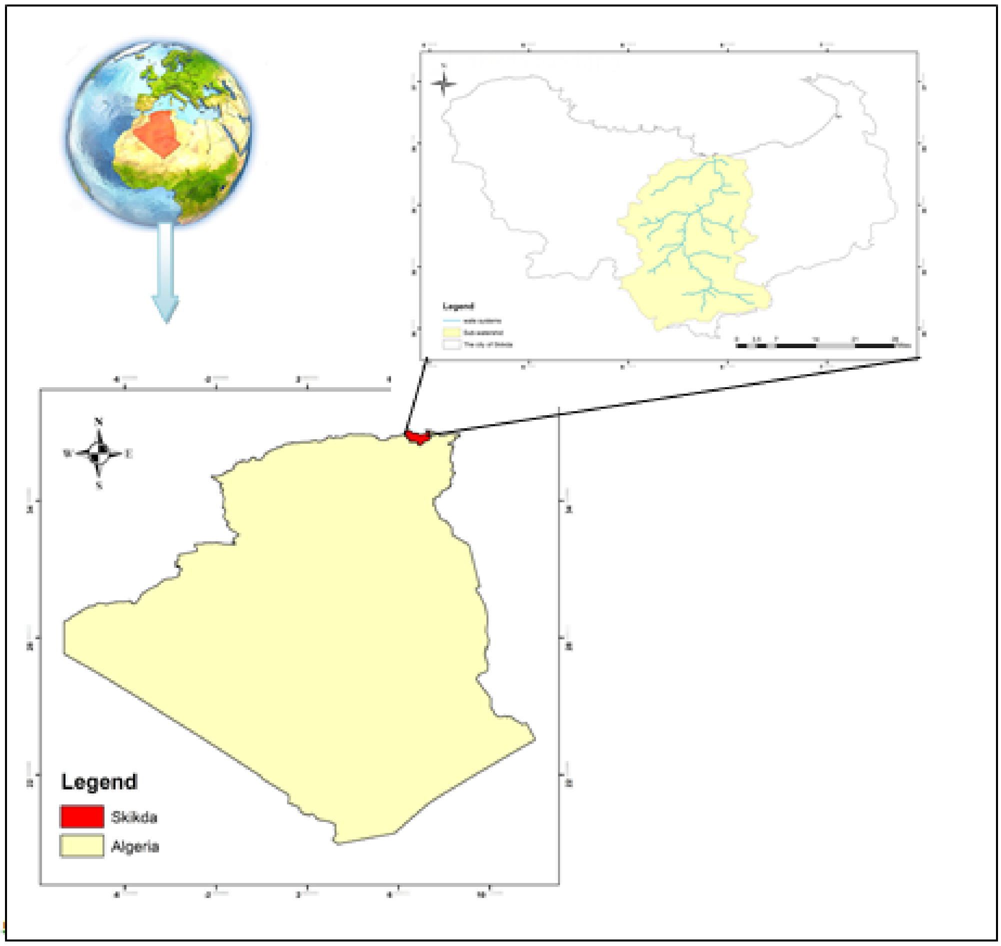

Figure 1. Geographical location of the study area

Geomorphology:

The relief of the region of Skikda is quite rugged, and more particularly in the coastal part and the massif of Collo. This relief is characterized by plains represent the total surface of the wilaya, and concentrated in the regions of Skikda, Collo, Ain Charchar and BenAzouz. These plains result from the outlets of Oued Guebli, Oued Saf-Saf and Oued El Kbi [5].

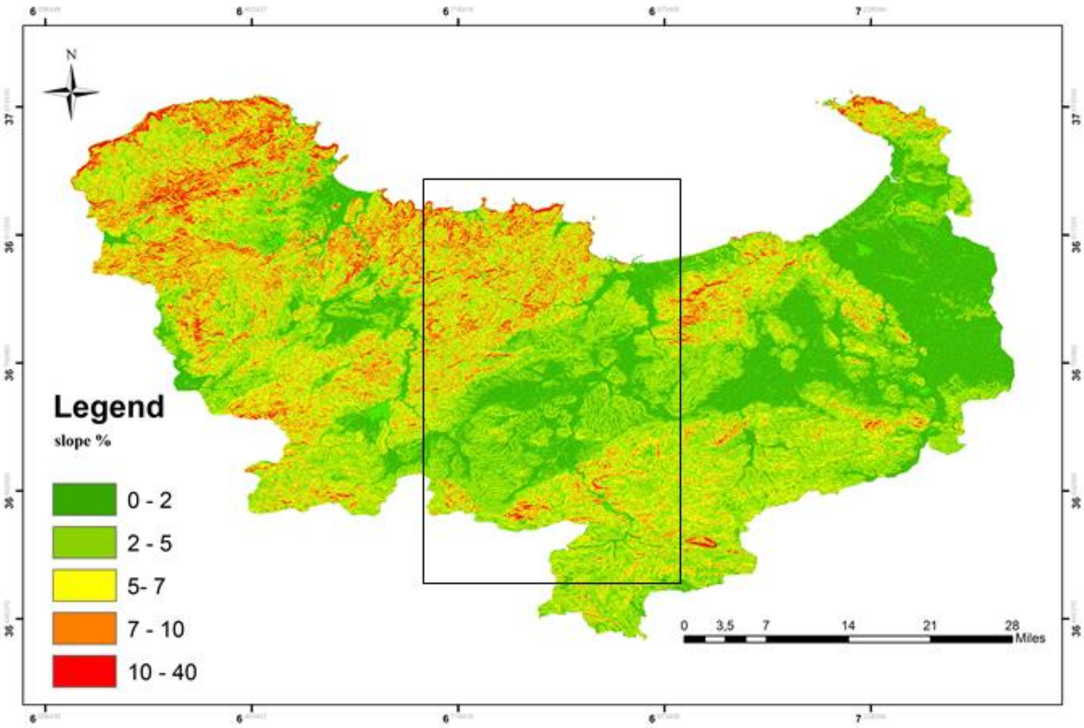

Figure 2. Slope map of the study area

MATERIALS AND METHODS

For our study, we conducted field studies on the site of oued zeramna and oued safsaf "Skikda", located between the altitudes 36°5N and 36°15N and longitudes 7°15E and 7°30 E. [3]. Where we collected four liquid samples and two liquid sludge samples from upstream and downstream of wadi saf and wadi zeramna. The coordinates of the sampling points are recorded in a notebook. For the liquid sludge samples we collected by manual shovel and put it in sealed and numbered boxes and the liquid samples were placed in glass bottles 500 ml, then place all samples in coolers with cold blocks. The scientific treatment by atomic adsorption spectrometry of the liquid samples is done at the research laboratory of the Faculty of Science and Universe University Mentouri Constantine. The liquid slurries were dried at room temperature for a period of 48 hours and then we crushed them by a Retsh PM 100 mill for 45 min, then we compressed The powder the previous process samples was put in the form of pellet for analysis by X-ray fluorescence The pellets were prepared under a pressure of 10 tons using a manual pelletize Retsch PP 25 [1]at the level of the laboratory Pollution and Treatment of Water, Constantine, Department of Chemistry, University of Constantine 1

RESULTS AND DISCUSSION

Atomic absorption spectrometry analyses were made for the water samples by the protocol of Rodier [6], to determine the concentration of heavy metals in the four samples. Figure 3 represents the average concentration in (mg/l) of the elements (Fr, Cu, Ni, As, Zn, Cd)
Iron varies between 0.2mg/l and 0.6mg/l the highest value recorded on oued Zeramna and oued safsaf exceed the norms (Tables 1 (these values are also explained by the leaching of the land and the corrosion of the installations [4]. Arsenic is higher than 0.3mg/l the highest values recorded in all samples and exceeds WHO standards. Because of the use of phosphate fertilizers, herbicides, insecticides, detergents (washing water) are naturally corrosive [8], because most of the surrounding areas are agricultural areas. Cadmium varies between 0.02mg/l and 0.05mg/l where we recorded the highest value in Wadi Saf Saf,

due to acid solubilization of food substances from glazed pottery, cans and galvanized kitchen utensils [6] .

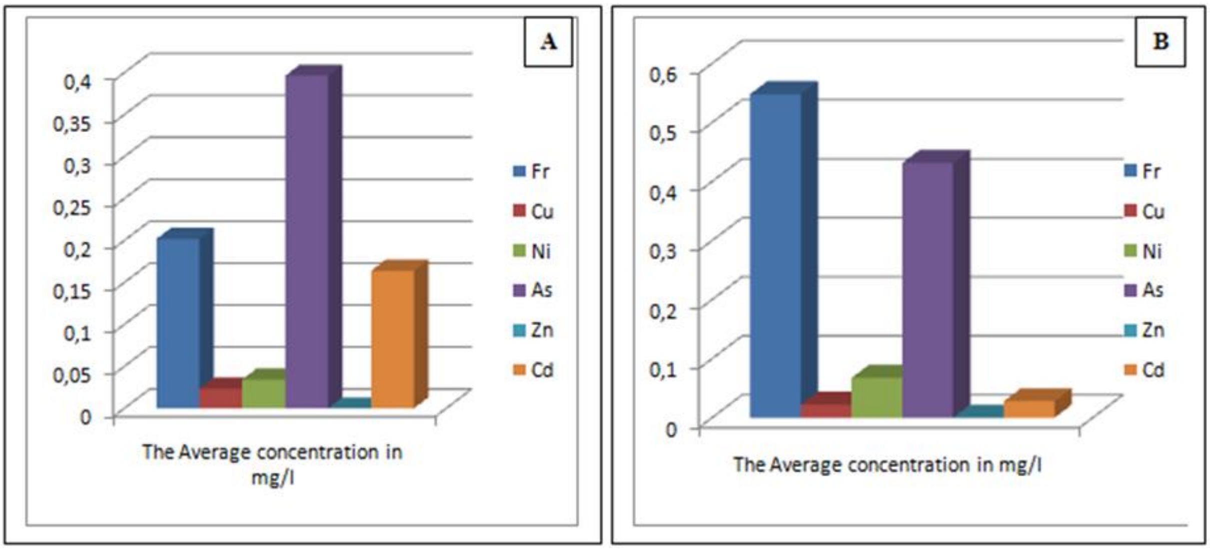

Figure 3. The average concentration in mg/l of heavy metals in water samples
A: mean concentration of elements (Fr, Cu, Ni, As, Zn, Cd) in oued Saf Saf.
B: mean concentration of elements (Fr, Cu, Ni, As, Zn, Cd) in oued Zeramna.

X-ray fluorescence analysis of the sludge samples was performed to determine the concentration of heavy metals in both samples. Figure 4 represents the average concentration in mg/kg of the elements (, Cu, Ni, As, Zn, Pb).

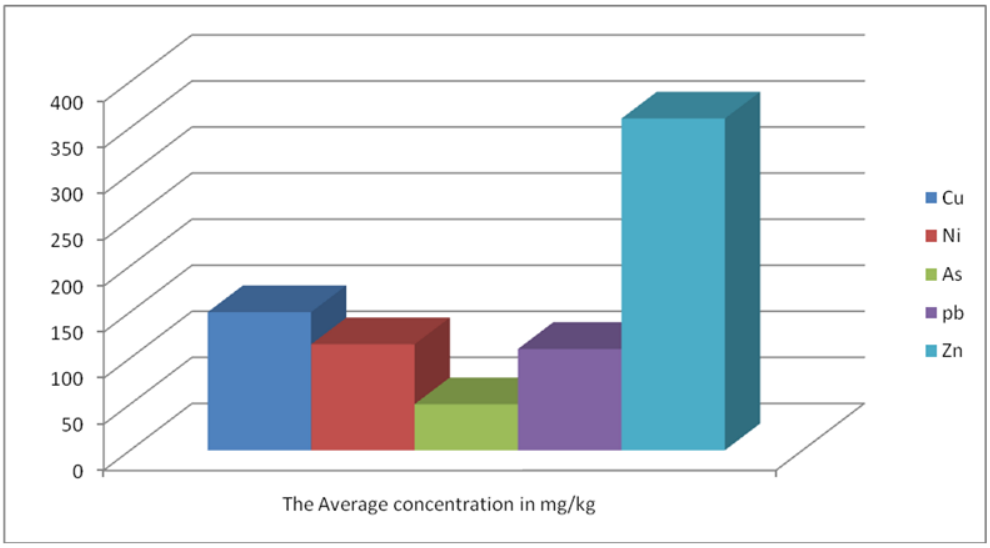

Figure 4. Average concentration in (mg/kg) of heavy metals in sludge samples

Copper varies between 100mg/kg and 200mg/kg where we recorded high values in all samples and exceeds the AFNOR standard (Table 1). Nickel varies between 100mg/kg and 150mg/kg. Arsenic varies between 20mg/kg and 80mg/kg. Lead was 110mg/kg and exceeds the AFNOR standard. Zinc varies between 300mg/kg and 400mg/kg.
The concentration of heavy metals in the sludge of the downstream decreases compared to the upstream because we show that the concentration of these metals in the sludge, upstream is higher than downstream because they are transported in water. In contrast to the water samples, the concentration of heavy metals is higher downstream and lowers at the source.

Table 1: Standards of heavy metals in water and soil [6]

Heavy metals	Zn	Cu	Ni	Pb	Cd
Algeria standards (Mg/l)	5	2	0.05	0.01	0.03
WHO standards (Mg/l)	3	2	/	0.01	0.03
The standards of AFNOR (Mg/kg)	300	100	50	100	100

CONCLUSIONS AND RECOMMENDATIONS

The evaluation of the quality of sediments and water was carried out by the results of the analysis of atomic adsorption and fluorescence x .The presence of deposits of lead, zinc, Nickel was mostly observed in wadi Saf and wadi Zeramna, which estimates the degree of contamination of the site according to The relative toxicity of each metal considered shows a severe Pollution, even by dangerous sediments. In fact, zinc and lead are very strong The contents of the sites contribute respectively to the ranking 360 mg/kg and 110 mg/kg for the potential danger of sediments during Zinc, copper, nickel and chromium are also present in High concentrations represent pollution, it is a threat to the environment and human health [7]. The industrial discharges have a polluting effect on water and contribute to the degradation of water resources of the region and the sea. And the inability to treat the water capacity in the wilaya of Skikda and the station away from the sea, which has made the valley polluted due to the presence of several industrial areas and residential water estuaries after the station, Therefore, the Ministry of the Environment must intervene to protect marine and natural life and human life from heavy pollutants to protect this system.

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Article submitted to the Proceedings Book of the VIth. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

FELDSPAR'S ROLE IN PROVIDING SOIL WITH MACRONUTRIENTS K AND CA (EXAMPLE: WADI EL-ANNAB NORTHEAST OF ALGERIA)

Hassni BELAIDI[1]*, A. BOUSSELIOU[1], S. KITONI[2] , S. CHELLAT[1]

[1]*Geology and Environment Laboratory, University of Constantine 1, Road Ain El Bey Zouaghi Slimane Constantine 25 000, Algeria*
[2]*Department of Process Engineering, Faculty of Process Engineering, University Salah Boubnider Constantine 3, Algeria,* *Corresponding author: hassnibelaidi@gmail.com

Feldspars are an abundant mineral group and make up about 60% of the earth's crust. They are present in many sedimentary deposits and are found in almost all igneous and metamorphic rocks. The crust-mantle interaction at the plate boundary and inside the plate is the primary source of these minerals. Common feldspars include orthoclase (KAlSi3O8), albite ($NaAlSi_3O_8$), and anorthite ($CaAl_2Si_2O_8$). Weathering of feldspars is important in soil formation, especially for increasing soil fertility for food production. The Feldspar group of minerals is an important mineral to sustain life on the Earth. The feldspar group minerals play an important role in the overall dynamics of macronutrients such as K and Ca in soils. The massif of Wadi El-Annab is made up of igneous rocks. This massif is surrounded by the forest from all sides and a big part of this massif is covered with plants. This region is characterized by significant rainfall and a good hydrographic system. This study of massif by thin sections shows that it consists mainly of feldspar groups, quartz, micas (biotite and muscovite) and calcite as a secondary mineral. The feldspar group includes orthoclase and plagioclases. The plagioclases represent 50% of all feldspar. The orthoclase represents 50% of all feldspar. The feldspars are altered and show microfractures. The alteration of the feldspars is mainly because of water while the microfractures are because of the incursion of plant roots in the floor.

***Keywords**: Feldspars, Macronutrients, Soil, Wadi El-Annab, weathering.*

INTRODUCTION

Earth is the only planet in the solar system that has the conditions of life. It is divided into the core, mantle and crust. The crust is the Earth's outermost layer, on which humans live, and it has a recognizable landscape (rocks, soil, and seabed). The chemical evolution and construction of continental material are controlled by orogeny, volcanism, and sedimentation [1-7]. Climate, weathering, and erosion have all played a part in the formation of mountain ranges and the formation of the Earth's crust. The upper crust consists of 14% Sedimentary rocks, 50% of felsic intrusions, 6% of gabbros, and 30% of gneisses, mica schists, and amphibolites [8]. The distribution of these rocks is controlled by serval geological processes such as eruption and intrusion of lava, weathering, erosion, and consolidation of sediment particles, and solidification and recrystallization of rock. More than 4000 minerals make up the Earth's crust, but feldspars account for 51% of it followed by quartz at 12%, and pyroxenes at 11% [9]. Common feldspars include orthoclase ($KAlSi_3O_8$), albite ($NaAlSi_3O_8$), and anorthite ($CaAl_2Si_2O_8$). Due to their instability at the Earth's surface, feldspar minerals respond to chemical, biological, and mechanical weathering. Agricultural production is associated with the erosion and weathering of rocks. The feldspar group is very important for the human health and life. The weathering of the feldspar increases the soil fertility. The feldspar group minerals have a significant role in the overall dynamics of macronutrients such as K and Ca in soils.

They include a variety of nutritional metals that become accessible to plants when the soil weathers. K-feldspar (potassium feldspar) is crucial for maintaining Earth's biological equilibrium [10-12]. Feldspars change to secondary minerals as a result of weathering and soil formation [13, 14] like kaolinite, illite, gibbsite, smectite… the latter is used to produce drug (Smecta). The purpose of this work is to study the feldspar group in the parent rock by studying the massif of Wadi El-Annab in the North-east of Algeria and knows the type and properties of their feldspar, know the important geological processes affecting the feldspar and the type of macronutrients liberated from it in this massif.

LOCALIZATION OF THE MASSIF OF WADI EL-ANNAB

The massif of Wadi El-Annab is located in the province of Annaba in Northeast of Algeria near to the Mediterranean coast. It is 16 km northwest of the capital of Annaba (Figure 1). The massif of Wadi El-Annab is one of group of magmatic massifs in Annaba. All of these massifs are surrounded by the forest from all sides and a big part of these massifs is covered with plants (Figure 2a). The region of Wadi El-Annab is also characterized by a good hydrographic system represented mainly by Wadi El-Annab that passes by the massif, and other valleys passing through it like Wadi Salah and Wadi Matma.

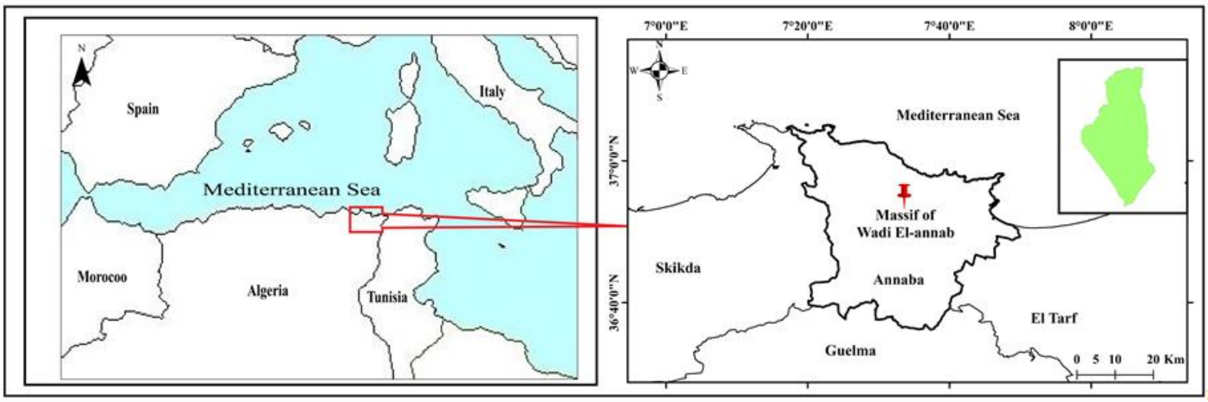

Figure 1. Localization of the massif of Wadi El-Annab

MATERIALS AND METHODS

Three typical samples were collected from the massif of Wadi El-Annab region for this study (Figure 2b). Each sample weighted about 2 kg. The sampling was randomly and the coordinates of the sampling location were recorded on a field notebook using a Global Positioning System (GPS). Each sample was labelled and numbered and sent to the laboratory for preparation of thin sections. The first phase of the preparation the thin sections were carried out at the level of the laboratory "de génie géologie (LGG)" University of Jijel. This phase just included the cutting of samples in the form of sugar cubes. The finalization of the preparation of these sections was carried out at the level of the laboratory "Géoresources-Environment et Risques Naturels" University of Oran 2.

STATISTICAL ANALYSIS AND GRAPHICAL PRESENTATION

The feldspar group is the main resource of potassium (K), sodium (Na) and calcium (Ca). Feldspars are divided into two main families: alkali feldspars and calc-sodium feldspars called plagioclases. The common alkali feldspar minerals are orthoclase and microcline ($KAlSi_3O_8$). They are both an important source of potassium, with potassium up to 16.92%. Calc-sodium feldspars or plagioclases consisting of an isomorphic series between a sodium pole, albite ($Na[AlSi_3O_8]$), and a calcium pole, anorthite ($Ca[AlSi_3O_8]$).

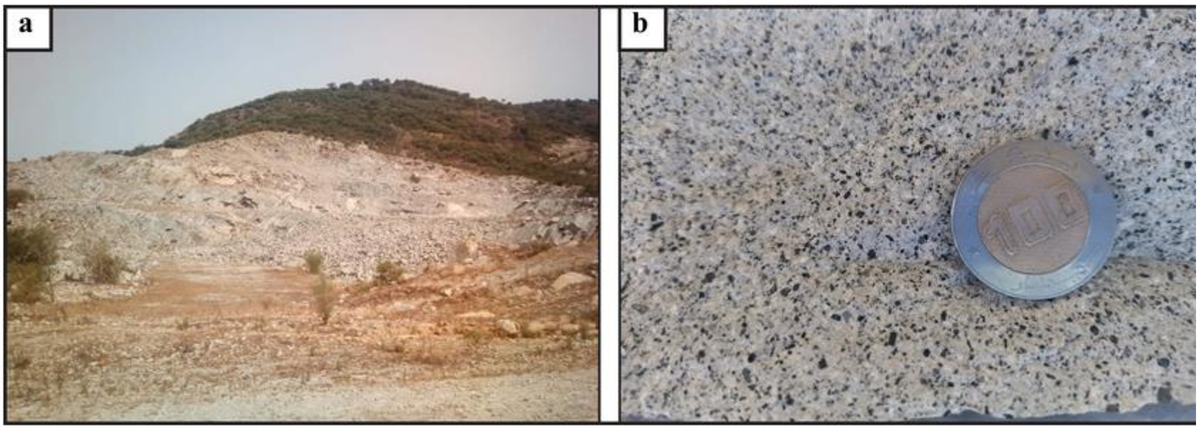

Figure 2. Photograph of the massif of Wadi El-Annab. a: Photo of the massif; b: photo of a sample

RESULTS AND DISCUSSION

The anorthite is the important source of Calcium in this series with 19.2% of Ca, followed by bytownite with 16.31 of Ca (Table 1) [15,16].

Table 1. Theoretical composition of feldspar group [15,16].

Minerals	Mineral Formula	K_2O	Na_2O	CaO	Al_2O_3	SiO_2
Alkali Feldspars						
Orthoclase	$KAlSi_3O_8$	**16.92**	0	0	18.32	64.76
Microcline	$KAlSi_3O_8$	**16.92**	0	0	18.32	64.76
Plagioclase Series						
Albite	$NaAlSi_3O_8$	0	11.82	0	19.44	68.74
Oligoclase	$(Na,Ca)[Al(Si,Al)Si_2O_8]$	0	9.34	4.23	23.05	63.38
Andesine	$(Na,Ca)[Al(Si,Al)Si_2O_8]$	0	6.92	8.35	26.57	58.16
Labradorite	$(Na,Ca)[Al(Si,Al)Si_2O_8]$	0	4.56	12.38	30.01	53.05
Bytownite	$(Na,Ca)[Al(Si,Al)Si_2O_8]$	0	2.25	**16.31**	33.37	48.07
Anorthite	$CaAl_2Si_2O_8$	0	0	**19.2**	35.84	44.4

The massif of Wadi El-Annab is made up of magmatic rock with a microlitic texture. The size of the minerals is millimetric. By observation with the eye, it shows that this massif consists mainly of three minerals: quartz, feldspar and biotite. To confirm this observation and to determine the characteristics of the minerals, a petrographic study was carried out using a polarized microscope. It was found that this massif consists of 45% feldspar, 35% biotite and 19% quartz as essential minerals and calcite as a secondary mineral. These minerals are bound together by cement.

1. Feldspars

Feldspars are the most dominant; they are represented by orthoclase and plagioclase. In orthoclase occurs as tabular and prismatic crystals. The size of the crystals is 0.5 to 1.5 mm in length and 0.3 to 0.7 in wide. The orthoclase always shows low birefringence of the 1st order where they have a light grey to white hue. They also show Carlsbad lusters, which are identified by the different luster of two associated minerals. Orthoclases are generally close to biotites (Figure 3b).
Plagioclases are more dominant than orthoclases. Plagioclases have a tabular shape. The crystal size of plagioclase is larger than the crystal size of orthoclase. It varies from 1 to 4 mm in length and from 0.5 to 2 mm in width. Plagioclases always show low birefringence of the 1^{st} order where they present

a light grey hue. Plagioclases are identified by their polysynthetic lusters formed by repeated crystals and the origin of the typical striped appearance (Figures 3a and 3d).

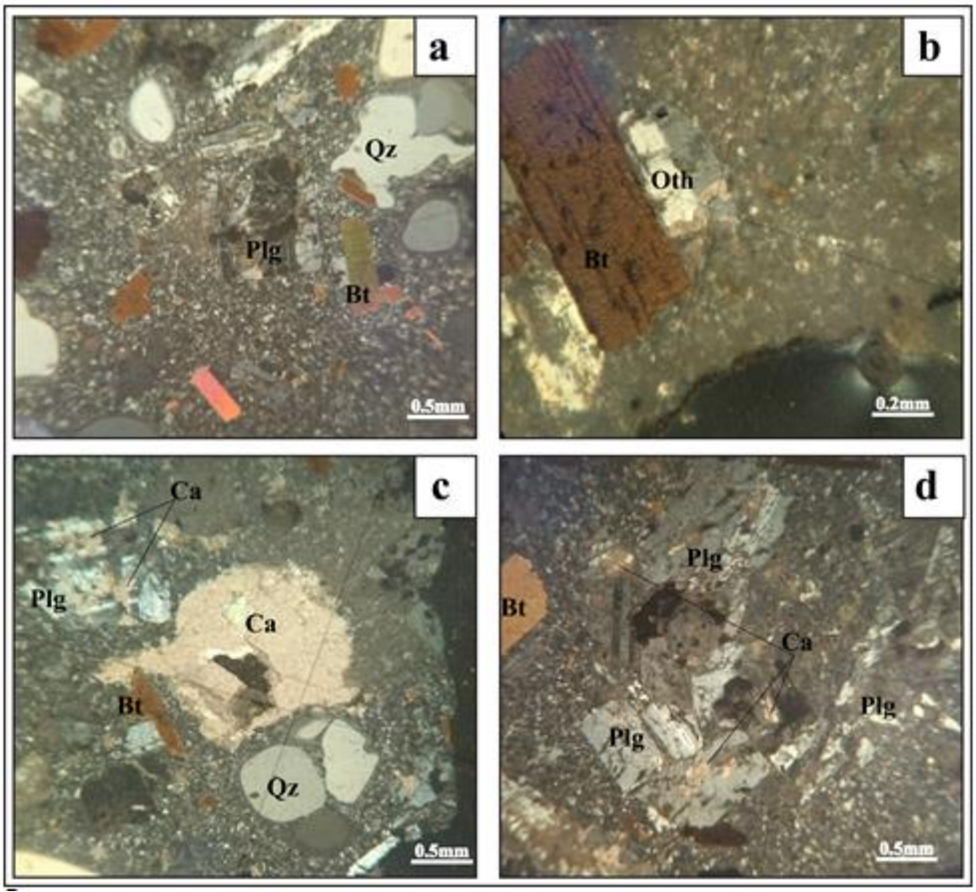

Figure 3. Photomicrographs show the main minerals that make up the massif of Wadi El-Annab. Qz: Quartz; Plg: plagioclases; Oth: Orthoclase; Bt: Biotite; Ca: Calcite.

2. Biotite

Biotite appears as elongated automorphic crystals. The size of the crystals is smaller compared to the crystal size of plagioclase. It is 0.5 to 2.5 mm in length and 0.2 to 0.5 mm in wide. Biotite is characterised by its strong birefringence with a brown and green hue of the 3rd order (Figures 3a and 3b).

3. Quartz

Quartz is less abundant than feldspars and biotite. It appears in the form of very clear patches with 0.5 to 2 mm in length and 0.5 to 1 mm in wide. It shows a weak 1st order birefringence with a light grey to white colour. It does not show any macles or cleavages (Figures 3a and 3c).

4. Weathering of the massif of Wadi El-Annab

Weathering occurs anywhere on the continents and at any time on our planet. Weathering is mainly of three types, namely mechanical, chemical and biological. The region of Wadi El-Annab is characterised by a high precipitation rate and a dense vegetation cover. The Wadi El-Annab massif is weathered. Quartz is a stable mineral that does not show any alteration. The decrease in birefringence of biotite confirms the beginning of the transformation from biotites to chlorites (Figure 3b). The alteration of feldspars is the most important in this massif. Most of the crystals are almost completely altered. They also show large microfractures. Plagioclase is more altered than orthoclase. The potassium feldspars are more stable than the plagioclases, which confirm that the Wadi El-Annab massif is richer in plagioclases than in potassium feldspars. Some crystals of the plagioclases are almost completely transformed into calcite and only relics remain (Figures 3c and 3d). The appearance of calcite is an indication that the dominant type of plagioclase is calcic plagioclase. The Wadi El-Annab massif is altered by three types of alteration: 1) mechanical, 2) chemical and 3) biological. Mechanical weathering is done by physical agents such as wind, water, gravity. Chemical weathering is mainly by water, acid rain, groundwater and air. Biological weathering is mainly by micro-organisms and plants. Plants play an important role in weathering, as plant roots penetrate the soil and cause the dissolution of minerals, decomposition and humification of organic matter. The Wadi El-Annab region is a forested area causing reduced temperature, high humidity, increased rainfall and decreased runoff to increase the penetration of water into the underlying rocks. This increases the weathering of the underlying rocks. Decomposing plants, organisms and microbes provide the soil with organic matter. Leaves and wood are also major contributors of organic matter. The weathering of the Ca-feldspars in the Wadi El-Annab massif results in the release of calcium (Ca) which is associated with the organic matter released by leaves, wood and microbes, which explains the appearance of calcite.

5. The role of weathering the massif of Wadi El-Annab in providing soil with macronutrient

The soil is important for maintaining life processes. It is where the atmosphere, biosphere, hydrosphere and lithosphere meet. Soil has always been important to humans and their health because it provides a resource that can be used for shelter and food production [17]. Intrinsic soil fertility refers to the nutrients that contain or retain minerals in rocks and sediments and their bioavailability through controlled weathering processes. In general, rock weathering involves the physical and chemical breakdown of the minerals that form the rock, with a corresponding loss of minerals. The elements released by these rocks are minerals that help to increase the fertility of the soil and also increase its ability to retain water. Calcium and potassium are the most important macronutrients that increase soil fertility and help plant growth. The existence of calcium in the soil also reduces the toxicity of elements such as sodium (Na) and magnesium (Mg). Calcium (Ca) also contributes to plant growth by increasing the stiffness of plant tissue. Potassium (K) is important for maintaining the ecological balance of the earth [11-13]. Potassium plays an important role in accelerating plant growth by speeding up cell division, accelerating photosynthesis and increasing respiration. The Wadi El-Annab massif is the only magmatic massif in the region and this makes it the main source of feldspars in this area. The massif is rich in main calcium feldspars. The alteration of the feldspars free calcium (Ca) and potassium (K) and this is what increases the fertility of the soil reflecting the presence of dense vegetation cover in this region.

CONCLUSIONS AND RECOMMENDATIONS

The massif of Wadi El-Annab is located in Annaba province in the northeast of Algeria. It is surrounded by the forest from all sides and covered almost totally with plants. The massif of Wadi El-Annab consists mainly of feldspar group, biotite and quartz. It also contains calcite as a secondary mineral. The feldspar group is the most abundant minerals in this massif. The plagioclases are more abundant than the orthoclase. The feldspars group is almost totally altered. The appearance of the calcite is an indication that the type of plagioclases is the Ca-plagioclases. The weathering of the massif of Wadi El-Annab shows in feldspars and biotite where some feldspars have only trace left and the decreasing of biotite birefringence. The massif of Wadi El-Annab is altered by three types of alteration: mechanical, chemical and biological appear in the microcrackings and the transformation of feldspars to calcite. The massif of Wadi El-Annab is the primary source of the macronutrients especially for calcium (Ca) in the region.

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HYDROGEOCHEMICAL ASSESSMENT OF THERMAL WATERS FROM SOUK AHRAS GEOTHERMAL SYSTEM, NORTH EAST OF ALGERIA

Halima BOUDRA[1], F. BOUAICHA[1], W. MELOUAH[2], M. BOUKHATEM[1]

[1]Geology and Environment Laboratory, University of Constantine 1, Road Ain El Bey Zouaghi Slimane Constantine 25,000, Algeria
[2]Faculty of Hydrocarbons, Renewable Energies and Earth and Universe Sciences Kasdi Merbah University, Ouargla, Algeria
Corresponding author: halimaboudrahydrogeologie@gmail.com

The geothermal resources of Algeria are numerous; they are manifested in the form of thermal springs or that are widespread throughout the Algerian territory, and especially in the North-East where the tectonic manifestations are abundant. The region of Souk Ahras, belongs to the hydrothermal system of carbonate karstified Cretaceous, located near the Algerian-Tunisian border has many hydrothermal springs, the most important of which is the source of Hammam Tassa and Ouled Zaid, the temperatures of these springs between 39 and 40°C. According to the results of chemical analysis that were conducted on the thermal springs in the study area at different periods, source El Demssa, Tassa, Ouled Zaid, El Khengua. The thermal springs have moderately high conductivities due to the presence of a triassic evaporite formation. The pH indicates slightly acidic waters in all sampling sites, Representation of the results in the Piper diagram, all hydrochemical facies of sodium bicarbonate character; this is due to the influence of the lithology of the study area.

Keywords*: thermal springs, hydrochemical facies, Algerian–Tunisian border, piper diagram, lithology, tectonic*

INTRODUCTION

Thermal waters are a new focus of human interest; their hydrothermal systems represent a source of energy with low environmental impact [3]. Algeria has significant reserves of thermal water, manifested on the surface by many thermal springs in the north of the country, especially in the extreme northeast, where it is characterized by a very varied chemical composition [4], the most important is Hammam Meskhoutine in Guelma, Hammam Sidi Trad in El Taref and Hammam Tassa in Souk Ahras. In order to determine a hydrogeochemical balance of thermal sources in the study area, we used previous studies [2] [7].

GEOGRAPHICAL LOCATION OF THE STUDY AREA:

In geological context: the work of geologists in eastern Algeria. As a result, several structural units have been shown from north to south:

- The Kabyle basement and the limestone chain;
- The flysch series (Massylian and Mauritanian);
- The Tellian series;

In addition, covering these units, we find:

- The Numidian clays and sandstones;

- The continental formations post-nappes of Miocene age of the basin of Constantine;
- The marine pliocene of the coastal plains.

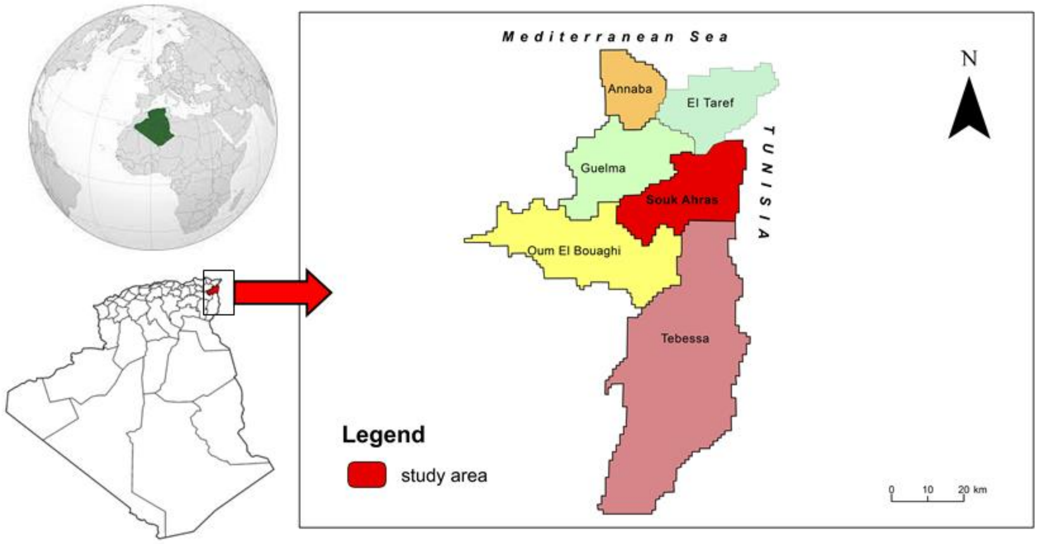

Figure 1. Geographical location of the study area

From the North to the South of the Algerian-Tunisian borders, we go from the Tellian domain where Numidian terrains dominate to the pre-Saharan and Saharan domains characterized by the importance of autochthonous outcrops, the thermal springs that appear in this region belong to different structural zones [4].

The study area presents mainly marl formations ranging from the Lower Cretaceous to the Mio-Plio-Quaternary. The Triassic diapiric outcrops widely around Souk Ahras where it is formed by a complex of marls and gypsiferous clays, pack rock blocks of various nature.

The Lias is known under a massive limestone facies, the lower Cretaceous presents a marly and chalky facies of the Barremo-Aptian, and at the base marls and fine sandstones with some chalky intercalations of the Albian. The upper Cretaceous is formed by a thick marly series with at the top some clayey limestone levels of the Cenomanian; the Turonian begins with large banks of fine limestone and marl. The Eocene corresponds to 30m of grey marls, the Ypreso-Lutetian from 20m to 30m of marly limestones; the marine Miocene is conglomerate, sandstone and marl.

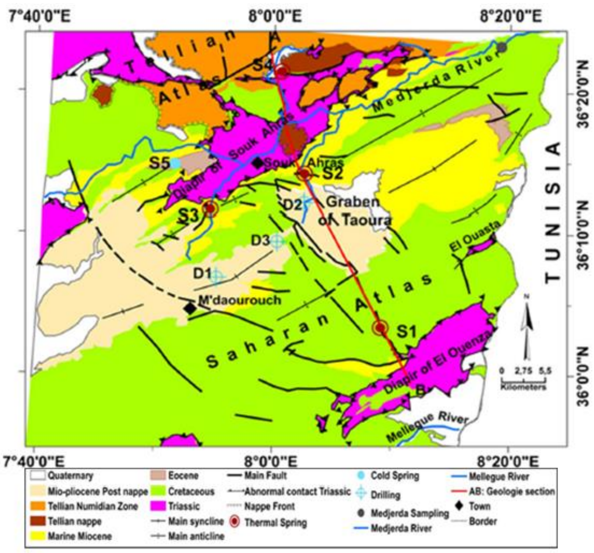

Figure 2. Geology of the study area with location of water points used in this study. (BOUROUBI, 2018)

MATERIALS AND METHODS

This study was based on data obtained during previous studies on the thermal springs of Souk Ahras conducted by BOUROUBI in 2018. At the study area level, nine thermal and cold samples were taken during the periods of March and June 2012 and September 2014. Parameters such as temperature (T), electrical conductivity (EC), total dissolved sulfate (TDS) and hydrogen potential (pH) were determined at the site (Table 1); Chemical concentrations of the samples taken in the study area were determined by the main major elements (Ca, Mg, Na, K, HCO_3, Cl and SO_4).

Table 1. Physical characteristics of water points (BOUROUBI, 2018)

Sampling point	Date	T °C	pH	EC (mS/cm)	TDS (mg/L)
S1	June 2012	27,1	5,85	6,5	5173
S2	June 2012	40	5,88	3,3	2244
S3	Sept 2014	27	6,8	1,7	1169
S4	June 2012	40	6,14	1,7	1288
S5	June 2012	22,5	6,14	1,3	1017
S6	Sept 2014	25	6,75	1	796
S7	June 2012	21	6,55	0,8	577
S8	Sept 2014	17	6,47	0,5	425
S9	April 2014	21	7,05	1,8	1272

RESULTS AND DISCUSSION

The spring water with temperature above 22°C is the thermal water, according to the results of the physical parameters of the thermal waters in the study area, three groups were identified: **Group (Ⅰ)** is the water of temperature varies between 22 to 37°C (Meso-thermal) which includes S1 and S3 springs,

Group (Ⅱ) is the water of temperature varies between 37 to 40°C (Ortho-thermal) and includes S2 and S4 springs. **Group (Ⅲ)** corresponds to cold ones [7].

Total dissolved mineralization ranged from 1.017 to 5.173 mg/L indicating brackish water for the majority of springs, in addition to a slightly acidic pH [7]. Hydrogeochemical analyses of thermal springs in the Souk Ahras region showed that the majority of the springs have calcic bicarbonate facies (Table 2).

Table 2. Geochemical facies of all analyzed waters

Sample	Date	Chemical facies
S1	June 2012	$rCl^- \; rHCO_3^- \; rSO_4^{2-}$ $rNa^+ \; rCa^{2+} \; rMg^{2+} \; rK^+$
S2	June 2012	$rHCO_3^- \; rCl^- \; rSO_42^-$ $rCa^{2+} \; rNa^+ \; rMg^{2+} \; rK^+$
S3	Sept 2014	$rCl^- \; rHCO_3^- \; rSO_4^{2-}$ $rNa^+ \; rCa^{2+} \; rMg^{2+} \; rK^+$
S4	June 2012	$rCl^- \; rHCO_3^- \; rSO_4^{2-}$ $rCa^{2+} \; rNa^+ \; rMg^{2+} \; rK^+$
S5	June 2012	$rHCO_3^- \; rCl^- \; rSO_4^{2-}$ $rCa^{2+} \; rMg^{2+} \; rNa^+ \; rK^+$
S6	Sept 2014	$rHCO_3^- \; rCl^- \; rSO_4^{2-}$ $rCa^{2+} \; rNa^+ \; rMg^{2+} \; rK^+$
S7	June 2012	$rHCO_3^- \; rCl^- \; rSO_4^{2-}$ $rCa^{2+} \; rMg^{2+} \; rNa^+ \; rK+$
S8	Sept 2014	$rHCO_3^- \; rSO_4^{2-} \; rCl^-$ $rCa^{2+} \; rMg^{2+} \; rNa^+ \; rK^+$

S9	April 2014	rSO_4^{2-} rCl^- $rHCO_3^-$ rCa^{2+} rNa^+ rMg^{2+} rK^+

- **Principal component analysis (P.C.A)**

We realized a global P.C.A concerning the points of the thermal waters analyzed in our zone of study. A.C.P includes 9 observations and 10 variables (T, pH, EC, Ca, Mg, K, Na, Cl, SO_4, and HCO_3).
The correlation matrix (Table 3) between the chemical elements shows that the variables that are well correlated with each other, namely: [Na, Mg (0.901)], [k, Na (0.968)], [Cl, Ca (0.980)], [Cl, Na (0.984)], [HCO_3, Ca (0.946)], [HCO_3, Mg (0.913)], [Cl, HCO_3 (0.944)].

- **Factorial analysis**

F1, F2 factorial plane: the observation of the correlation circle formed by the two factorial axes F1 and F2 shows us that the factor F1 expresses 72.59% of the variance (Figure 3). This axis groups the following variables: Ca, Mg, Na, k, HCO3, Cl and EC. This factor reflects the characteristics of the water-rock interaction.
A strong correlation of electrical conductivity with Ca, Mg, Na, k, HCO_3, Cl, indicates that mineralization is highly influenced by the dissolution of evaporate formations.
A strong correlation of calcium and magnesium with bicarbonates is generally related to the dissolution of carbonate formations where calcic bicarbonate facies predominate.
The second axis F2, which expresses 16.60 % of the variance, opposes the temperature T° to the hydrogen potential and the sulfate.

Table 3. Correlation matrix of chemical elements analyzed

Variables	T °C	pH	EC	Ca	Mg	Na	k	HCO3	Cl	SO4
T °C	**1**									
pH	-0,549	**1**								
EC	0,349	-0,602	**1**							
Ca	0,459	-0,700	0,979	**1**						
Mg	0,130	-0,547	0,914	0,857	**1**					
Na	0,302	-0,524	0,989	0,944	0,901	**1**				
k	0,305	-0,602	0,982	0,976	0,866	0,968	**1**			
HCO_3	0,301	-0,700	0,964	0,946	0,913	0,951	0,957	**1**		
Cl	0,426	-0,613	0,993	0,980	0,872	0,984	0,971	0,944	**1**	
SO_4	-0,251	0,508	0,126	0,030	0,278	0,148	0,056	-0,061	0,098	**1**

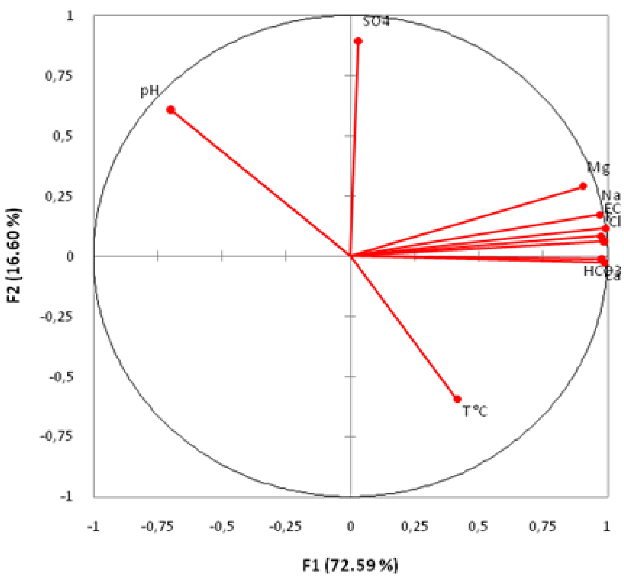

Figure 3. Projection of the variables on the F1F2 plane

Table 4. Barycenters of variables by classes

Class	T °C	pH	EC	Ca	Mg	Na	k	HCO3	Cl	SO4
1	27,10	5,85	6,50	547,46	135,86	740,04	30,10	1929,35	1219,83	146,01
2	40,00	5,88	3,30	378,33	34,75	300,01	16,03	842,64	655,11	3,84
3	24,00	6,92	1,75	157,10	32,80	177,80	4,68	265,42	294,94	278,57
4	29,16	6,34	1,33	146,68	36,29	102,61	2,73	451,52	181,61	91,87
5	19,00	6,51	0,65	94,98	10,93	15,86	1,36	283,72	30,12	27,85

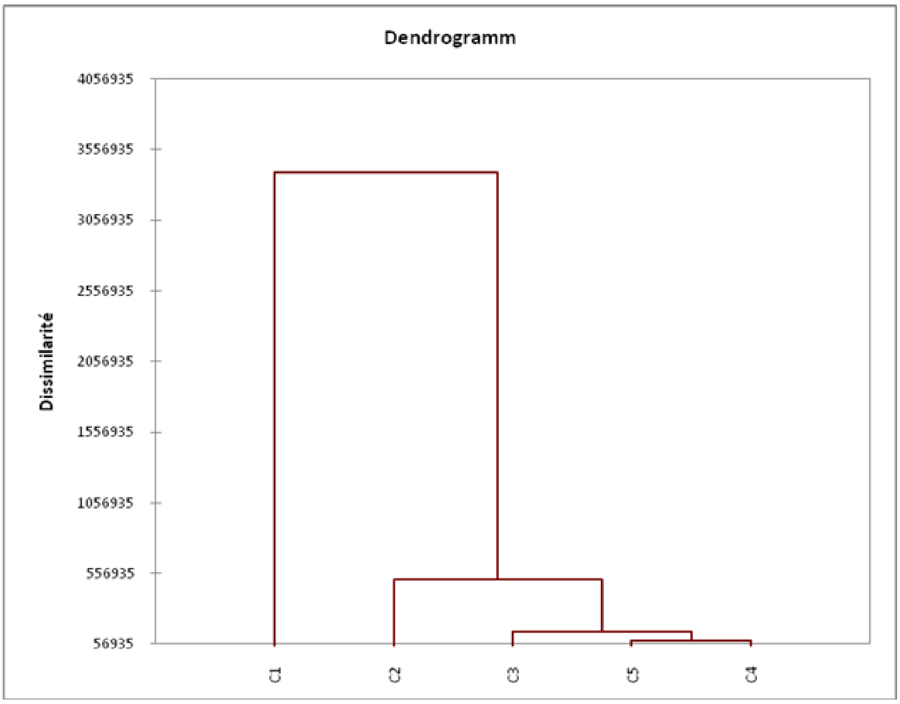

Figure 4. Hierarchical ascending classification of observations (H.A.C.)

The statistical treatment of the observations by this method brings out five classes (Figure 4):
Class 1: Bicarbonates are predominant ions in this group, with significant concentrations of chlorides, sodium and magnesium. The electrical conductivity in this class is very high at about 6,500 mS/cm, this type of water was observed in the source 1
Class 2: In this class also the bicarbonates are predominant of order 842.640 mg/l with high concentrations of chlorides, calcium and sodium. The electrical conductivity also high 3,300 mS/cm, this type of water was observed in S2.
Class 3: This class is characterized by the dominance of chloride and sulfate ions 294.940 mg/l and 278.570 mg/l respectively, the increase of SO4 and Cl is the consequence of the dissolution the increase of SO_4 and Cl is the consequence of the dissolution of the Triassic formations (diapirs zone) with an average salinity of 1,750 mS/cm. This type of water was observed in springs 3 and 9.
Class 4: Springs 4, 5 and 6 belong to this class, the order of abundance of cation concentrations in this group is Ca> Na> Mg> K and the anion concentrations are: HCO_3 > Cl > SO_4. The waters of this class more or less saline (EC of order 1,333 mS/cm).
Class 5: This type of water has an abundance of cations and anions in the following order: Ca> Na> Mg> K and HCO_3 > Cl > SO_4, with low salinity the average EC = 0.650 mS/cm. Ca and HCO_3

dominate the cations and anions of the group, these ions are due to the dissolution of carbonate formations.

CONCLUSION

The thermal waters of Souk Ahras region are slightly acidic and have medium to high conductivity. The hydrogeochemical analyses of the thermal springs of the study area showed that the majority of the springs have calcic bicarbonate facies. The principal component analysis (PCA) carried out on the various samples analyzed highlighted the elements characterizing the chemical facies.

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Article submitted to the Proceedings Book of the VIth. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

EVALUATION OF SURFACE WATER QUALITY FOR DRINKING PURPOSES: A CASE OF GUENITRA DAM (NORTH-EAST ALGERIA)

Selma HADEF*, Faouzi ZAHI, Taha Hocine DEBIECHE, Abdelmalek DROUICHE

*Geological Engineering Laboratory (LGG), University of Mohamed Seddik Benyahia - Jijel, Algeria, *e-mail: selmahadef18000@gmail.com, Phone: 0783085766*

The Guenitra dam is located in the south-western part of Skikda region (north-eastern Algeria). It occupies the downstream part of its catchment area with a total capacity of 120 hm^3 and a regulatable volume of 48 hm^3/year. Its waters are used for different purposes (drinking water, industry and irrigation). The latter is exposed to anthropogenic activities including mainly urban waste and leachates from the abandoned polymetallic sulphide mine of Sidi Kamber. A six-month monitoring (November 2017 to April 2018) was carried out on the waters of the Guenitra dam by the National Agency for Hydraulic Resources of Constantine (ANRH), with the aim of evaluating the water quality of the Guenitra dam based on the determination of the water quality index (WQI) and the organic pollution index (OPI). The OPI shows that 80% of the samples belong to the moderate quality type of water (3 < OPI < 3.9). While the WQI shows that 70% of the samples have a good quality (25 < WQI < 50), which is suitable for drinking purposes, with the exception of the March and April waters which revealed poor quality and unsafe water (WQI > 75). This degradation of water quality is seasonal due to variations in water inflow to the dam.

***Keywords:** organic pollution index (OPI), water quality index (WQI), Guenitra dam, Algeria.*

INTRODUCTION

Water is a natural resource indispensable for life and an essential component of the ecosystem. This resource has an important impact on the socio-economic activities development and indeed in the worldwide environmental system. In general, water resources are vulnerable to various types of pollution such as, anthropogenic activities which cause major problems of water and environmental pollution [1] and natural processes (rainfall irregularity, erosion, minerals weathering) [2], [3], [4]. Therefore, continuous water quality monitoring is essential for the sustainable management and the protection of water resources [5], [6]. It aims to assess the water quality and its suitability for different purposes; drinking water, agricultural and industrial uses, etc. [7]. Generally, water quality is defined in terms of its physical, chemical and biological parameters, by comparing the values of these determined parameters with accepted guidelines. This approach enables the correct identification of pollution sources and may be essential for assessing its suitability. However, it does not show trends in the spatial and temporal evolution of water quality in a watershed [8]. Several studies have shown that surface water quality has suffered in recent years, a real degradation due to different pollution sources (urban and demographic growth, agricultural and industrial development) and having an impact on flora and fauna [9], [10], [11], [12]. In addition, the reduction in rainfall has prolonged the drought periods.

Algeria currently has more than eighty-three (83) dams, which constitute an important resource for drinking water supply, irrigation and industry [13], [14]. Recently, the region of Skikda (North East Algeria) has experienced several problems concerning the quantitative and qualitative aspect of water in response to demographic growth and industrial and agricultural development [15]. The

Guenitra dam is one of the most important sources of drinking water supply for the wilaya's capital, however it is influenced by several anthropogenic discharges, mainly the impact of leaching products from the Sidi Kamber abandoned mine [16] and urban discharges from Beni Oulbene and Oum Toub towns upstream of the dam which are discharged directly into the wadis without any prior treatment [17]. Water quality index (WQI) is a very useful parameter for assessing surface water quality. It is considered as one of the most important tools to provide information about water quality to concerned citizens and the policy makers [18]. The objective of this work is to assess the water quality of the Guenitra dam and their suitability for drinking and irrigation purposes through the quality indexes such as the global water quality index (WQI) and the organic pollution index (OPI).

PRESENTATION OF THE STUDY AREA

The Guenitra dam is located at about thirty kilometers in the southwest of Skikda city (North East Algeria). It was the first one that was constructed in the wadi Guebli watershed, it occupies the downstream part of the Guenitra sub-watershed on the riverbeds of five main wadis namely: wadi Fessa, wadi Charfa, wadi Magramene, wadi Malouh and wadi Essouk (Figure 1). The dam is characterized by an area of about 202 Km^2 and a storage capacity about 125 million m^3. It ensures the supply of drinking water to the Skikda town and the surrounding agglomerations, the industrial zone and the irrigation of the perimeters of Emdjez-Edechich and the Saf-Saf valley [19], [20], [21]. Currently, the dam is subject to noxious anthropogenic activities such as, wastewater discharges from Oum Toub and Beni Oulbane towns and agricultural waters as well as leaching products from Sidi Kamber abandoned polymetallic sulfide mine, which may induce a deterioration of the dam water quality [17]. According to the Guenitra dam meteorological station, the annual average rainfall in the study area is 650 mm/year. This region is characterized by a Mediterranean climate with two distinct seasons; one humid and rainy and the other dry and relatively rainy.

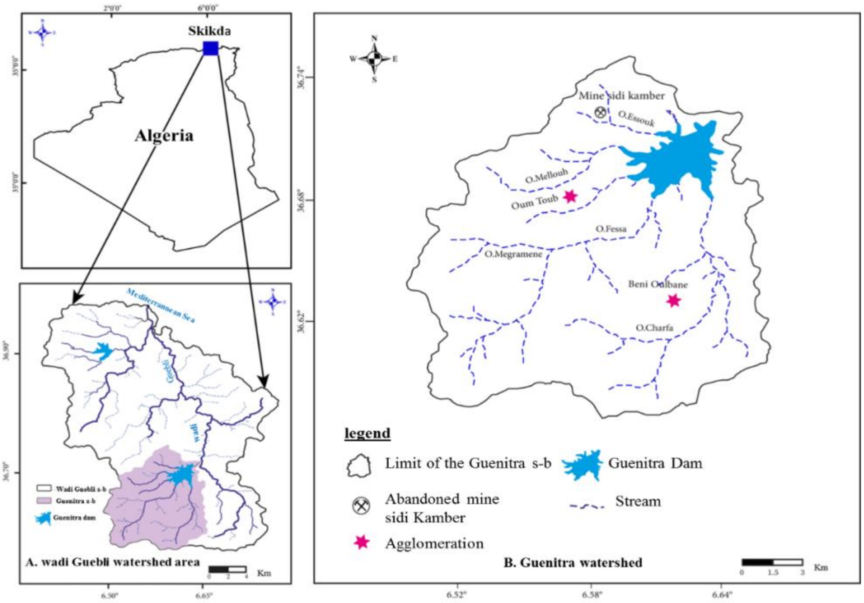

Figure 1. Location map of the Guenitra dam; (A). Wadi Guebli watershed, (B). Guenitra Watershed

Geologically, the dam watershed includes different structural domains that are part of the so-called "internal zones" of the Maghreb chain. According to Mahdjoub [22], the metamorphic rocks (Kabyle basement) of Proterozoic to lower Paleozoic age are the most widespread and are covered by their Mesozoic limestone cover (limestone chain). In addition, the Tellian units and the flysch formation could also be present with a lesser importance. On the Kabyle basement, the Sidi Kamber abandoned mine (northwest of the Guenitra dam) has been installed. This deposit is composed of a series of massive sulphide veins dispersed on both sides of wadi Essouk. Sulfide mineralization is represented by galena (PbS), sphalerite (ZnS), pyrite-marcasite (FeS_2) and barite ($BaSO_4$) [16]. In 1976, the mining activities of the Pb-Zn deposit were stopped, since then, only barite was mined by open pit until 1984, when the mine was permanently closed. However, the resulting leachate continued to flow into wadi Essouk without prior treatment [20].

MATERIALS AND METHODS

In order to assess the water quality of the Guenitra dam and to monitor the evolution of its physico-chemical composition (pH, OD, Rs, SO_4^{2-}, COD, BOD_5, PO_4^{3-}, N-NH_4 and N-NO_3), a six-month monitoring (November 2017 to April 2018) was carried out on the waters of the dam by the National Agency for Hydraulic Resources of Constantine (ANRH). For the evaluation of the dam water quality in terms of drinking water and irrigation purposes, two indices were used namely; the water quality index (WQI) and the organic pollution index (OPI).

Water Quality Index (WQI)

The WQI has been identified as an important technique for identifying and evaluating the influence of natural and anthropogenic activities that generate water quality and its sustainability for consumption [23], [24]. The WQI is used for water quality assessment and consists of comparing the quality parameters to the World Health Organization standards (WHO) [25]. The WQI is calculated using the weighted arithmetic index method [26], [27], [28], [29], [30], [31], based on several key water chemistry parameters (pH, OD, Rs, SO_4^{2-}, COD, BOD_5, PO_4^{3-}, NNH_4 and N-NO_3) [32]. For each quality parameter, different weights were assigned (Wi) depending on its relative importance in water quality for domestic consumption and its health implications when encountered at high concentrations in waters. The following equations are involved in determining the WQI:

$$WQI = \sum Qi\ Wi / \sum Wi$$

Qi: Quality rating scale for each parameter calculated according to this expression:

$$Qi = 100\ [(Vi - Vo) / Si - Vo)]$$

Where: Vi: Concentration of the parameter i^{th} in the analyzed water, Vo: the ideal value of this parameter in the pure water, Si: it is recommended of standard value of the parameter i^{th}.
Wi: The unit weight for each parameter calculated according to the following formula:

$$Wi = K / Si$$

Where; K: Proportionality constant calculated according to the following equation:

$$K = 1 / \sum (1/Si)$$

Five quality classes can be identified based on WQI values (Table 1).

Table 1. Classification and use of water according to WQI values [27].

WQI value	Water quality	Possible use
0-25	Excellent water quality	Drinking water, irrigation and industry
> 25-50	Good water quality	Drinking water, irrigation and industry
> 50-75	Poor water quality	Irrigation and industry
> 75-100	Very Poor water quality	Irrigation
> 100	Unsuitable for drinking purpose	Appropriate treatment required before use

Organic Pollution Index (OPI)

The OPI was proposed by Leclercq and Maquet [33], it allows to evaluate the quality of water and its degradation under the influence of anthropogenic activities, and to determine and estimate the organic pollution degree of waters [34]. The concept of this index is to classify the pollutant values into five (05) classes (Table 2) that corresponds to the average of the pollution classes for each parameter [35], [36], [37], [38].

Table 2. Grid of organic pollution index classes [39].

Parameters	DBO5 mg-O_2/l	$NH4^+$ mg-N/l	NO_2^- µg-N/l	PO_4^{3-} µg-P/l	OPI	Organic pollution
5	<2	<0.1	<5	<15	5.0 – 4.6	Null
4	2-5	0.1-0.9	6-10	16-75	4.5 – 4.0	Poor
3	5.1-10	1-2.4	11-50	76-250	3.9 – 3.0	Moderate
2	10.1-15	2.5-6	51-150	251-900	2.9 – 2.0	High
1	> 15	> 6	> 150	> 900	1.9 – 1.0	Very high

RESULTS AND DISCUSSION

The assessment of drinking water quality is a timely necessity when drinking water availability is threatened by natural and anthropogenic activities. This study was conducted on Guenitra dam waters using the WQI and the OPI which provide the composite effect of chemical parameters on water quality. The descriptive statistical characteristics of the physicochemical variables used in this study concern the minimum, maximum, mean and standard deviation values (Figure 2). Obtained results indicate that the pH is slightly alkaline (7.25<pH<7.78). The water mineralisation is relatively high with a dry residue of between 420 and 466 mg/l. The dissolved oxygen concentration ranges from a minimum value of 71.43% to a maximum value of 87.5%. Nitrates, ammonium and phosphates do not reach the World Health Organisation standard [25] (Table 3). While Nitrite levels exceeding the WHO standard are due to the transformation of NH_4^+ into NO_2^- by oxidation. Biochemical oxygen demand (BOD5) oscillating in the WHO drinking water standard range (3-5 mg/l), while chemical oxygen demand is very high (26 < COD < 35 mg/l), exceeding the accepted WHO standard (20-25 mg/l).
The COD/BOD_5 ratio exhibits values ranging from 8.75 to 17.5 (> 4), which indicates the dominance of non-biodegradable organic matter, reflecting the impact of industrial and agricultural discharges. This situation requires continuous monitoring of discharges before they reach the dam and pre-treatment of the water before it is consumed as drinking water.

Table 3. Descriptive statistics of physico-chemical parameters (November 2017 -April 2018)

Parameters	pH	Rs	O_2d	NO_2^-	NO_3^-	NH_4^+	PO_4^{3-}	DBO_5	DCO	DCO/DBO5
Units	/	mg/l	%	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	/
Min	7.25	420	71.43	0.039	1.00	0.080	0.000	2.00	**26.00**	**8.75**
Max	7.78	466	87.50	**0.162**	7.00	0.270	0.030	4.00	**35.00**	**17.5**
Mean	7.49	440.09	78.91	0.083	4.16	0.153	0.017	2.51	**30.50**	**12.82**
SD	0.20	17.30	5.77	0.047	2.64	0.073	0.012	0.84	4.93	2.82
WHO (2011)	6.5 - 8.5	1500	70 - 90	0.1	< 50	0.5	0.5	3 - 5	20-25	4

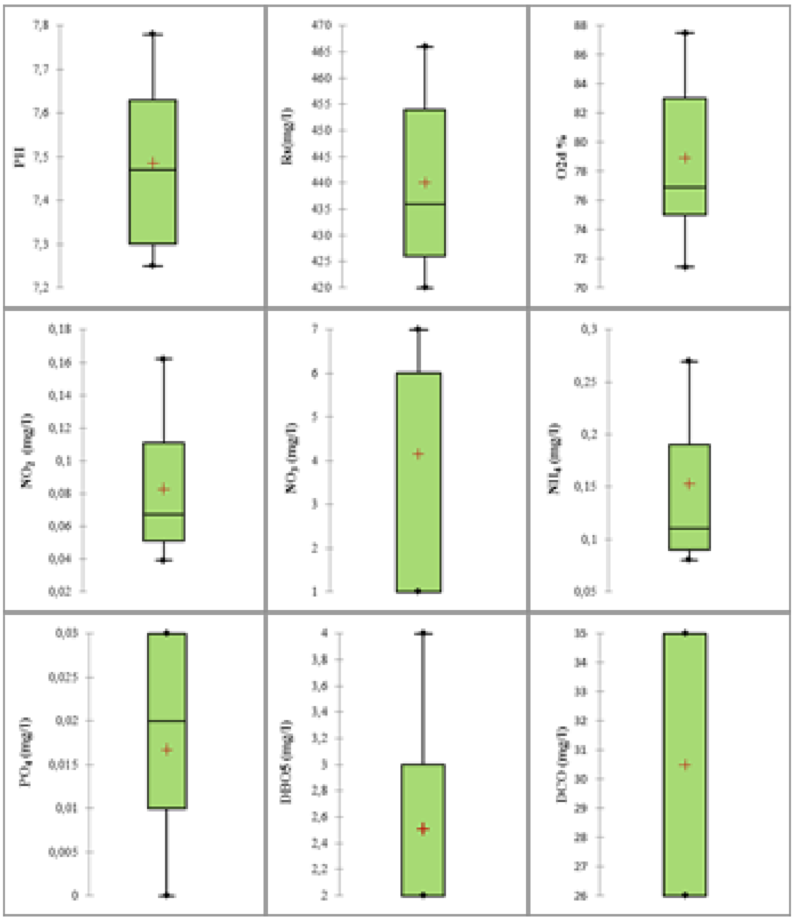

Figure 2. Box plot of physicochemical parameters (November 2017 to April 2018).

Water Quality Index (Wqi)

In this study, the water quality of the Guenitra dam was assessed by the WQI method. The relative weight (Wi) of each physico-chemical parameter and the proportionality constant K were first calculated using the maximum values of the World Health Organisation drinking water standard for the physico-chemical parameters studied. Indeed, nine (9) important parameters: pH, Rs, DO, NH_4^+, NO_3^-, NO_2^-, PO_4^{3-}, BOD5 and COD were taken into account in calculating the WQI value. The results reveal the presence of three water quality classes (Table 4). The good quality class (25<WQI<50) characterises the water from November to February, when rainfall is abundant, causing good dilution of the water. However, the water from March to April has a very poor quality and is not drinkable (WQI >75) (Table 4). The high WQI values are mainly related to high nitrite (NO_2^-) and COD values. This is due to the decrease in the rainfall amounts, which increases the discharge rate compared to the natural runoff.

Table 4. WQI of the waters of the Guenitra dam (November 2017-April 2018)

Month	WQI	Water quality	Possible use
November 2017	41.91	Good water quality	Drinking water, irrigation and industry
December 2017	47.65		
January 2018	50.85		
February 2018	36.41		
March 2018	84.08	Very Poor water quality	Irrigation
April 2018	117.56	Unsuitable for drinking purpose	Appropriate treatment required before use

Organic Pollution Index (Opi)

The IPO provides information on the urban discharge impact on the Guenitra dam water quality during the monitoring period (November 2017- April 2018). The OPI is calculated on the basis of the main pollutants such as: BOD5, Nitrites (NO_2^-), Phosphates (PO_4^{3-}), Ammonium (NH_4^+), where they have classified the water quality in five (5) categories. In our case two (2) quality classes were identified (poor and moderate pollution) (Table 5).

Table 5. IPO of Guenitra dam water (November 2017 to April 2018)

Month	OPI	OPI Class	Organic pollution
November 2017	3.75	3.0 – 3.9	Moderate Pollution
December 2017	4	4.0 – 4.5	Pollution poor
January 2018	3.75	3.0 – 3.9	Moderate Pollution
February 2018	3.75		
March 2018	3.5		
April 2018	3.5		

The low organic pollution class (4< IPO <4.5) was observed during December 2017 (IPO = 4). While the moderate organic pollution class (3< IPO <3.9) was identified during the remaining months (November 2017, January - April 2018) with an IPO index fluctuating between 3.5 and 3.75. This pollution is mainly related to urban discharges from Oum Toub and Beni Oulbane agglomerations.

CONCLUSIONS AND RECOMMANDATIONS

The hydrochemical study provided a local view of the Guenitra dam water quality in relation to physico-chemical descriptors and a large scale view using the water quality index (WQI) and organic pollution Index (OPI) method.
This study clearly indicates that the importance of understanding the relationship between water quality and quantity in helping water managers to better understand some of the key characteristics of water quality. The application of the water quality index and the organic pollution index is very useful for assessing water quality.
These indicators indicated that the surface water of the Guanitra dam is about 80% of good quality and 20% of moderate organic pollution. This pollution could be attributed to anthropogenic activities such as agricultural activities and uncontrolled discharges from the various neighbouring agglomerations.
Finally, the management of contaminated sites, including abandoned mining areas, and the pre-treatment of mining discharges as well as the treatment of wastewater discharges from urban areas located upstream of dams, are recommended to protect water resources, including dams, from any type of water pollution, whether for drinking water or irrigation purposes

ACKNOWLEDGEMENTS

The authors of this article would like to thank the managers of the Guenitra dam for all the facilities they have given us to acquire the data necessary to carry out this work.

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Article submitted to the Proceedings Book of the VI[th]. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

CARBON FIBER, THE BLACK WONDER

Rudolf SZABÓ[1*], Lóránt SZABÓ[2]

[1*]*Rejtő Sándor Foundation, Budapest, Hungary, ingtex@t-online.hu*
[2]*Institute of Environmental Engineering and Natural Sciences, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Budapest, Hungary, szabo.lorant@rkk.uni-obuda.hu*

In recent decades to meet the growing demands of users the performance of machines and equipment has increased significantly due to the widespread use of electronic solutions and accurate manufacturing. However, this has also increased energy demand and the CO_2 emissions. There is virtually no alternative to lightweight constructions: the carbon fibres reinforced materials (FRP), that are superior to steel and aluminium in almost all respects when it comes to cutting the weight and a number of beneficial properties. And, in terms of specific stiffness and lightness, carbon fiber reinforced plastics is simply unbeatable.
The aerospace, automotive, high performance machine parts, the wind-power industries, the hydrogen storage vessels producers have been aware of this they are being used in rapidly increasing quantities in more and more areas. The presentation will to give provide an overview of the use of the CFRP.

Keywords: applications, carbon fiber, composites, lightness, stiffness, tension

INTRODUCTION

In the various ages, materials used by man changed significantly, in our time polymers, as competitors to metals are becoming more and more significant (Figure 1).

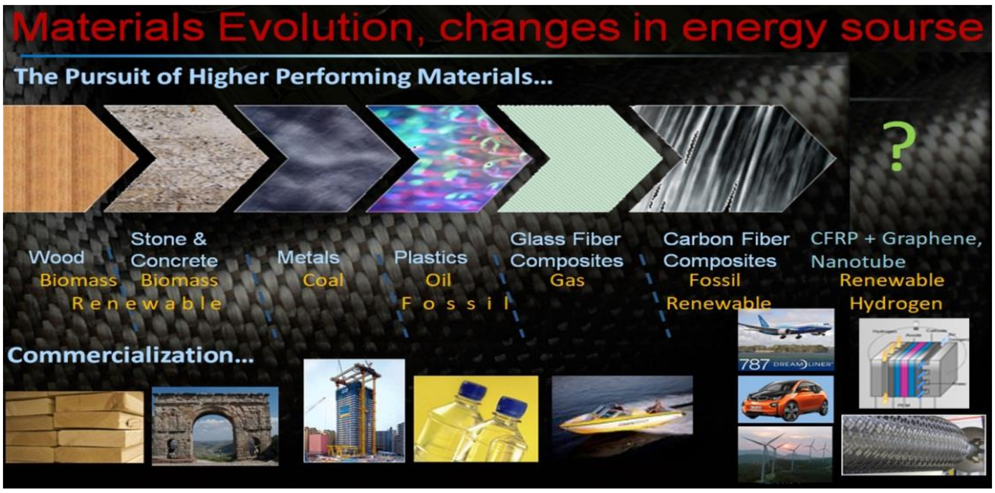


Figure 1. Evolution of used materials as a function of energy sources

Another great challenge of today is to ensure the ever increasing demands for energy, while reduction of carbon dioxide emissions harmful to the environment is a must. Coal and the carbon atoms, has previously made a decisive contribution to technological development (it has become an essential source of energy since the Industrial Revolution, and a key blending element for steel/cast iron structures). The ratio of the amount of structural materials is illustrated in the Figure 2.

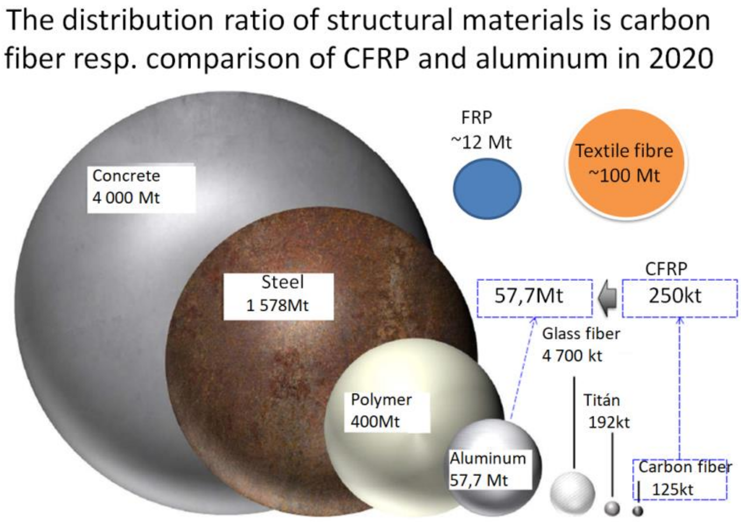


Figure 2. The distribution ratio of structural materials

Carbon fiber, which is largely used as a composite, makes up a small proportion but is growing rapidly due to its many excellent properties. Technical developments make it possible, even technical and economic requirements, to use new, high-performance materials. The final product was formed from the previously block-shaped section materials by cutting. Today, dynamically growing 3D printing shapes the end elements of the end product by superimposing thin planes, which has greatly facilitated the creation of lightweight structures. Facilitation of structures is essential to reduce the use of this energy and thus CO_2 emissions. Today, the knowledge and application of carbon atomic arrangement and compounds is crucial for high-tech developments. The specific surface area of small micro/nano-sized materials is large relative to the mass, and the surface can be treated to provide strong bonding between different materials (Figure 3).

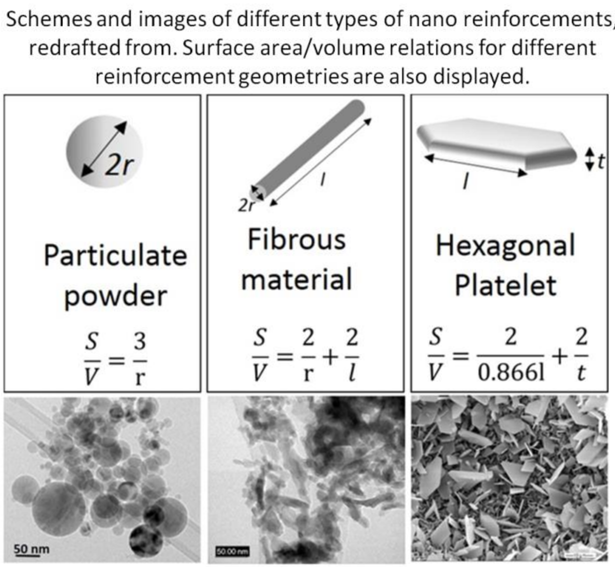


Figure 3. Schemes and images of different types of nano reinforcements

For example the little solid material’s embedded into a matrix, well-dispersed little parts (graphene nanotubes) create a 3D reinforced and conductive network that provides a new set of properties and has minimal compact on the other key properties of final product (Figure 4).

Figure 4. Particle size distribution in a given volume

Carbon atom connection structures

The structure of the **carbon atom** is illustrated in the figure. The four electrons of the outer electron orbit create a huge number of possibilities for connection with other atoms as well as between carbon atoms (Figure 5).

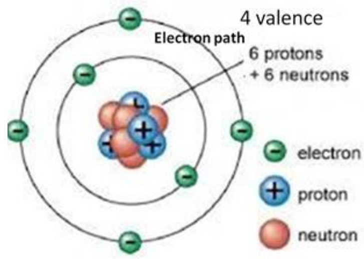
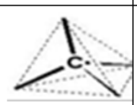
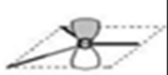
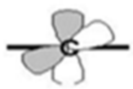


Figure 5. The carbon atom

Earlier for example the carbon in two basic, but startlingly different forms (allotropes) was known, namely graphite (the soft, black stuff in pencil "leads") and diamond (the super-hard, sparkly crystals in jewelry). The amazing thing is that both these radically different materials are made of identical carbon atoms. The atoms inside the two materials are arranged in different ways, and this is what gives the two allotropes their completely different properties (Table 1):

- **graphite** is black, dull, and relatively soft (soft and hard pencils mix graphite with other materials to make darker or fainter lines);
- **diamond** is transparent and the hardest natural material so far discovered.

Table 1. Connection of a carbon atom

Number of one carbon atom attached to a carbon atoms	**4**	**3**	**2**
Fragmentation of connected atoms			
Incidence	**Diamond 3D**	**Graphene Sheet**	**Polyamide chain Linear**
Possible number of electron p-bonds	**0**	**1**	**2**

In the last century, **polymers** have been artificially formed chain molecules by the linear coupling of carbon atoms. Polymer chain molecules can be used to make high strength (especially aromatic) fibers during fiber drawing (Figure 6).

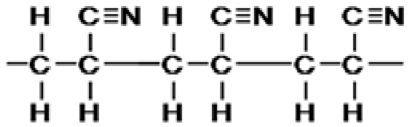


Figure 6. Polyacrylonitrile (PAN) chain molecule

The last few years, scientists have discovered various other carbon allotropes with even more interesting properties. There are present in Figure 7.

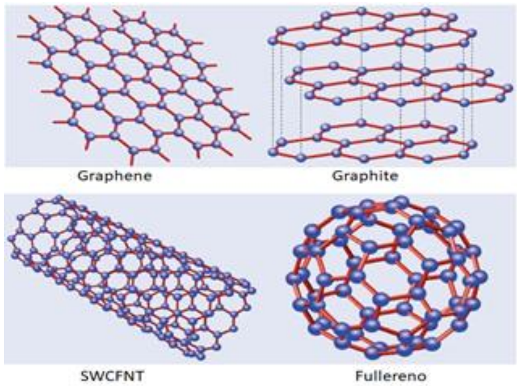


Figure 7. Honeycomb sheets of carbon just one atom thick

- **Fullerenes** (discovered in 1985) hollow cages of carbon, including the so-called Buckyball, made from a kind of football-shaped cage of 60 carbon atoms).
- **Nanotubes** (discovered in 1991; flat sheets of carbon atoms curled into amazingly thin, hollow tubes one nanometer in diameter)—and (drum roll). Single Walled Carbon Nano Tube (SWCNT) have an excellent properties; in mechanical (100 times stronger than steel), in thermal (thermal stability up 1600°C in vacuum), in electronic (5 times lighter then copper) and chemically inert, compatible with almost all materiel (Figure 8).

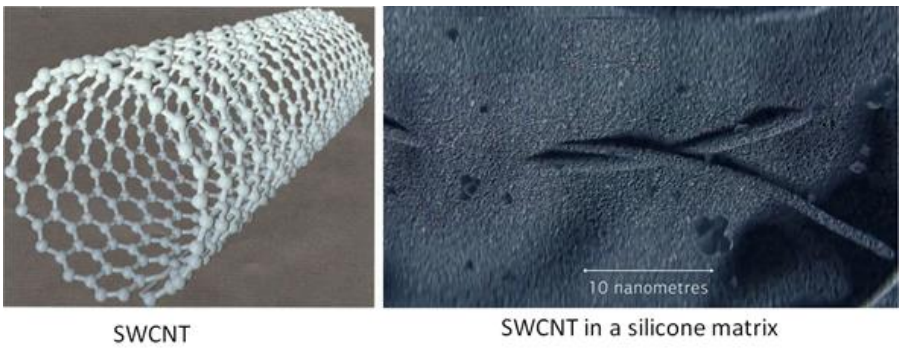


Figure 8. Nanotubes

Embedded into composites it is used as a directional structured reinforcing, bracing material. If the 20th century was the age of plastics, the 21st century seems set to become the age of **grapheme** (discovered in 2004) - a recently discovered material made from honeycomb sheets of carbon just one atom thick (0.345nm). It's just about the lightest, strongest, thinnest, best heat- and electricity-conducting material ever discovered. And if we're to believe the hype, it promises to revolutionize everything from computing to car tires and solar cells to smoke detectors (Figure 9).

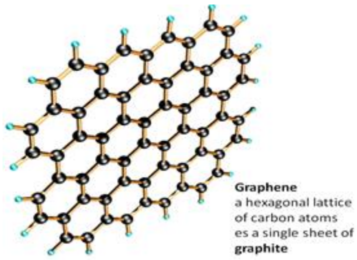


Figure 9. Grapheme is a honeycomb lattice

Nanofibres is very fine fibres (d<500 nm), produced with electrostatic spinning technology. It's possible to make very fine nonwoven structure for filtration (Figure 10).

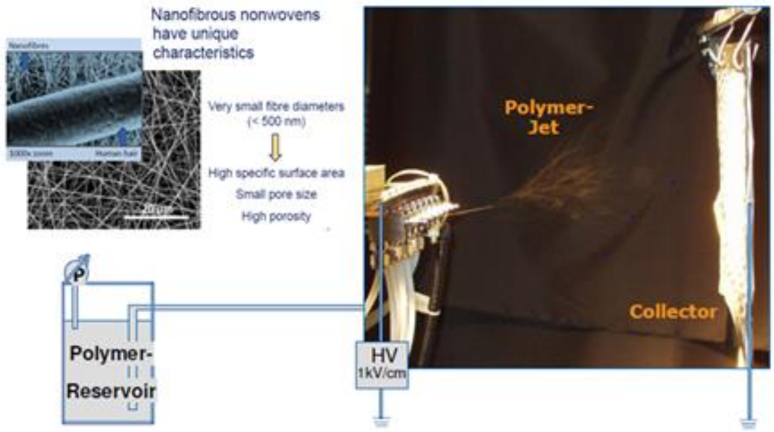


Figure 10. Electrostatic spinning of nanofibres

Carbon, OPAN and Graphite fibers to produce using identical raw material (PAN Precursor) and in the first phase of production, also using identical (Oxidation) processes, produces three types of black fibrous material, namely; oxidized (OPAN), carbonized and graphite fibers, it's properties, processing and field of application is significantly different (Figure 11).

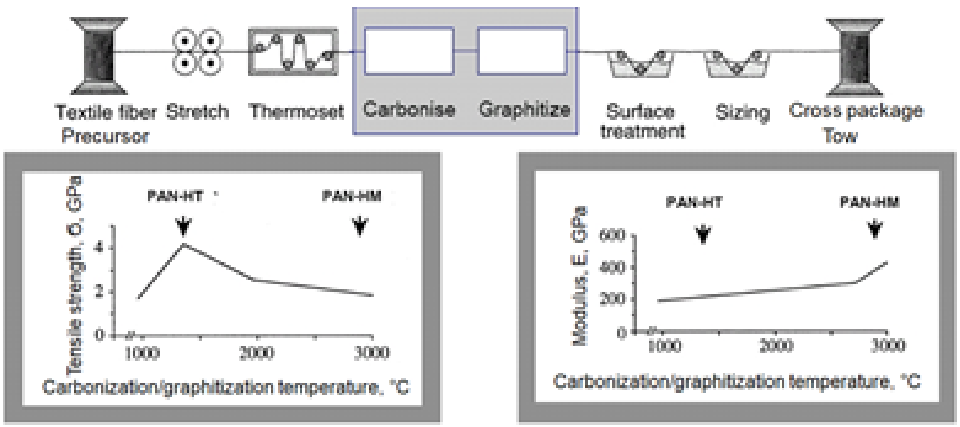


Figure 11. Production of carbon fibers from PAN precursor

The **oxidized fiber** - the so called **O**xidized **P**oly**a**crylo**n**itril fiber (OPAN, OPF) - (having high LOI (**L**imited Oxygen Index) value and excellent heat resisting, heat – sound insulating properties) can be processed into technical products or for e.g. protective clothing's using the well-known textile technology processes.

A significant part of the textile products made from OPAN is carbonized, from C&C composites airplane brake discs or brake linings are made. Another large part of the products, the sheet nonwoven fabrics after carbonization, constitute a functional element in fuel cells. The thusly resulting paper like 99% carbon content material is used for fuel cell in hydrogen driven electric motors or electrical energy storage. The **carbon fiber** following oxidation is produced by passing it through (under tension) high temperature nitrogen gas, thusly carbonizing it. The chemical structure of the graphite lattice plane formed in the direction of the fiber axis ensures high rigidity and strength.
The from the initial so-called PAN precursor fiber produce carbon fiber and graphite fiber continuously, depending on the carbonization temperature. At the end of the carbon fiber production line, the surface of the fiber is activated; a sizing material corresponding to the composite matrix is applied and then wound on a spool (Figure 12).

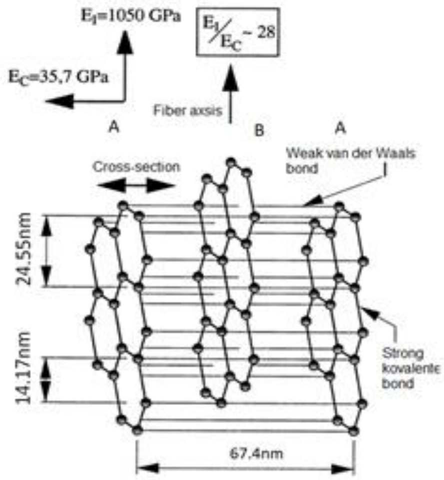


Figure 12. Lattice structure of a single carbon crystal

Carbon fiber is brittle and a good conductor of electricity, therefore in its processing special care is required. Carbon fiber has an Ø of 7 μm (approx; 0.7 dtex fineness), its tow contain a high number of parallel fibers (2, 4, 12. 24, 50 k (k→kilo, 1000 filament) (Figure 13). The specific mechanical properties of fibers far exceed those of conventional metallic structural materials (Figure 13).

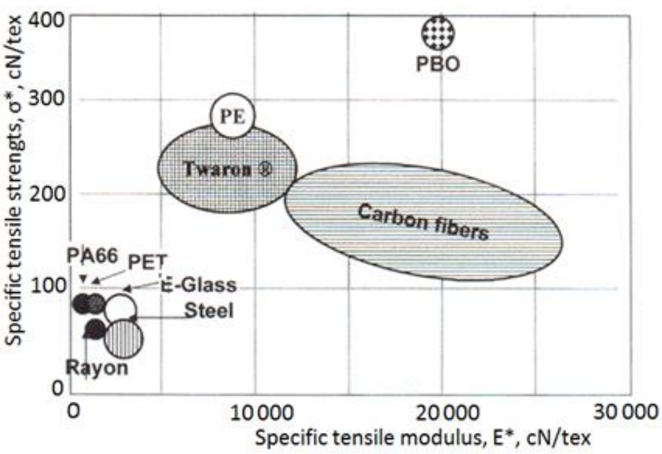


Figure 13. Performance comparison

Table 2 shows mechanical properties of some materials.

Table 2. Connection of a carbon atom

Materials	RSM[1]	Modulus GPa	RSTS[2]	Tensile strength GPa	Density ρ, g/m³	Diameter
Graphene	**~20**	~1000	**~750**	100-400	1,8-2,2	plate
SWCNT	**~32**	~1000	**~350**	100-200	~0,7-1,7	1-20 nm
Carbon nanofibers	**~9**	~500	**~15**	3-7	~1,8-2,2	20-200 nm
Carbon fibers	**~5**	230	**~12**	3,5	~1,8	7 µm
CFRP UD	**~3**	~120	**~6**	~1,8	~1,4	-
Aramid fibers	**~2**	60	**~15**	3,6	1,44	5-10 µm
Glass fibers	**~1**	75	**~5**	2,2	2,6	5-10 µm
High Tensile Steel	**1**	210	**1**	1,3	7.8	-

RSM[1] - Relative Specific Modulus (X material specific modulus/steel specific modulus)
RSTS[2] - Relative Specific Tensile Strength (X material specific Tensile Strength /steel specific Tensile Strength)

Textile structures, features

The carbon fiber is very fragile due to its low elongation (ε = 1-1.5%), which makes the textile processing of the cable very difficult. The surface of the cable throwing elements has a special design, the so-called orange peel-like.

A further complicating condition is that the small broken fibers float in the air, and due to the good electrical conductivity of the carbon fiber, the control electronic equipment of the machines must be protected to prevent short circuits and the destruction of the electronic panels. For this reason, the processing of carbon cables requires great professional experience and expensive equipment (Figure 14).

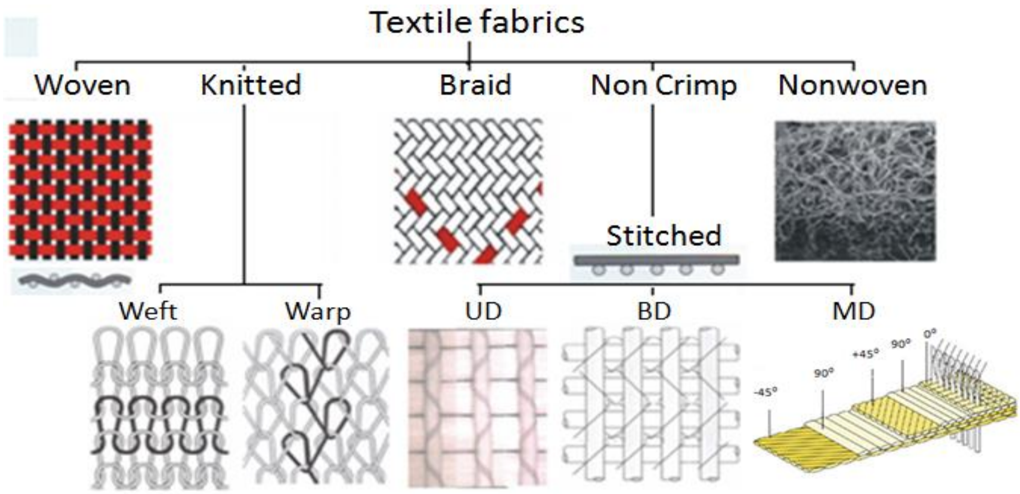


Figure 14. Types of textile fabrics

The orientation of the cables in the direction of the loads allows the production of anisotropic, high-performance composites (Figure 15).

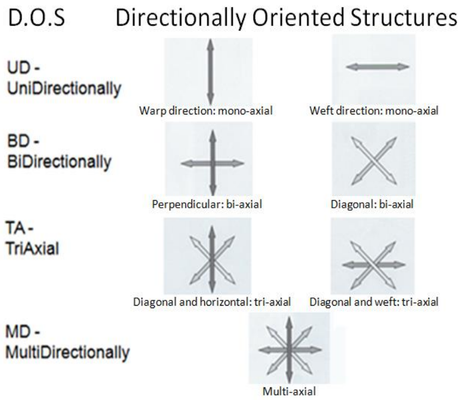


Figure 15. The orientation of the cables

In many cases, high rigidity is an important requirement for CFRP. For this reason, and also due to the high modulus of the carbon fiber, the design of the textile construction its straight position of the fibres is achieved by laying the cables (Figure 16).

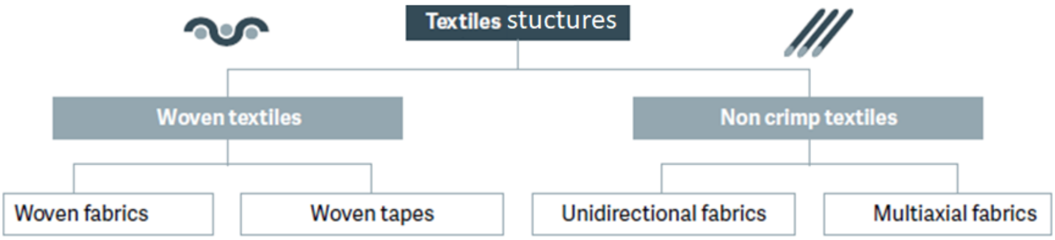


Figure 16. Textile structures

The fibers should be evenly distributed in the matrix. When placed in the form of a tow, the space in the cable gaps is filled only by the matrix, which is disadvantageous in terms of mechanical properties. By spreading the cable, this error can be eliminated and the liquid matrix evenly fills the space between the fibers (Figure 17).

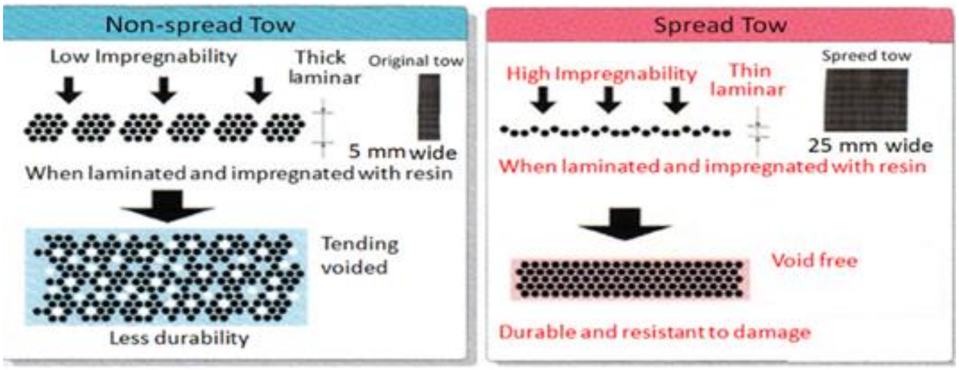


Figure 17. Fibres arrangement for non-spread and spread tow

Composite productions, properties

A composite is a material that is composed of several components, so that each of the individual components can be clearly differentiated physically from the other. The individual components then interact with each other so that the new material has new, improved properties that could not have been achieved with any of the individual components alone. A composite material consists of one or more than one reinforcement and one matrix (Figure 18).

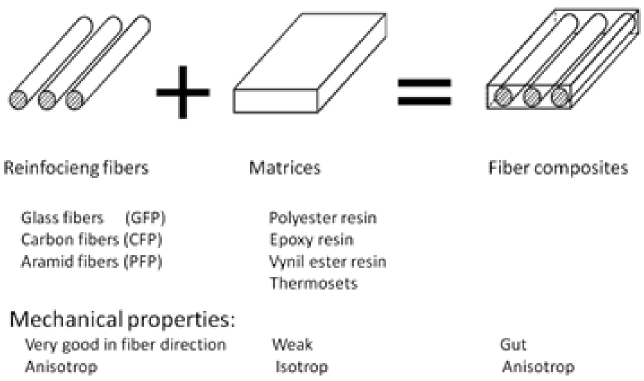


Figure 18. Structure of fibres composites

The matrix is the embedding material for the reinforcement. It serves the cohesion of the reinforcing material, protects the reinforcement from environmental influences and is mainly responsible for the uniform application of force for reinforcement. The matrix may be made of plastic (PMC), metal (MMC) or ceramic (CMC).
Similarly, there are various types of amplification. These are often categorized according to their form. Thus one differentiates e.g. between fiber-reinforced, particle-reinforced composites. The reinforcement serves to carry the load and thus increases the mechanical properties of the matrix in the composite.
Plastics, often referred to as polymer, are macromolecular chains of covalent bonds that are synthetically produced. Depending on the type of plastic, the properties can vary from elastic to brittle, or transparent to completely opaque. Mechanical properties, thermoforming or chemical resistance depend heavily on the choice of macromolecules, the manufacturing process and the addition of additives.
Plastics are divided into 3 categories: thermoplastics, thermosets and elastomers.
Thermoplastics consist of linear or branched macromolecules and can be plastically deformed after heating and also melt at elevated temperatures.
For **thermosets**, however, the macromolecules are spatially closely networked. This has the consequence that thermosets do not plastically deform and do not melt.
Elastomers are colloquially often referred to as rubber. These consist of wide-meshed macromolecules, which allow deformation under load, but retract elastically once the load is released. The cross-linking also makes it impossible to melt an elastomer (Figure 19).

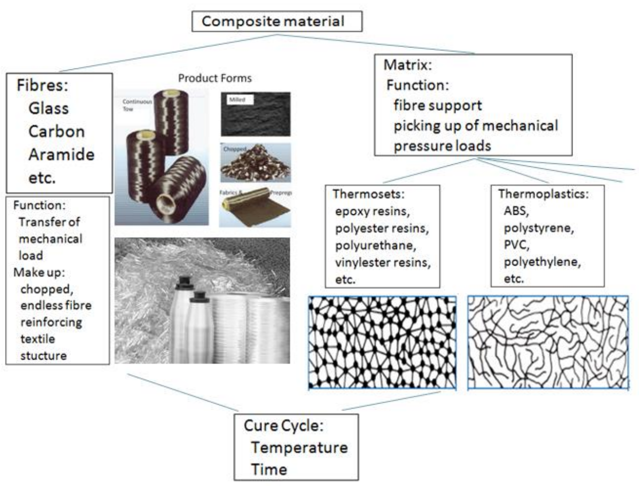


Figure 19. Types of composite materials

Fiber Reinforced Polymers (FRP) in which fibers or textile structures are embedded in a plastic (Figure 20).

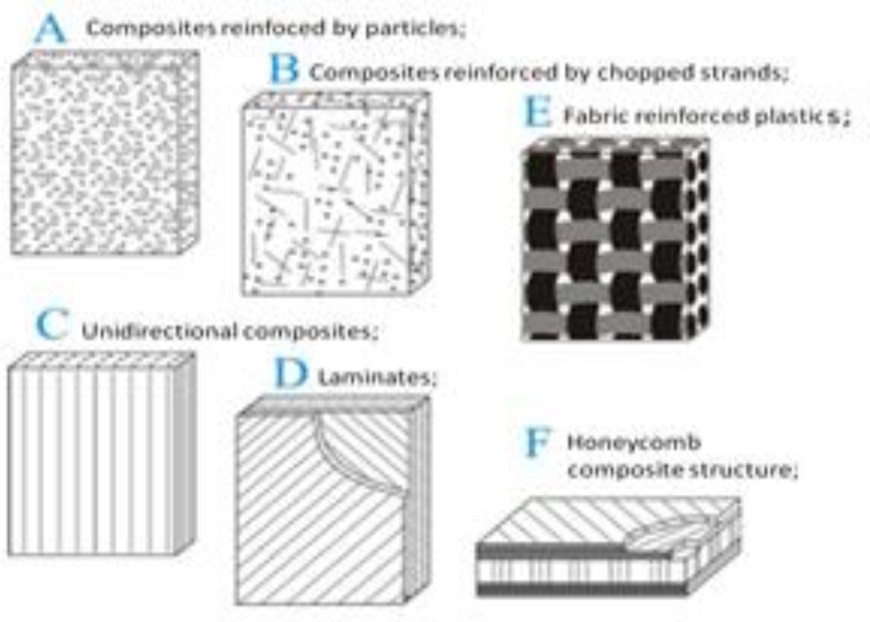


Figure 20. Structure of composite

Composite can be divided into:

- Low Performance Composites; typically with chopped and milled glass and carbon fibres
  No textile process inwolved. Fibers are injected into the moulding process or directly sold as glass or carbon fibre mats (see A and B pictures).
- High Performance Composites; typically with filaments or long strached of carbon, p-aramid, glass
  Textile processes are involved: Non crimped fabrics (UD, MD), weaving (spreaded, 3D structures), braiding, embroidery, laminates, etc. structures (see C, D, E, F structures).

Carbon Fiber Reinforced Polymer (CFRP) the ideal material for lightweight construction:

- Light weight,
- High specific strength,
- High specific stiffness,
- High bending stiffness,
- Excellent fatigue strength,
- Good vibration damping,
- X-ray transparency,
- High chemical resistance,
- Low thermal expansion,
- Corrosion resistance

Application of composites

Composite materials are increasingly used for primary structures in aerospace, transportation, marine, renewable energy production and storage, industrial, commercial and recreational structures.

Lightweight construction is short for lightweight, and implies a design technique that aims to maximize weight savings. Reasons for this include the targeted cost or raw material savings, as well as the increase of payloads or the simplification of assembly and handling. The way in which lightweight construction can be achieved varies. Thus, integratively constructive material and production engineering means can be used in an overall structure (Figure 21).

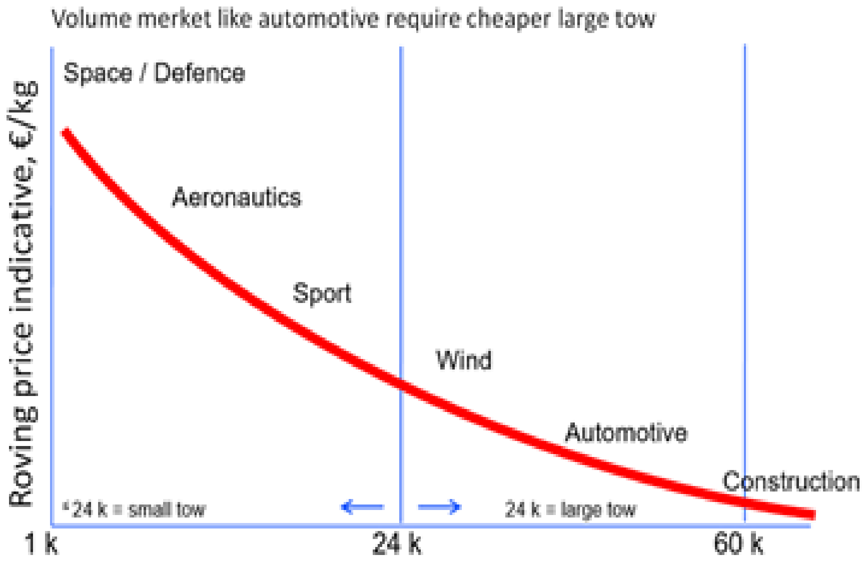


Figure 21. Small tow versus large tow segmentation

Reasons for a desired lightweight construction can be different. Often a weight saving, especially in the automotive or aviation sector, can reduce energy consumption and thus costs and raw materials during use. Frequently accelerating or decelerating loads (e.g., road or rail vehicles, elevators, robotic parts) can increase payload and reduce operating costs. Lightweight construction continues to offer a flexible alternative for installations or in building construction (Figure 22).

Figure 22. Applications of composites

In general, materials with low density and high mechanical properties are used in particular. This can be either a monolithic material or a composite material. Lightweight metallic materials are e.g. Aluminium, magnesium and titanium. In addition, fiber composites are nowadays regarded as a frequently used material category. In addition to space travel and aviation, a radical change is expected in the field of vehicles to reduce pollution, both for propulsion fuels and for new structures (Figure 23).

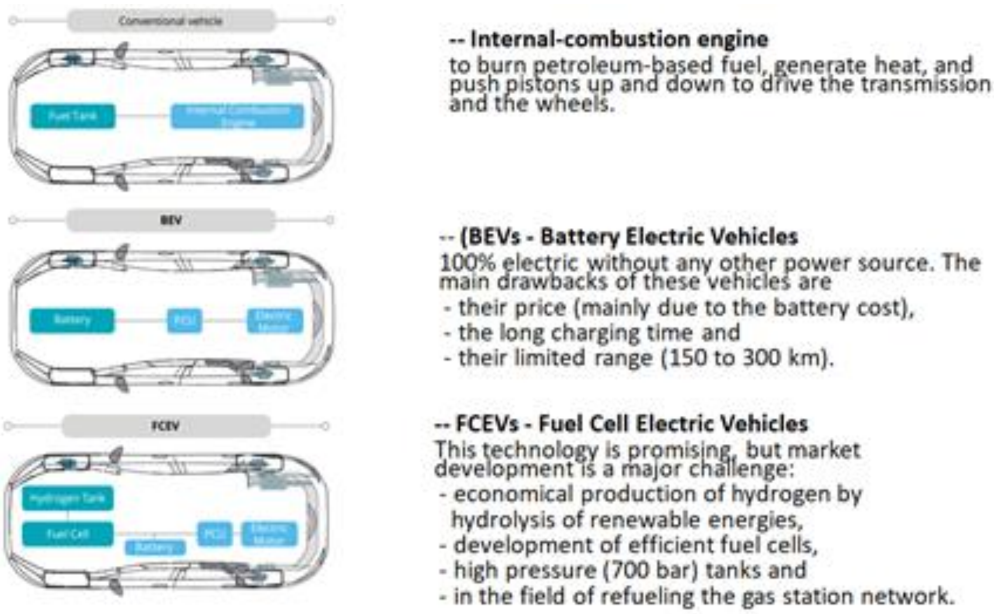


Figure 23. Propulsion system of vehicles

In addition to space travel and aviation, a radical change is expected in the field of vehicles to reduce pollution, both for propulsion fuels and for new structures. The rapid spread of electric vehicles is expected in the coming years, for which the development of lithium-ion batteries is essential. Within a few decades, with the increase in the share of renewable energy, energy storage will also become crucial. Renewable energy, which is also of great importance for the environment, is expected to be widely used in the storage of hydrogen obtained from the decomposition of water and for the electric propulsion of vehicles.

Technology for storing hydrogen in high pressure CFRT tanks and fuel cell propulsion has been developed, however, in the current situation; economy is not yet cost effective. In addition to space travel and aviation, a radical change is expected in the field of vehicles to reduce pollution, both for propulsion fuels and for new structures. The rapid spread of electric vehicles is expected in the coming years, for which the development of lithium-ion batteries is essential. Within a few decades, with the increase in the share of renewable energy, energy storage will also become crucial. Renewable energy, which is also of great importance for the environment, is expected to be widely used in the storage of hydrogen obtained from the decomposition of water and for the electric propulsion of vehicles.

Technology for storing hydrogen in high pressure CFRT tanks and fuel cell propulsion has been developed, however, in the current situation; economy is not yet cost effective (Figure 24). As the share of renewable energy sources increases, energy storage will become necessary for the continuous supply of energy, with the hydrogen economy promising. With the hydrogen produced by decomposing water in the overproduction phase of renewable energies, the electric drive from the high-pressure tanks of vehicles with the fuel cell is technologically developed and solved. Hydrogen has a high specific energy content (E=40 000 Wh/kg), but even at 700 bar its density (ρ=40 kg/m^3) is low. Reducing the weight of the hydrogen tank can only be achieved with a composite tank reinforced with carbon fiber winding, which will project a huge demand for carbon fiber in the near future. Technology for storing hydrogen in high pressure CFRT tanks and fuel cell propulsion has been developed, however, in the current situation; economy is not yet cost effective (Figure 24).

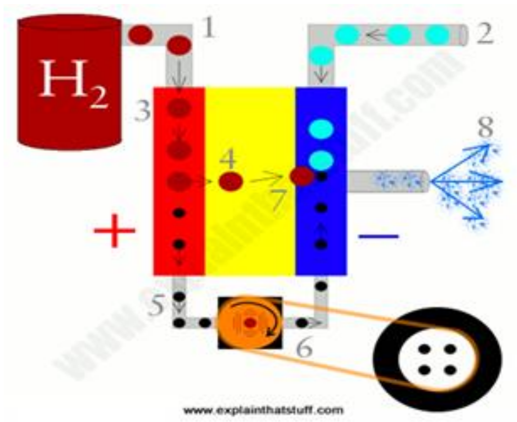


Figure 24. Schematic illustration of hydrogen drive

The use of composite in national economies is an indicator of development similar to electronics (Figure 25).

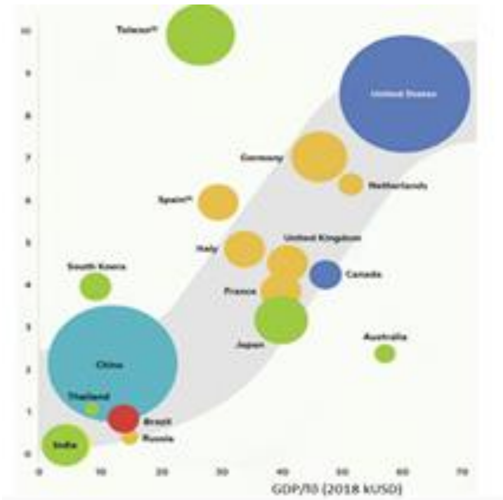


Figure 25. Comparison of countries by GDP and per capita composite production (kg/capita), 12.4 Mt in 2018s

CONCLUSIONS AND RECOMMENDATIONS

Thanks to the many outstanding properties of composites and intensive technological developments, they can be expected to be widely used in many key areas in the future. The use of CFRP materials to reduce the weight of high-efficiency, large-sized wind blades and high-pressure vessels can be expected for a bright future. Hydrogen propulsion technology is well developed, development is unbroken, economy is not yet competitive, but its future is indisputable, which is also desirable in terms of reducing environmental pollution and CO_2 emissions (a big step forward).

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Article submitted to the Proceedings Book of the VIth. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

PHYTOREMEDIATION OF POTENTIAL TOXIC ELEMENTS BY NATIVE TREE SPECIES IN MINED- SPOILED SOILS IN MÁTRASZENTIMRE, HUNGARY

Jovito L. OPEÑA[1,2]* , Gábor Endre HALASZ[2], Jószef Tibor ÁRGYELÁN[3], Mark Kalman HORVATH[2]

[1]Marinduque State College, Boac, Mariduque Philippines, [2]Hungarian University of Agriculture and Life Sciences, Institute of Environmental Sciences, [2]Department of Chemistry, Institute of Environmental Sciences, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary, [3] Nitrokémia PLC, Munkás tér, H-8184, Balatonfüzfö, Hungary
[*]Corresponding author::E-mail: jovito1565@gmail.com

Potential toxic elements such as Arsenic (As), Cadmium (Cd), Copper (Cu), Lead (Pb), and Zinc (Zn) are commonly left behind after mining operation. Being non-biodegradable, these elements serve as source of contamination for the soil and water ecosystems and create hazards to human health. This research work evaluated the phyto extracting ability for potential toxic elements by four (4) endemic tree species that are predominantly growing in an abandoned mining spoil sites in Mátra mountains in Hungary. Plant and soil samples were collected in the field and analyzed using ICP-OES. Results showed that the soil was highly contaminated with heavy metals, largely Pb, As, and Zn which were 10x to 60x more than the typical non-contaminated Hungarian soil. Among the trees evaluated, Carpinus betulus showed the highest potential for Pb dendroremediation, having a mean concentration value of 4071.67 mg kg^{-1}dry weight in roots, 439.06 mg kg^{-1}dry weight in stems and 92.53 mg kg^{-1} dry weight in leaves. Betula pendula and Salix caprea bioaccumulated 475.8 and 395. 97 mg kg^{-1} dry weight of Zn in their leaf biomass. Both trees had a Bioconcentration Factor (BCF) value of >1.0 but < 10 which classified them as potential phytoextractors of Zn. Salix caprea gave the highest Translocation Factor (TF) for Cd while Betula pendula gave the highest TF for Zn.

Keywords: potential toxic elements, dendroremediation, bioconcentration factor (BCF), translocation factor (Tf)

INTRODUCTION

Ecological restoration after an enormous anthropogenic disturbance like mining operation is a difficult task. Aside from negative impacts it created in micro-climatic environment, the metal extraction activity laid waste the soil ecosystem laden with high amounts of potential toxic elements such as heavy metals (Gonzales et al., 2008). Restoration of the ecosystem through soil decontamination from potential toxic elements is the most recalcitrant problem (Dobson et al., 2007). Phytotoxicity problem as a consequence of elevated concentration of heavy metals in soils have both direct and indirect hazards to human health.

The indirect effects through food chain or pollution of ground and surface waters (Pulford et al., 2002). Physical and chemical methods of soil metal decontamination of polluted soil ecosystems destroy soil structure and render the soil biologically dead (Mc Grath, 2001). Engineering methods like excavation, transport and dumping of contaminated soils were too expensive (Salt et al., 1995). In US, the estimated cost was 1 million dollars per acre (Raskin et al., 1997) or a total cost of 400 B US dollars to 1.7 trillion US dollars (Stomp et al., 1994).

Phytoremediation an emerging phytotechnology which is the use of plants in the removal, reduction, immobilization and degradation of heavy metals in the soil (Lasat, 1999). It is economically, ecologically, socially acceptable and has aesthetic value as phytotechnology (Stomp et al., 1994). Plant species that are commonly used in the bioremediation are called hyperaccumulator (Baker, 1981). This group of plants are capable of accumulating and tolerating considerable level of heavy metals. The heavy metals are absorbed from the soil, then translocated and accumulated in plant biomass (Baker and Brooks, 1989).

Selection of the most suitable plant species for targeted potential toxic elements is the key for a successful phytoremediation work (William, 2008). The plant should be able to sustain growth at high concentration of metals and at the same time able to produce large amount of above ground biomass. Among the most cited research work on phytoremediation were on Thlaspi caerulescens, a known hyperaccumulator Cd and Zn (Baker and Brooks, 1989), Pteris vittata, a fern species found hyper accumulator of arsenic (Ma et al., 2001), Brassica juncea for Pb and Zn (Marchiol et al., 2004, Gisbert et al., 2006), and Pitygramma calomenalos for As phytoremediation (Visoottiviseth et al., 2002).

Most reported hyperaccumulators are slow growing and produce limited biomass. On a per hectare basis and per year growth rate, the total accumulated potential toxic elements is less compared to non- hyperaccumulator tree species. Hyperaccumulator plant species can be trees, shrubs, grasses and ferns but trees are generally preferred as phytoremediator. Trees have many advantages as compared to small plant species like shrubs, grasses and ferns. These are fast growing and produce relatively large volume of harvestable biomass. The use of trees is cheaper and more environmentally acceptable technology (Evangelou et al., 2013). Although heavy metal uptake of trees is not as high as metallophytes but due to its greater biomass yield, the removal of metals from the soil could be more effective with respect to hyper accumulating plants (Greger and Lundberg, 2006). Moreover, trees have long term ecological values. Trees can live for many years even growing in highly contaminated soils (William, 2008).

The most commonly studied tree in Europe for phytoremediation were willows (Salix viminalis) and poplar trees (Populus alba), primarily because these trees are fast growing, produced large amount of biomass, and can survive in broad range of climatic and soil conditions (Greger and Lundberg, 2006). In Sweden, willows are largely cultivated for the phytoextraction of Cd and Zn and at apparently for bio-energy production (Greger and Lundberg, 2006). A tree species, Betula alnoides is highly recommended species for the reforestation of mining sites with high levels of Pb and Zn in several countries (Wang et al., 2015).

Trees vary in their ability to grow in highly contaminated soil. The most ideal tree species are those species naturally growing in mine tailing areas as they have evolved sophisticated adaption mechanisms to tolerate potential toxic levels of metals in the soil (Mendez and Maier, 2008). Local or endemic tree species are desirable since these are already adapted to local conditions and just need the ability to survive in harsh environment of potential toxic elements. Moreover, sources for mass propagation are accessible and readily available. The search for a nobel tree species for phytoremediation of potential toxic elements is the need of time. This field research activity was conducted to determine the phytoextracting ability of tree species growing in heavy metal contaminated soils in an abandoned mining site in Mátraszentimre, Hungary.

MATERIAL AND METHODS

The Research Area. This research work was conducted in the abandoned mined spoil dumping site located in Mátraszentimre, Heves county, Hungary (Figure 1). The mean annual temperature is 5.9°C, mean annual rainfall is 670-750 mm per year, the highest rainfall is observed at the end of fall and at the beginning of winter (Odor et al, 1998). The natural vegetation surrounding the dump sites are mixed beech and evergreen forest with oak trees interspersed with bushy and grassy spaces. Pine plantations can also be normally observed in plantations (Odor et al, 1998).

The mining operation, a closed type of mining, ceased in decades ago due to falling prices of metals in the world market. The mining dump site serve as source of potential toxic elements and poses danger to the downstream ecosystems like rivers, farms and resident communities.

Phytoremediation activity is needed in the area to lessen the downward mobility of heavy metals and to protect the soil ecosystems and water sources.

Soil Sampling and Analysis

Soil samples were collected in eight (8) sampling points along the main dump sites (Figure 1). One sampling point (E), being the farthest from the main dump site served as control and considered to be not contaminated with heavy metals from mining operation.

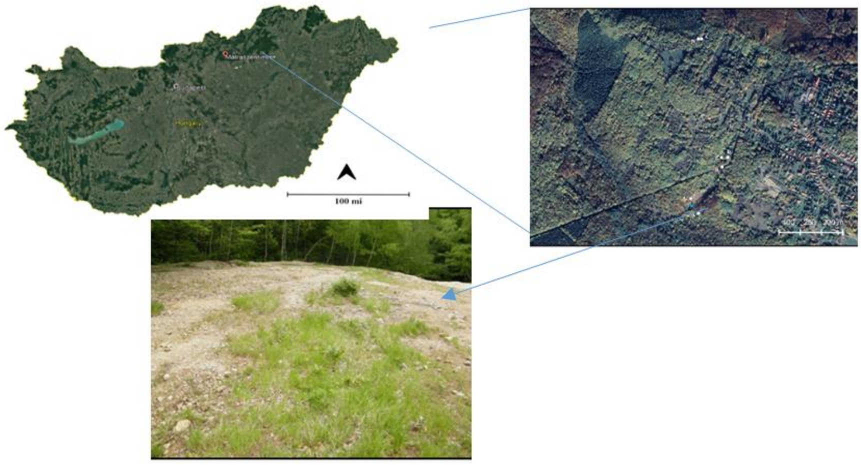

Figure 1. Sampling Area (Mátraszentimre, Mátra Mountains, Hungary), maps taken from Google Earth.

In each sampling point surface soils were collected using soil auger from 0-25 cm depth. Soil samples were mixed thoroughly in each sampling point to make composite samples. Around 1kg composite sample from each sampling point was taken and brought for laboratory analysis in Hungarian University of Agriculture and Life Sciences, Institute of Environmental Sciences, Gödöllő, Hungary. Before analysis, samples were air dried, grounded and sieved in using 2mm sieve. Around 50 g soil sample was used for chemical analysis. Soil samples were digested with HNO_3 and H_2O_2, and concentrations of potential toxic elements in soils were analyzed using ICP-OES based on Hungarian standards (MSZ-21470-50-2006).

Plant Sampling and Analysis

Samples of tree species were collected around the 8 sampling points in the main dump site. Four (4) endemic tree species identified in the area were assessed in this study. The native tree species were Betula pendula (Birch), Carpinus betulus (Hornbean), Fagus sylvatica (Beech), and Salix caprea (Goat willow).

Whole plant samples of trees with height two feet and below were collected in this work. Plant samples were washed initially with tap water and later with distilled water to remove soil contaminants. The samples were air dried for 2 weeks and cut into 1cm pieces. Root, stem and leaf samples for each tree species were prepared separately. Extraction to determine the levels of potential toxic elements were carefully followed using Hungarian Standard through microwave assisted digestion with HNO_3 and H_2O_2 Concentrations of potential toxic elements were analyzed using ICP-OES based on Hungarian Standard (MSZ-21470-50-2006).

Bioconcentration Factor (BCF)

The BCF value of all 4 trees species studied in this research was calculated. Bioconcentration factor is a measure of ratio between the levels of heavy metals accumulated inside the whole plant or plant parts over the level of heavy metals in the contaminated soil. It is an indicator of the ability of the plant to accumulate potential toxic elements with respect to the level of potential toxic elements in the soil. The BCF for each tree species was calculated using the following formula (Zayed et al., 1998):

BCF = Concentration of heavy metals in plant / Concentration of heavy metals in soil

It is a good indicator to easily determine if a given tree under observation can be classified as hyper accumulator, accumulators, and phyto excluder in a given contaminant in soil. Plant with BCF greater than 10, as hyper accumulators, between 1 and 10 as accumulators, and with a value of less than 1 as excluders (Zayed et al., 1998). It will also measure the phytoremediating capacity of plant species even at lower concentrations of potential toxic elements in soil environment.

Translocation Factor (Tf)
Another important parameter, to determine the phytoextracting ability of trees is Translocation factor (Tf). Translocation factor is a measure of plant ability to translocate the heavy metals from the roots to upper harvestable parts of the plant (stems and leaves). Translocation factor is the ratio between concentration of heavy metals between the shoot (leaves + stems) and the root (Zayed et al., 1998). It measures the mobility of potential toxic elements from roots to harvestable organs.

RESULTS

Concentrations of potential toxic elements of mined spoil soils located in Matraszentimre, Northern Hungary were summarized in Table 1. The soil had elevated concentrations of As, Cd, Cu, Pb and Zn. The contamination of the mine spoiled soils can be attributed to mining activities conducted in the area decades of years ago. Concentration of Cd is 4.77 times higher than the normal soil in the forest. The mean concentration level of Cu in mined spoil soils is 32.81 mg kg^{-1} dry weight of soil which is 4.25 times higher than normal soil. The concentration levels of Pb like Cd were also above the normal soils. The concentration levels of Pb had a mean value of 1929.71 mg kg^{-1} dry weight of soil, more than 92x of Pb in the normal soil. The concentration levels of Zn at the site were nearly 6x of Zn in a typical Hungarian soil. It had a mean value of 421.26 mg kg^{-1} dry weight of soil. Likewise, As concentration levels at the site were very high. The As mean concentration value of 885.57 mg kg^{-1} dry weight of soil was 39x of As in normal forest soil in the research area.

Table 1. Concentrations of potential toxic elements in mined –spoil soils in Mátraszentimre, Mátra Mountains, Hungary

Potential Toxic Elements	Forest Soil (A) Mean (mg kg-1)	Mine Spoiled Soil (B) Mean (mg kg-1)	Concentration Levels Ratio (B/A)
Cadmium (Cd)	Bdl*	4.77 ±0.28	4.77
Copper (Cu)	7.71±0.04	32.81 ±0.07	4.25
Lead (Pb)	20.9±1.5	1929.71±6.4	92.33
Zinc (Zn)	74.6±0.5	421.26	5.65
Arsenic (As)	22.48±0.88	885.57±9.56	39.53

*bdl-below detection limits ($<$ 0.001 mg kg^{-1})

CONCENTRATIONS OF HEAVY METALS IN TREE SPECIES IN THE MINING SITE

Arsenic (As)
The amount of As in tree biomass was summarized in Table 2. The levels of As varied significantly among tree species in roots and stem but not in leaves. The As in roots of Carpinus betula, Betula pendula, and Salix caprea, with mean values of 17.25 mg kg^{-1}, 16.27 mg kg^{-1}, and 14.75 mg kg^{-1}, respectively were significantly higher than As in roots of Fagus sylvatica, having the lowest results with a value of 3.187 mg kg^{-1} in their roots. The same significant differences were noted in the stem

but all values in the stem were much lower than those in the roots, Carpinus betulus had the highest mean values for both root and stem. The As levels in the leaves of the four tree species were statistically the same but the highest numeric values was obtained in *Betula pedula* (1.46 mg kg^{-1} As in leaves). The levels of As were below the detected value compared to other plant species considered phyto accumulator of As.

Table 2. Mean concentration levels (mg kg^{-1}) of As in roots, stem and leaves of tree species growing in mined out soils in Mátraszentimre, Mátra Mountains, Hungary

Tree Species	As in Roots	As in Stems	As in Leaves
Betula pendula	16.274±0.831 A	0.283±0.141 B	1.464±1.67 A
Carpinus betulus	17.247±2.294 A	5.833±2.025 A	0.627±0.24 A
Fagus sylvatica	3.187±0.560 B	0.633±0.612 B	0.843±0.018 A
Salix caprea	14.755±0.953 A	0.749±0.109 B	0.285±0.070 A
p-value	0.044	<0.001	0.760
Remarks	Significant	Significant	Not Significant

* Mean ± Standard Division (SD).
Mean values in the same row with different letters as statistically different (P<0.05) u
Tukey’s test

Cadmium (Cd)

Table 3. Mean concentration levels (mg kg^{-1}) of Cd in roots, stem and leaves of tree species growing in mined spoil soils in Mátraszentimre, Mátra Mountains, Hungary

Tree Species	Cd in Roots	Cd in Stems	Cd in Leaves
Betula pendula	0.591±0.06 A	0.360±0.09 B	0.475±0.76 B
Carpinus betulus	0.942±0.06 A	0.613±0.01 B	0.050±0.015 B
Fagus sylvatica	0.158± 0.011 A	Bdl	Bdl
Salix caprea	1.577±0.024 A	4.302±0.017 A	4.702 ±1.579 A
p-value	0.120	<0.010	<0.001
Remarks	Not Significant	Significant	Significant

bdl- below detection limits, * Mean ± Standard Division (SD).
Mean values in the same row with different letters as statistically different (P < 0.05) using Tukey’s test

Table 4. Mean concentration levels (mg kg^{-1}) of Cu in roots, stem and leaves of tree species growing in mined spoil soils in Mátraszentimre, Mátra Mountains, Hungary

Tree Species	Cu in Roots	Cu in Stems	Cu in Leaves
Betula pendula	6.209 ±0.176 A	8.684 .±0.061 A	4.145 ±0.040 A
Carpinus betulus	11.490 ±0.240 A	3.658 ±0.143 A	7.226 ±0.24 A
Fagus sylvatica	2.578 ± 0.018.A	2.737 ±0.098 A	6.801 ±0.057 A
Salix caprea	9.861 ±0.070 A	4.398 ± 0.018 A	5.708±0.229 A
p-value	0.272	0.310	0.718
Remarks	Not Significant	Not Significant	Not Significant

* Mean ± Standard Division (SD).
Mean values in the same row with different letters as statistically different (P<0.05) using Tul
test

Lead (Pb)

The levels of Pb present in tree biomass were presented in Table 5. The concentration levels of Pb on trees were significantly different on roots, stems and leaves. The tree species that contains highest level of Pb in the biomass was *Carpinus betulus*. It has a concentration mean value of

4071.67 mg kg^{-1}dry weight in roots, 439.057 mg kg^{-1}dry weight in stems and 92.532 mg kg^{-1}dry wt. in leaves.

Table 5. Mean concentration levels (mg kg^{-1}) of Pb in roots, stem and leaves of tree species growing in mined spoil soils in Mátraszentimre, Mátra Mountains, Hungary

Tree Species	Pb in Roots	Pb in Stems	Pb in Leaves
Betula pendula	1227.120 ± 4.917 B	260. 630±1.857 B	8.276 ±0.267 B
Carpinus betulus	4071.67± 45.713 A	439.05 ± 1.061 A	92.532 ± 0.730 A
Fagus sylvatica	75.834 ± 1.101 D	2.805 ± 0.024 D	2.5000± 0.133 D
Salix caprea	216.14 ±0.966 C	46.166 ±0.720 C	9.006 ±0.054 C
p-value	0.004	0.014	0.014
Remarks	Significant	Significant	Significant

* Mean ± Standard Division (SD).
Mean values in the same row with different letters as statistically different (P<0.05) using Tul test

It was followed by Pb concentrations observed in Betula pendula with a mean value of 1227.12 mg kg^{-1} dry wt in roots, 260.63 mg kg^{-1} dry wt in stems and 8.28 mg kg^{-1} dry wt in leaves of Pb. The mean concentration levels of Pb in *Salix caprea* were 216.14 mg kg^{-1} dry wt in roots, 46.166 mg kg^{-1} dry wt in stems, and 9.006 mg kg^{-1} dry wt in leaves. Lowest concentration levels of Pb were observed in *Fagus sylvatica* with a mean value of 75.834 mg kg^{-1} dry wt. in roots, 6.801 mg kg^{-1} dry wt. in stems, and 2.805 mg kg^{-1} dry wt. in leaves.

Zinc (Zn)

The levels of Zn present in tree biomass were presented in Table 6. The tree species that contains highest level of Zn in the biomass were in the stems of *Betula pendula* (Birch tree). The mean observed value of Zn were 243.975 mg kg^{-1} dry wt. in roots, 583.180 mg kg^{-1} dry wt. in stems, and 475.575 mg kg^{-1} dry wt. in leaves. It was followed Zn concentration levels found in *Carpinus betulus* with an observed mean value of 335.320 mg kg^{-1} dry wt. in roots, 351.660 mg kg^{-1} dry wt. in stems, and 111.200 mg kg^{-1} dry wt. in leaves of Zn.

Table 6. Mean concentration levels (mg kg^{-1}) of Zn in roots, stem and leaves of tree species growing in mined spoil soils in Mátraszentimre, Mátra Mountains, Hungary

Tree Species	Zn in Roots	Zn in Stems	Zn in Leaves
Betula pendula	243..975±1.504 A	583.180 ±1.504 A	475.575 ±2.219 A
Carpinus betulus	335.320 ± 4.439 A	351.660±2.216 A	111.200 ±0.561 B
Fagus sylvatica	133.947 ±1.362 A	171. 427 ±1.332 A	71.285 ±0.709 B
Salix caprea	216.055 ±0.292 A	285. 825 ±1.217 A	395. 970 ± 1.436 A
p-value	0.634	0.128	<.001
Remarks	Not Significant	Not Significant	Significant

* Mean ± Standard Division (SD).
Mean values in the same row with different letters as statistically different (P<0.05) using Tul test

High Zn value were also observed on the leaves of *Salix caprea* with concentration levels of 395.970 mg kg^{-1} Zn in leaves, 285.825 mg kg^{-1} dry wt. in stems, and 216.055 mg kg^{-1} dry wt. in roots. Lowest observed value was observed in *Fagus sylvatica* with an observed mean levels of 133.947 mg kg^{-1} dry wt. in roots, 171.427 mg kg^{-1} dry wt. in stems, and 71.285 mg kg^{-1} dry wt. in leaves.

BIOCONCENTRATION FACTOR (BCF)

Bioconcentration factor is a measure of how much potential toxic elements accumulated by each tree species based on the concentration of potential toxic elements present in plant tissues over the concentration values potential toxic elements in the contaminated soil were it is growing. A BCF value of >1.0 means, the plant can bio-accumulate potential toxic elements higher than the concentration levels of heavy metals present in the soil. A BCF value of <1.0 means the plant species has lower concentration of potential toxic elements in their plant tissues compared to the concentration levels of potential toxic elements present in the mined spoil soils. The root, stem and leaves of all four tree species had less than 1.0 BCF for As, Cu and Pb but not for Cd and Zn. For Cd, the roots, stems and leaves of Salix caprea had BCF values of 1.58, 4.30 and 4.39, respectively while the roots of Carpinus betulus had BCF value of 1.13. For Zn, the root BCF of all tree species ranged from.1.11 to 1.37 while the stem of all except Fagus sylvatica were also above 1.0, ranging from 1.45 to 4.40. The Zn levels in the leaves of two tree species (Betula pendula and Salix caprea) were likewise above 1.0, at 3.03 and 2.07, respectively Based on the analyses of significant differences in BCF values among tree species for each potential toxic element, as expected, The BCF of roots, stems and leaves for As, Cu and Pb were not significantly different. For Cd, however, significant differences among BCF of tree species were not for stem but not for stem and leaves. The stems and leaves BCF of Salix caprea were significantly higher than those of the other tree species. Although all of the BCFs for Zn in the roots and stems of the four tree species were all above 1.0, none was found significantly different. The BCF of Zn in the leaves of Betula pendula and Salix caprea were significantly higher than those of Carpinus betulus and Fagus sylvanica.

Table 7. Bioconcentration Factor of different tree species for the uptake of As, Cd, Cu. Pb, and Zn

Potential Toxic Elements	**Tree Species**					
	Betula pendula	Carpinus betulus	Fagus sylvatica	Salix caprea	p-value	Remarks
As in Roots	0.067±0.051 A	0.049±0.029 A	0.066±0.105 A	0.055±0.047 A	0.985	Not Significant
As in Stem	0.017±0.006 A	0.019±0.002 A	0.014±0.010 A	0.013±0.010 A	0.624	Not Significant
As in leaves	0.066±0.092 A	0.033±0.022 A	0.017±0.006 A	0.015±0.007 A	0.780	Not Significant
Cd in roots	0.183±0.173 A	1.131±1.009 A	0.158±0.242 A	1.577±0.346 A	0.067	Not Significant
Cd in Stem	0.359±0.590 B	0.332±0.140 B	Bdl	4.299±2.516 A	0.008	Significant
Cd in Leaves	0.475±0.792 B	0.050±0.055 B	Bdl	4.387±1.134 A	< 0.001	Significant
Cu in Roots	0.169±0.034 A	0.457±0.142 A	0.077±0.035 A	0.420±0.352 A	0.058	Not Significant
Cu in Stem	0.254±0.370 A	0.273±0.158 A	0.203±0.219 A	0.188±0.158 A	0.975	Not Significant
Cu in leaves	0.301±0.328 A	0.370±0.376 A	0.117±0.025 A	0.222±0.120 A	0.707	Not Significant
Pb in roots	0.425±0.285 A	0.698±0.595 A	0.393±0.431 A	0.173±0.161 A	0.612	Not Significant
Pb in Stem	0.216±0.227 A	0.148±0.035 A	0.003±0.001 A	0.067±0.005 A	0.257	Not Significant
Pb in Leaves	0.202±0.335 A	0.069±0.059 A	0.037±0.063 A	0.013±0.006 A	0.651	Not Significant
Zn in roots	1.368±1.259 A	1.208±0.510 A	1.172±0.558 A	1.111±0.056 A	0.983	Not Significant
Zn in Stem	4.396±5.459 A	2.056±1.775 A	0.835±0.112 A	1.447±0.244 A	0.556	Not Significant
Zn in Leaves	3.030±1.284 A	0.568±0.574 B	0.648±0.274 B	2.071±0.205 A	0.016	Significant

bdl- below detection limits, * Mean ± Standard Division (SD). Mean values in the same row with different letters as statistically different (P<0.05) using Tukey's test

TRANSLOCATION FACTOR (TF)

Translocation Factor (Tf) is a measure of ratio between the concentrations levels of potential toxic elements present in stems and leaves to the concentration levels of potential toxic elements present in the roots. A value of Tf <1.0 means that the potential toxic elements has high mobility to the upper harvestable plant tissues. Tf values of less than 1.0 for As and Pb were noted in all four tree species. However, Cu and Zn had Tf values greater than 1.0, in all four trees, with high values ranging from 1.60 to 4.68. For Cd, Tf value of more than 1.0 was obtained only in Salix caprea. Based on the analyses of Tf values among trees, significant translocation factor was observed on concentration levels of Cd in Salix caprea with an observed value of 3.17. Significant Tf value for Zn was also observed on the harvestable tissues of Betula pendula and Salix caprea with a value of 4.682 and 3.171, respectively. Translocation factor for As, Cu, and Pb was found to be not significant (Table 8).

Table 8. Translocation Factor of different potential toxic elements in shoots and leaves of different tree species.

Potential Toxic Elements	**Tree Species**					
	Betula pendula	Carpinus betulus	Fagus sylvatica	Salix caprea	p-value	Remarks
As	0.153±0.136 A	0.308±0.370 A	0.705±0.751 A	0.070±0.002 A	0.560	Not Significant
Cd	0.838±0.932 B	0.563±0.145 B	Bdl	3.174 ±0.229 A	0.002	Significant
Cu	2.430±3.00 A	1.593±0.910 A	2.856±1.282 A	1.865±0.555 A	0.839	Not Significant
Pb	0.839±0.932 A	0.576±0.124 A	0.210±0.098 A	0.273±0.1267A	0. 476	Not Significant
Zn	4.682 ±1.402 A	2.091±1.019 B	1.5690±0.968 B	3.171 ±0.005A	0.037	Significant

* Mean ± Standard Division (SD). Mean values in the same row with different letters as statistically different (P<0.05) using Tukey's test

DISCUSSION

Heavy Metals in the Soil

The mined spoil soils under study had elevated concentrations of As, Cd, Cu, Pb and Zn. The As mean concentration levels of 885.57 mg kg^{-1} dry weight were way above the 15 mg kg^{-1} As per dry weight of soil is considered toxic to plants and animals. The mean concentration of Cd of 4.77 mg kg^{-1} dry weight of soil was generally toxic. The accepted level of Cd in Hungary is 1.0 mg kg^{-1} Cd per unit dry wt. of soil. Similarly, the concentration levels of Pb were also above the normal soils in Hungary. The mean concentration level of Pb was 1929.71 mg kg^{-1} dry weight of soil. These values, so with As and Cd concentration levels were much higher than the acceptable concentration levels based on Hungarian Joint Decree No 10/2000 with a toxicity limit of 15 mg kg^{-1} for As, 1.0 mg kg^{-1} Cd, 100 mg kg^{-1} Pb, and 200 mg kg^{-1} Zn (Gazdag and Sipter, 2008). The mean concentration levels of Zn had value of 421.89 mg kg^{-1} dry weight of soil were also above the 200 mg kg^{-1} dry weight of soil which is acceptable level in soils in Hungary (Gazdag and Sipter, 2008). The concentration levels of Cu had a mean value of 32.28 mg kg^{-1} dry weight of soil were little higher the normal plant requirement ts of 20-30 mg kg^{-1} (Marschner, 1995). Unlike the levels of As, Cd, Pb and Zn, the levels of Cu were within the Hungarian acceptable standard with a limit concentration value of not more than 75 mg kg^{-1} (Gazdag and Sipter, 2008).

The result of this research work were mostly above the reported contaminated soils in Hungary such as the road side soils (Simon, 2001), soils in Gyongyosoroszi (Simon, 2005) and the sediments in Toka Creek (Odor, et al., 2008), suggested their high potential toxicity in plants.
Compared to contaminated soils of other countries, soil heaps sampled in Shrewsbury, contains higher Pb, while contaminated soils located in Maaltheide, Belgium, contained higher Zn (Vangrosveld et al., 1995). Soils in smelter plant in Belgium contains very high Zn (Kopponen et al., 2001) and soil samples in a contaminated area in El Paso, Texas, USA have higher results on concentration levels of Pb and Cu (Gardea-Torresday, 1996). Kabata-Pendias and Pendias (2001), suggested that the levels acceptable and not toxic for soils is 1.0 mg kg^{-1} dry wt for Cd, 60-125 mg kg^{-1} dry wt for Cu and 70 to 400 mg kg^{-} dry wt for Zn. Concentration of Zn between 100-900 mg could have phytotoxic effects on plants. Based on these criteria, the concentration levels of Cd, Cu and Zn under study is still within acceptable concentration levels

CONCENTRATION OF POTENTIAL TOXIC ELEMENTS IN TREES

Screening and evaluation of trees growing in soils polluted with potential toxic elements is very important in selecting the most suitable species for any successful revegetation program (Gonzales, et al., 2008). Plants growing in metalliferous soils cannot prevent metal uptake. The strategy of survival is more of tolerance rather than avoidance of metal toxicity (Dobson et al., 2007). Among the elements observed, Cu and Zn were considered as essential elements. Cd and Pb are highly reactive elements. The level of potential toxic elements in roots, foliage, and stem were observed in this research work crucial in the choice of tree species for phytostabilization establishment (Mendez and Maeir, 2008).

Arsenic (As)

All of the trees evaluated in this study, bioaccumulated low levels of As. The levels of As was higher in roots compared to stems and leaves. Levels of As ranges from 3.187 mg kg^{-1} dry weight in the roots of Fagus sylvatica to 17.247 mg kg^{-1} dry wt. observed in roots of Carpinus betulus. The BCF ratio for all trees was <1.0 indicating that these trees are heavy metal excluders (Baker, 1981). Trees are not known as hyperaccumulator of As compared to ferns, grasses and sunflower. Trees tend to absorb little amount of As compared to its biomass. In a research report, willow can absorb only around 1.92 to 2.11 mg kg^{-1} As (Simon et al., 2012). The result of the study is considered below compared to other plant species which absorb more than 1000 mg kg^{-1} dry weight of As. The most popular hyperaccumulator of As reported is Pteris vittata, a fern species which can bioaccumulate above 10,000 mg kg^{-1} dry wt (Ma, et al., 2001).

Cadmium (Cd)

Cd is a non-essential element and considered to be one of the most hazardous element or heavy metal (William, 2008). Cd is highly mobile in the biological systems and present potential risks to human health (Adriano, 1986). Cd generally inhibits tree growth resulting in low biomass production (Robinson et al., 2000). Among the tree species evaluated, Salix caprea showed the highest potential for phytoremediation of Cd. Salix caprea had very high concentration levels of 4.70 mg kg^{-1} dry wt. in leaves and 4.302 mg kg^{-1} dry wt. in stems, resulting to significant Tf and BCF. The Tf indicated that the Cd in harvestable parts of S. caprea is more than 3 times higher than concentration value of Cd in roots. The bioconcentration factor for Cd were also highest in Salix caprea with a mean concentration value of 1.58 mg kg^{-1} in roots, 4.30 mg kg^{-1} in stems and 4.39 mg kg^{-1} in leaves. This showed that the phytoextraction of Cd using Salix caprea could restore soils in Cd contaminated areas in Hungary.
The other tree species that absorbed high levels of Cd was Betula pendula with a concentration value 1.39 mg kg^{-1} dry wt. of Cd in their leaf biomass but it had low BCF and Tf values. This level of Cd which is above 1.0 mg kg^{-1} Cd is considered toxic (Kabata-Pendias and Pendias, 2001) and above the acceptable Hungarian standard of 1.0 mg kg^{-1} dry wt. (Gazdag and Sipter, 2008). Other tree species evaluated showed <1.0 mg kg^{-1}dry wt. of Cd in their biomass.

In a similar research work conducted in Sudety, Mountains in Poland, higher results were observed also in Salix caprea which accumulated 54.1 mg kg^{-1} Cd, while Betula pendula accumulated 11.8 mg kg^{-1} Cd in leaves (Wislocka et al., 2006). Wieshammer, (2007) showed that Salix caprea can absorb 116 mg kg^{-1} dry wt. of Cd in a pot experiment. Other research work showed that Salix contain more Cd leaves than in stems (Hammer et al., 2003). Fagus sylvatica was reported high amount of Cd (Zupunski et al., 2015). However, it gave a lower result value for Cd uptake in this study. This could be attributed to a lower Cd concentration value in soil in the study area relative to their study area.

Some other trees were reported well in absorbing Cd. A study in France, reported that poplar can bioaccumulate up to 200 mg kg^{-1} Cd (Robinson, 2000), while in New Zealand, willows showed phytoextracting potential in cleaning Cd contaminated soils (Robinson, 2000). Salix viminalis (Willow) can uptake 5.7 mg kg^{-1} dry wt. of Cd in leaves (Greger and Lundberg, 2006). Two studies, (Pietrini et al., 2015 and Zupunski, et al., 2015), however, indicated that willows were more tolerant to Cd than poplar.

Copper (Cu)

All tree species bioaccumulated Cu within range of normal requirements in plants. Levels of Cu ranges from 2.59 mg kg^{-1} dry weight in the roots of Fagus sylvatica to 11.49 mg kg^{-1} dry wt observed in roots of *Carpinus betulus*. These levels of Cu are considered non-toxic. The normal concentration levels of Cu in plants ranges from 10-30 mg kg1 (Marschner, 1995). The BCF and Tf values for Cu were also low. BCF values for Cu for all leaves of trees were less than 1.0. These tree species, therefore, have low potential to be candidate for phytoextraction of Cu. The concentration level of Cu in soil is low, which influence the low absorption of Cu among trees. The translocation factor among trees is above 1.0 and the highest was observed in Betula pendula with a value of 2.430. This showed low mobility of Cu from roots to shoots of birch tree. The low mobility of Cu in plants is due to xylem binding of Cu (Nissen and Lepp, 1997). Cu is preferentially bounded in xylem with less mobility compared to Zn (Nissen and Lepp, 1997). Cu mobility is restricted and large proportion of absorbed Cu is retained in roots (Kopponen et al., 2001).

On the contrary, some trees were reported good in absorbing Cu. Eucalyptus camaldulensis can uptake 297.8 mg kg^{-1} of Cu (Assareh et al., 2008) while *Phragmites australis* known as aquatic reed can uptake 849-1154 mg kg^{-1} dry weight of Cu (Ait-Ali et al., 2004). The creosote bush species, Larrea tridentata, creosote bush species, in a heavy metal contaminated area in Texas, USA absorb 953 mg kg^{-1} and 370 mg $kg^{-1}$of Cu in its roots, stem and leaves, respectively (Gardea-Torresday, 1996). The soil in this area also had elevated levels of Cu at around 4.993 mg kg^{-1} dry wt. Cu (Gardea –Torresday, 1996).

Birch leaves in North-western Russia, concentration of Cu in Betula pubescens trees near the Cu smelter plant was 6-12 times higher in than trees growing in normal soils (Koslov 1995). These results showed that the concentration levels of Cu in soils influences the absorption capacity of trees for Cu.

Lead (Pb)

Another potential toxic elements are observed at high level of concentrations among trees in the research work was Pb. High levels of Pb were observed in roots of Carpinus betulus and Betula pendula with a mean value of 4071.67 mg kg^{-1} and 1227.12 mg kg^{-1} dry wt Pb, respectively. These values of concentration levels were both above 1000 mg kg^{-1} dry wt Pb which could classify these tree species as hyperaccumulator of Pb (Baker and Brooks, 1989).

The levels of Pb in stems and leaves were also high in Carpinus betulus with a mean concentration value of 439.05 mg kg^{-1} dry wt Pb in stems and 92.532 mg kg^{-1} dry wt Pb in leaves but much lower than roots. Both *Carpinus betulus* and *Betula pendula* showed that Pb can be easily accumulated in roots compared to stem and leaves. Other trees species have been reported with similar response ad were considered as good Pb accumulators. The Pb levels of Betula pendula were 135 mg kg^{-1} dry wt Pb in stems and 78 mg kg^{-1} dry wt Pb in leaves (Evangelou et al., 2013). *Paulownia fortunni* accumulated Pb up to 1179 mg kg^{-1} while *Bronssonetia papyrifera* (L.) accumulated 973.3 mg kg^{-1} Pb in the leaves (Zhao et al., 2013).

Very high levels of Pb can be tolerated by some tree species. Salix caprea can tolerate and grew in soils up to 17,000 mg kg^{-1} of Pb while *Betula pendula*, a pioneer tree species that can tolerate soils that contains as much as 29,000 mg kg^{-1} of Pb but the soil contains high levels of Ca which enhances the tree tolerance to Pb (Eltrop et al., 1991). Poplar is also reported to have high tolerance to Pb (Evangelou et al., 2013).

Although high Pb values were obtained in the plant analyses, BCF values for all trees for Pb were also below 1.0. This means that the high concentration value of Pb in trees is due to the concentration value of Pb in the soil samples. Translocation factor for Pb for all trees were also below 1.0. This showed that Pb has low mobility from roots to shoots. Most of the Pb absorbed was retain in the roots of Carpinus betulus and Betula pendula, which are advantageous in using these trees for phytostabilization of Pb contaminated soils. Low BCF value could not categorize these trees as phytoextractor of Pb but essential for phytostabilization purposes (Mendez et al., 2008).

Zinc (Zn)

The normal range for Zn requirement in trees is around 15-20 mg kg^{-1} dry wt. (Marschner, 1995). Results of this research work showed that *Betula pendula* and *Salix caprea* can bioaccumulate high levels of Zn in their biomass. *Betula pendula* absorb 583.18 mg kg^{-1} Zn in stems and 475.57 Zn mg kg^{-1} in leaves while *Salix caprea* had 285.83 mg kg^{-1} Zn in stems and 395. 97 mg kg^{-1} Zn in leaves. Highest BCF value were also observed in *Betula pendula* with a mean value of 4.40 in stems and 3.03 in leaves followed by leaves of Salix caprea at 2.07. Translocation factor for Zn were also high in *Betula pendula* and *Salix caprea*. These values indicate that the two tree species could be phytoextractor of Zn. High Tf value is desirable. However, if the plants are food for animals, high translocation factor of metals can pose risks. It could lead to higher transfer of Zn to other animals in the ecosystem at toxic levels (Pulford et al., 2002, Assareh et al., 2008). *Betula pendula* was reported to contain higher Cd and Zn concentrations in leaves or stems (Zupunski et al., 2015). It is not known as hyperaccumulator of Zn since it absorbed less than 10,000 mg kg^{-1} dry wt. of Zn (Baker and Brooks, 1989), but it is a Zn metal tolerant tree (Kopponen et al., 2001).

The presence of mycorrhiza in Birch tree was found important factor that lead to high uptake and translocation of Zn (Brown and Wilkins, 1985).

The association with mycorrhiza provided larger surface area that that promotes greater absorption of Zn in *Betula pendula* (Brown and Wilkins, 1985). *Salix caprea* has been reported to absorb high amount of Zn. A study showed that *Salix caprea* can absorb 4680 mg kg^{-1} dry wt. of Zn in a pot experiment (Weishammer et al., 2007) while another study indicated 2020 mg kg^{-1} dry wt. of Zn in leaves (Fernandez et al., 2017). Some trees were reported well for Zn removal. Willows can remove 5-27 kg/ha/yr of Zn (Meers et al., 2005) while *Eucalyptus camaldulensis* can uptake 253 mg kg^{-1} dry wt. of Zn (Assareh et al., 2008) and Salix viminalis can bioaccumulate 200 mg kg^{-1} of Zn in their leaves (Hermle et al., 2006).

CONCLUSION

The tree species that demonstrated highest potential for hyperaccumulation of Pb is *Carpinus betulus* since the absorbed value were more than 1000 mg kg^{-1} dry wt. of Pb in roots. It is therefore, a good candidate for the phytostabilization of Pb contaminated sites. It gave Tf value of less than 1.0 showing less mobility of Pb in the harvestable parts. *Salix caprea* is potential tree for phytoextraction of Cd and Zn while *Betula pendula* has shown as potential phytoextractor of Zn. Further research work is still needed in the physiological and chemical mechanism of uptake of these potential toxic elements. Pot experiments are needed to determine the growth rates of each tree species and their capacity to absorb other toxic elements per unit time for the future restoration of heavy metal contaminated soils.

ACKNOWLEDGEMENTS

The authors like to be thankful for the support of Tempus Foundation for the financial support of this research work and the Nitrokémia PLC- which is responsible for the rehabilitation of the mined out areas and for giving us permission to collect plant and soil samples in the area. This research was supported by the Ministry of Innovation and Technology within the framework of the Thematic Excellence Program 2020, Institutional Excellence Sub-Program (TKP2020-IKA-12) in the topic of water-related researches of Hungarian University of Agricultural and Life Sciences.

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Article submitted to the Proceedings Book of the VIth. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

ENVIRONMENTAL IMPACT OF BARITE WASTES FROM THE AIN MIMOUN MINE, KHENCHELA, NORTH-EAST ALGERIA.

Meriem BOUKHATEM*, N. CHABOUR, F. BOUAICHA, R. KOURICHE, H. BOUDRA

Geology and Environment Laboratory, University des Frères mentouri Constantine 1, Road Ain El Bey Zouaghi Slimane Constantine 25 000, Algeria, * Corresponding author : boukhatem.meriem2100@gmail.com

The barytic deposit of Ain Mimoune is a complex vein of hydrothermal type, which represents a very interesting mining potential on an economic level in view of the quality and quantity of the extracted ore. It is located at the northern flanks of the Khenchela anticline. To this effect the mining industry in Algeria occupies of the exploitation of this type of ore especially in the oil field. In spite of the productivity of the factory and good quality of the concentrate resulting from the jig REMER, a loss in useful mineral in the waste rock. This waste presents a serious threat for the environment and the habitat. In order to verify the impacts of these mine wastes, a mineralogical and hydrogeochemical study was carried out. Principal component analysis (PCA) was applied to samples taken from different mining sites in order to better understand the geochemical associations characterizing this study area as well as the possible origin of existing metallic contaminants. The analyses show a high degree of pollution by Ba with a maximum value of 9000 mg/kg for the samples downstream of the treatment plant on soils and 124.66 mg/L for surface and groundwater. Concentrations in waters in some stations largely exceed the norms of potability (W.H.O. norm, AFNOR norm). In the soil, the Ba and Pb content exceed that considered as natural. The results show the degradation of the environment in the proximity of the mining center. This is translated by the high content of barium Ba, lead Pb, NO_3 and NH_4.

Keywords*: barytic, Ain Mimoune, hydrothermal, environment, pollution, barium*

INTRODUCTION

Since antiquity, humans have always had recourse to mineral substances in various forms for their daily needs. Hence the extractive mineral industry has become an essential activity in the development of research and extraction techniques.

To this effect, extraction activities concerning the exploitation of baryte have been actively developed in Algeria, providing 50 000 tons of baryte used mainly in the oil drilling sector. Among the most important, we find the deposit of Ain Mimoune located in the wilaya of Khenchela.

The treatment of this mineral was carried out by wet gravimetric separation by jigging. Where the rejects of the recovery method on the one hand contains an acceptable content of barite sulfate, but on the other hand occupying thousands of hectares in the vicinity of the plant which cannot be biodegraded and therefore persist in the environment for long periods of time.

Their accumulation in the environment can affect humans and animals by threatening their habitat but also their health. The aim of our work is to know the pollution by heavy metals in the Ain Mimoune region and to evaluate the environmental danger which represents the potential migration of the pollutants towards the ground and the surface water by the chemical characterization of the various environmental components.

STUDY AREA SETTINGS

The Ain Mimoune ore deposit is part of Khenchela province. It's located in the North Eastern of Algeria between the longitude 6°56'55.07" and 6°57'40.27" East and the latitude 35°25'05.87" and 35°25'06.12" North with an area about of 641 Hectare. It was discovered in 1968 during a systematic exploration of the region [1].
The baryte deposit is located in the oriental part of the Auras Mountain range which extends along the NE-SW direction [3]. It is represented by a bundle of veins outcropping at the surface with a strong dip (30°-90°) and with a power of 2.5 to 3 m. The most important extent of the veins is 1km. The highest altitude of the vein (vein N°11) and the lowest altitude (vein N°1) are equal to 1250 m. The veins are distant from the industrial form of the mine by about 6 to 12.5 km [2].
From a geological point of view (Figure 1), the study area is characterized by terrains of Cretaceous age dominated by detrital marl-sandstone in which large limestone banks form ledges sometimes giving important reliefs [1]. These geological formations are affected by a very marked plicative and brittle tectonics whose structures are most often the seat of a very important polymetallic mineralization Ba-Pb (Zn- Cu - Hg)
The climate of the region is of continental Mediterranean type. It is semi-arid characterized by irregular average rainfall of order of 478mm, high temperatures in summer 42 ° and very low in winter (-2°) whose annual average is 24.42 with clouds falling quite frequently [5].
The massif of Khenchela offers a strong orographic represented by moreieure chainon such as djebel aidel 2173 m, Ras kodaleine 1945m, Kef tifekressa 1817m and Rass serdoun 1700m [2].

Figure 1. (A) Geographical location of the study area, (B) satellite Google Earth photo of the spatial distribution of sampling.

MATERIALS AND METHODS

In order to verify the degree of metallic contamination generated by the mining of Ain Mimoune, a sampling campaign was carried out in dry period between June and July 2018. We took care of sampling on a large surface of the study area. Three solid samples were taken from the soil, sterile. Similarly, ten liquid samples containing dissolved matter and or in suspension were taken from the wadi, wells and water source.
For each water point, we measured in situ the physico-chemical parameters such as temperature, pH by pH-meter E520 Metrohm Herisau and the electrical conductivity of the water by a Hanna conductivity meter (HI 9035). The liquid samples were stored in plastic bottles with a capacity of 1.5L and transported in a cooler at a temperature of about 4°C until they were analysed [6]. The soil samples were dried in an oven at a temperature of 450°C for 24 hours and then the samples were acid-

etched and filtered. The analysis of chemical samples elements (Ca^{2+}, Mg^{2+}, Cl^{-}, and HCO_3^{-}) was carried out in the laboratory of geology and environment at the university of Constantine 01 by the volumetric method (Table 1). The determining elements of the pollution (NO_2^{-}, NO_3^{-}, Br_2, NH_4^{+} and Ba) and the heavy minerals (Cd, Zn, Cu, Pb and Hg) were analysed at the laboratory of environmental analysis and chemical test on minerals (Ain Mlila, Algeria).
The statistical study was based on the diagrams and the PCA. The intermediate correlations, the correlation coefficients between the variables and the two axes F1 and F2 and the projection of the variables in the space of the axes F1 and F2 were obtained with a software XLSTAT

Table 1. Equipment used for the determination of the different elements analysed

Analysis method	Chemical element	Laboratory
The spectrometry	NO_2^{-}, NO_3^{-}, Br_2, NH_4^{+}	L.A.C.I.P. Ain M'LILA
Atomic absorption	Ba	
AAS PERKINELMER	Cd, Zn, Cu, Pb, Hg	
Turbidimeter	SO_4^{2-}	
Flame photometer	Na^{+}, K^{+}	

RESULTS AND DISCUSSION

Mineralogical Study

The deposit of Ain Mimoune is in the form of a vein structure, with barytic reserves (geological resources of 1.86 MT and exploitable reserves estimated at 1.25 MT) and with an average content of 70% in BaSO4 as types of mineralization in the mine of Ain Mimoune [4]. We find the hydrothermal mineralization of malachite, azurite and sometimes of cinnabar, sphalerite and chalcopyrite. In addition to the baryte veins, there are many other occurrences such as copper, lead, quartz and calcite mineralisation:

- **Barite 1:** is characterized by coarse crystals with elongated emanations or in the form of aggregates with fibrous and actiniform structure.
- **Barite 2:** is presented by crystals forming ranges in the form of isometric grains.
- **Quartz 1:** develops in contact with the vein and contains numerous field rock intercalations.
- **Quartz 2:** is found in the barite mass in the form of automorphic crystals.
- **Dioptase**: appears as rounded and angular grains disseminated in the baryte.
- **Chalcopyrite:** occurs in the form of irregular separation along the fissures in the barium.
- **Sphalerite:** is presented in the form of rounded grains.
- **Cinnabar:** is represented in dissemination in the pane base.
- **Calcite:** gives irregular contact separations.
- **Dolomite:** is developed in the central part in the form of vienules and irregular separation.
- **Iron hydroxides**: are arranged irregularly in the contact along the cracks.
- **Malachite and azurite:** occur as isolated separates and nests. All these metalliferous occurrences have negligible quantities and are of no economic interest [2].

Sample Analysis

The qualitative study of surface and ground water in the vicinity of the mine Ain Minoune was revealed by a physico-chemical study of sampled water (Table 2). It shows that the water temperature varied between 10.9-21.6°C. These temperatures are both influenced by the ambient temperature of the atmosphere. A
ll the surface waters present relatively alkaline pH because of the enrichment in calcite which are due to the dissolution of the carbonate formations present in the big limestone banks and the Mio-Pliocene deposits where these waters percolate (Figure 2).

Table 2. Chemical analysis results (July 2018).

Variable	Minimum	Maximum	Mean	Standard deviation
pH	7,550	8,380	8,093	0,282
T°C	10,900	21,600	18,560	3,479
Conductivity (ppm)	128,000	259,000	195,200	37,774
TAT F	11,750	30,450	15,580	5,803
Ca^{2+} (mg/l)	6,130	104,810	47,519	24,554
Mg^{2+} (mg/l)	4,070	66,170	11,196	19,405
Na^+, K^+ (mg/l)	49,400	81,600	58,115	11,944
HCO_3^- (mg/l)	53,910	209,770	85,188	55,246
SO_4^{2-} (mg/l)	83,650	203,120	120,576	49,072
Cl^- (mg/l)	17,150	91,400	32,593	26,205
NH_4^+ (mg/l)	0,011	3,460	0,388	1,080
NO_3^- (mg/l)	9,470	85,130	48,508	24,114
NO_2^- (mg/l)	0,007	0,314	0,045	0,095
Ba (mg/l)	2,340	124,660	22,328	36,387
Pb (mg/l)	0,006	0,082	0,046	0,023
Zn (mg/l)	0,054	0,210	0,085	0,055
Cd (mg/l)	0,000	0,203	0,074	0,062
Cu (mg/l)	0,017	0,091	0,033	0,026
Hg (mg/l)	0,000	0,003	0,000	0,001

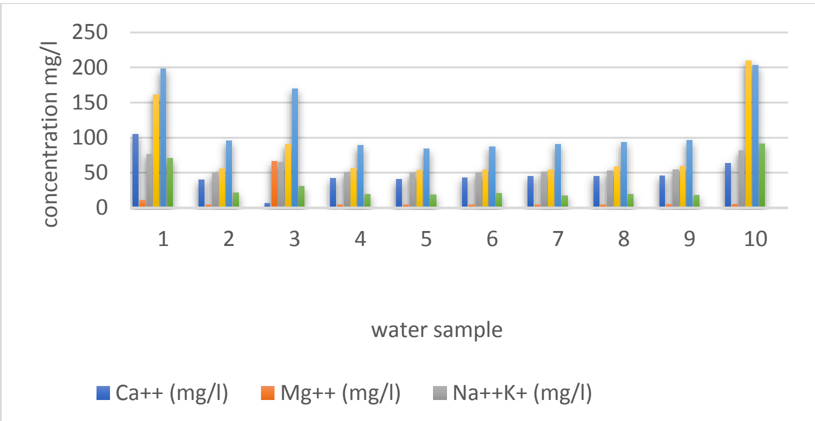

Figure 2. Spatial variation of chemical elements in the study area.

The results of the chemical analysis amount that the most abundant cations in surface waters are sodium (Na^+) and calcium (Ca^{2+}), their contents oscillate between 49.4 mg/l to 81.6 mg/l for Na^+ and 6.13 mg/l to 104. 81 mg/l for Ca^+, followed by magnesium (Mg^{2+}) and (k^+) with low concentrations of 66.17 mg/l to 4.07 mg/l, therefore we can classify by increasing order the cations as follows: r% k < r% Mg+< r% Ca< %r Na+.
The most abundant anions in the study area are sulfate ($S0_4^-$). The concentrations vary between 83.65 mg/l to 203.12 mg/l for sulfate due to the dissolution of the Cretaceous terrain which is predominantly marl, 53.91 mg/l to 209.77 mg/l for carbonates and 17.15 mg/l to 94.4 mg/l for chlorides (Figure 3).

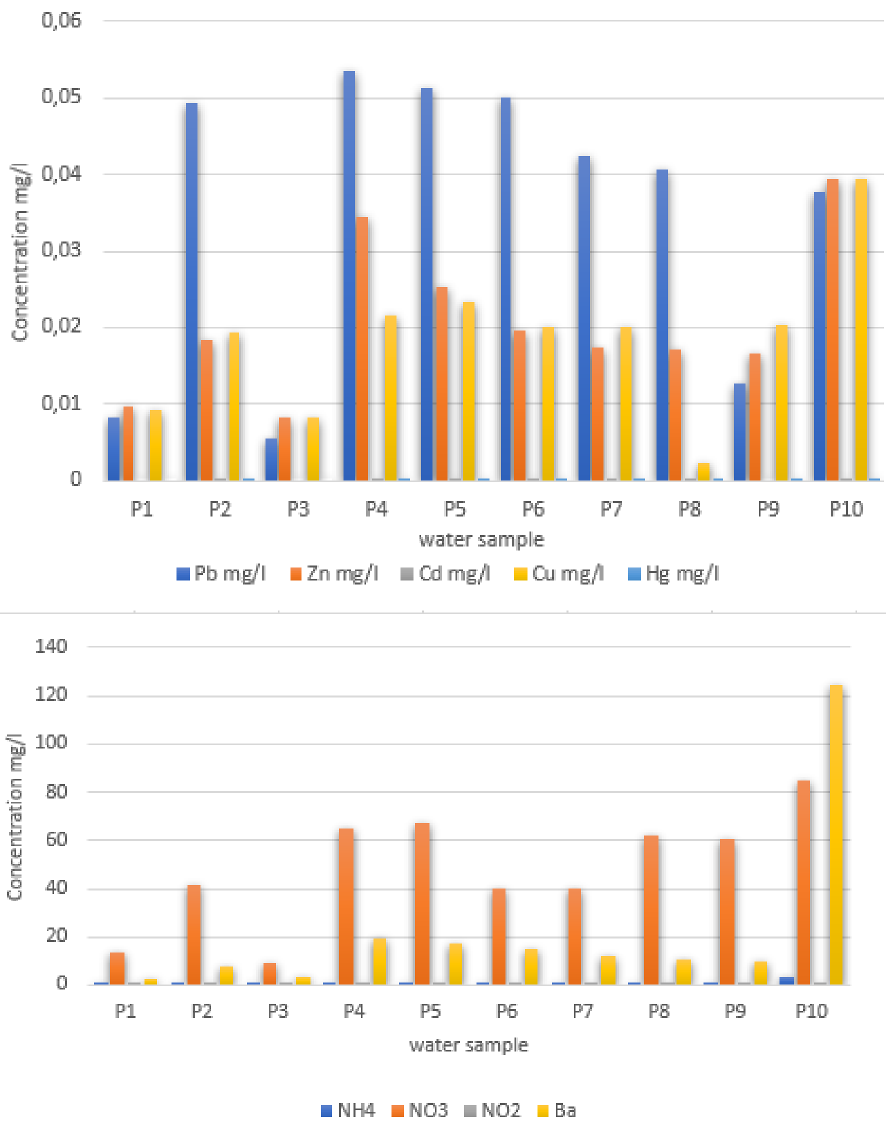

Figure 3. Spatial variation of chemical elements in water sample

The contents of Zn, Ca, Cu and Hg in the water samples remain lower than that admitted by the World Health Organization (WHO) for drinking water. The order of abundance in most element is as follows Zn>Cu>Cd>Hg (Figure 4).

The metallic contents varying respectively from 8.3 mg/l to 39.4 mg/l, from 2.3 mg/l to 39.3 mg/l, from 0 mg/l to 0.11 and from 0 mg/l a 0.3 mg/l. In fact, the levels of Pb and Ba exceed the national and WHO standards in several places, with the highest levels at the site of the mine workings and discharge.

The remarkable enrichments in Pb and Ba taken in the proximity of the mine's treatment discharge, which ranged from 8.3 mg/l to 53.6 mg/l and from 2.34 mg/l to 124.66 mg/l, respectively. These two compounds are not very water soluble and have low geochemical mobility.

In our case lead is associated with barite ore in the form of lead sulfide. These high values may be due to the impact of the mine and tailings on the surface water in the vicinity of the mining centre. To define the potability of the studied waters we are based on norms established by the WHO, the potability of the waters and not drinkable to the human consumption and are met at the level of all the point of waters of the region of study whose agricultural solution constitutes the main type of the pollution of also that of industrial origin caused by Ba.

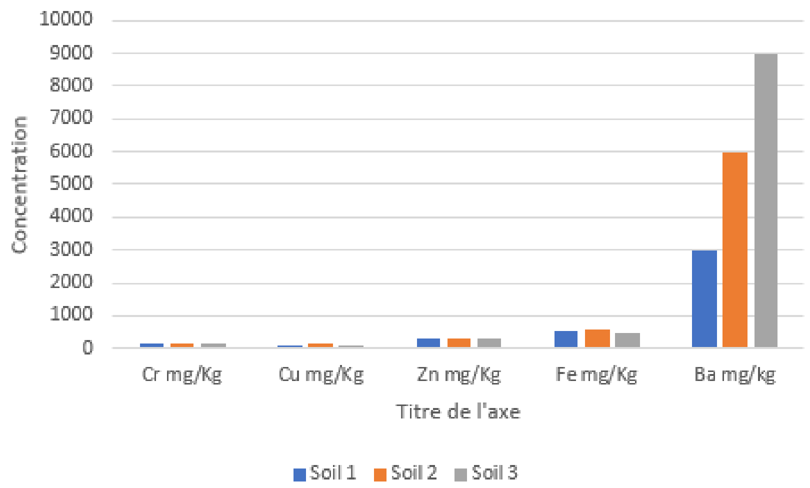

Figure 4. Spatial variation of metallic elements in soil sample

For the metal element in the soil sample, the analysis showed a relatively high concentration of TME, the order of abundance in most elements is as follows: BA>Fe>Zn>Cr>Cu. Fe, Zn and Ba recorded high value in all samples and exceed the norms of FANOR. The concentration varied respectively 497 to 544mg/kg and 3000 to 9000mg/kg.

The high concentration of Ba shows that the soil samples were moderately or highly contaminated by barite. This pollution is due to the irrational extraction of the substance because 25% of the part is rejected with the processing waste [7], occupying thousands of hectares of the territory of Ain Mimoune; this waste presents a crucial problem for the environment and the habitat (Table 3).

Figure 5 shows the results of principal component analysis (PCA) which was applied to better understand the possible origins of metal contamination in surface waters [8]. The two axes considered to describe the correlations between the variables related to the spatial structure holds alone 64% for axis 1 and 21.55% for axis 2. Axis 1 is expressed towards its positive poles influenced mainly by the metallic elements Ba, Zn Cd Cu Hg and the polluting elements NH_4^+, NO_2^-which present the good correlation between them. This factor could indicate the signature of the industrial and agricultural origin of this pollution, essentially by the barium. While axis 2 is defined by the elements Pb, NO_3^- towards its positive pole and the pH towards its negative pole. This factor probably is a secondary contamination and related to the erosion of the discharges of Ain Mimoune. The main factor 3 advocates about 15% of the total variance influenced only to the conductivity which indicates that the latter is not related to mining discharges but only to geological formations of the Cretaceous.

Table 3. Correlation between variables and factors.

	F1	F2	F3	F4	F5
pH	-0,689	0,430	-0,522	0,139	0,217
Conductivity (ppm)	0,337	-0,626	0,680	0,039	0,156
NH4+ (mg/l)	0,995	-0,046	-0,042	-0,038	0,036
NO3- (mg/l)	0,612	0,648	0,310	0,302	-0,077
NO2 (mg/l)	0,995	-0,007	-0,064	-0,051	0,044
Ba (mg/l)	0,993	0,069	-0,025	-0,031	0,085
Pb (mg/l)	0,618	0,739	0,193	0,070	0,027
Zn (mg/l)	0,757	-0,520	-0,369	0,130	-0,046
Cd (mg/l)	0,747	0,571	-0,160	-0,261	-0,014
Cu (mg/l)	0,752	-0,472	-0,433	0,143	-0,034
Hg (mg/l)	0,995	-0,041	-0,042	-0,037	0,036
Own value	6,996	2,371	1,226	0,229	0,093
Variability (%)	63,597	21,556	11,144	2,079	0,847
% cumulative	63,597	85,153	96,297	98,375	99,222

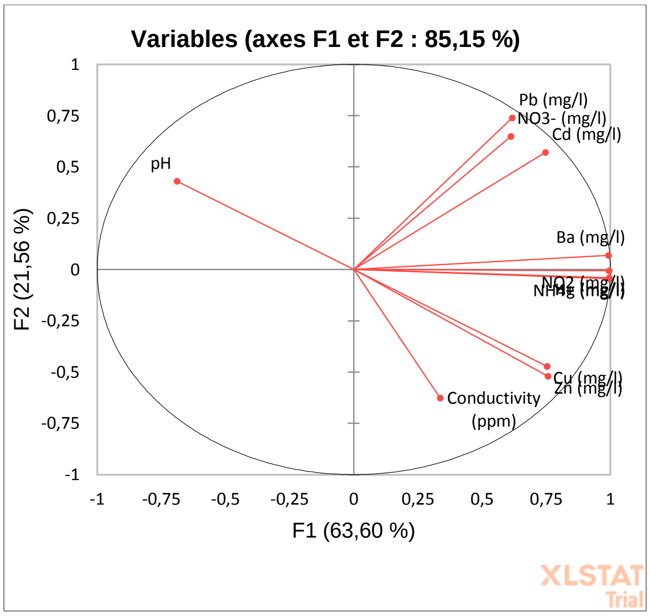

Figure 5. PCA applied to chemical elements

In the circle of correlation, the 1st component (F1) contributing to 64% and defined by the parameters of industrial and agricultural pollution, namely NH_4^+ (0.989), NO_2^- (0.99), Ba (0.985), Zn (0.573), Cd (0.559), Cu (0.566) and Hg (0.99) with the inertia of 21.55% of the second component F2 is defined by the parameters NO_3^-(0.42), Pb (0.546) and pH (0.475). The examination of the correlation matrix between variables reveals the presence of a first set of variables made up of variables that are well correlated with each other [9]:

pH: with parameters of conductivity, ammonium, Nitrate, Nitrogen dioxide, Barium, Lead, Zinc Cadmium, Copper and Mercury.

Ammonium: with Nitrate, Nitrogen dioxide, Barium, Lead, Zinc, Cadmium, Copper, mercury.

Nitrate: with Nitrogen dioxide, Barium, Lead, Zinc, Cadmium, Copper, mercury.

Nitrogen dioxide: with Barium, Lead, Zinc, Cadmium, Copper, mercury.

Barium: with Lead, Zinc, Cadmium, Copper, mercury.

Lead: with Zinc, Cadmium, Copper, mercury.

Zinc: with Cadmium, Copper, mercury.

Cadmium: with copper; mercury.

CONCLUSIONS AND RECOMMENDATIONS

This study showed that the mining centre of Ain Mimoune, in the eastern part of the Auras, has a high potential of pollution of industrial origin by Ba and that of agricultural origin by ammonium, Nitrate. The environmental impact of the mining activity in the region is confirmed. The mining centre has an effect not only on the environmental aesthetics of the area, but also on the surface waters and soils in the vicinity of the mine, contaminated by toxic trace metal elements. High levels of trace elements Ba have been recorded in surface water (2.34 mg/l to 124.66 mg/l) and soil sample (3000 mg/kg to 9000 mg/kg). We propose that the processing water of the mine be purified before it is released into the wadi Ain Mimoune in order to preserve the water table and protect surface waters against pollution by heavy metals. It is even for the solid waste which must be tries then stokes tries very far from the points of water.

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Article submitted to the Proceedings Book of the VI[th]. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

NATIONAL SECURITY: INTERPLAY OF ENVIRONMENTAL, HUMAN AND FOOD (IN)SECURITIES IN NIGERIA

Bitrus Eniyekenimi DAUKERE[1]*, Olatunde Isaac OLANIYI[2]

[1]*Department of Geography, Nigerian Army College of Education, Ilorin, Nigeria, dauksenies@gmail.com, +234 806 376 0421*
[2]*Department of Political Science, Nigerian Army College of Education, Ilorin, Nigeria, latundeolaniyi@gmail.com, +234 810 128 1355*

The recognition of safe biosphere and environment as critical elements in security architecture has received increased multidisciplinary attention in recent years. Issues of environmental security have deepened the depth and broadened the scope of security discourse. The security or otherwise of the Nigerian geopolitical construct is a reflection of its environmental security as well as the dynamic interplay of human security and food security. This paper examines human, food and environmental dimensions of security in Nigeria, with focus on how each dimension mutually reinforces the other and combines to impact national security. The study relied on secondary data from both quantitative and qualitative methods. Using content analysis, it is observed that environmental issues are central to the (in)security of Nigeria and its people. It argues that the environmental degradation resulting from extractive productions in the Niger-Delta region coupled with the continued desertification of the arid north cumulatively stresses the security balance of the country. The study reveals that environmental (in)security constitutes the remote cause of farmer-herders crises, kidnapping, cattle rustling, banditry and piracy in Nigeria. These insecurity indicators have also threatened food security in the country. The paper therefore recommends compliance with environmental safety protocols and resilient development practices in industrial and extractive sectors and divestment from non-renewable energy. It argues further for the government's effective management of ensuing competition over water resources in the middle–belt and southern parts asides provision of adequate water channels in the northern part of the country. The paper concludes that addressing man-made and nature induced environmental issues constitute the roadmap to a strengthened national security.

Keywords*: environmental security, farmer-herder crises, food security, national security, sustainable development*

INTRODUCTION

The security of lives, livelihoods and estates remain the primary essence of the modern state. In the face of shifting socioeconomic and political changes, all peoples across regions of the world continue to rely on the government, which is the principal agent of the state for protection. The state's provision of the feeling of safety of its citizens is hypothetically the security that the state is purposed to fulfill. The internationalisation of interactions beyond the micro level of private individuals to macro level inter-state relations makes the concept of security germane for the state. Each state pursues protection of itself via all means available from the predatory and anarchical actor nature of the international system.

National security encompasses the protection of a state's territorial integrity as well as deployment of all capabilities to wade off aggression or to discourage invasion from outside the state. Empirical evidence of guerrilla warfare, intra-state conflicts and civil wars has necessitated re-conceptualisation of security architecture which recognises formidable capability to suppress aggression from within the state as well. While dominant thinking on security has largely been military in nature, there has emerged the prevalence of security threats traceable to non-military sources. This expansive view of security beyond the traditional conception which holds state as the primary referent has sparked

Barry Buzan, one of the foremost revisionists of "security" in the post-Cold War era espoused the multifaceted complexity of the concept. He argued that the extant conception of security was "too narrowly founded", he thus propounded a broader framework which incorporates among others environmental, political, societal and economic sectors of security. While attempting an inquiry with this framework it is important to note that none of the sub-security concepts exhaustively address the issue of security. Each should not be addressed separately, "each one is intricately and complexly linked with the next forming a web of information that must detangle to understand each concept individually in order to be able to see how they affect each other on the whole" (Stone, 2009). The environment is an aggregate of all external conditions and influences affecting the life and development of an organism. Environmentalism is an expression of a more inclusive view of how the environment influences man, his livelihood and estate. All living creatures exist in a certain habitat and their interaction is interdependent and inextricably intertwined. The environment is made up of natural biophysical components and processes comprised primarily of land, water and air. The complexities of human interactions within and with the socio-ecological systems (SESs) are included. Attempts to understand the intricate relationship between a biological organism and the physical environment in which it survives dates back to discourses by social thinkers from Hippocrates, Thucydides and Plato in the ancient time to Bodin & Montesquieu in recent times (Johari, 2009). The investigation of these linkages was based on a better understanding of the environmental conditions that the organisms in question may face. Initial attempts at securitizing the environment on a global scale are traceable to the emergence of global environmental problems, such as global warming and depletion of ozone layer. While environmental issues began to gain relevance in political discourse in the 1970s, the depletion of stratospheric ozone or global warming among other environmental problems in the 1980s brought the debate on environmental security to the fore. With the publication of Our common future by the World Commission on Environment and Development in 1987, 'environmental security' gained entry into international debates (Trombetta, 2008). The limitation of earliest debates on environmental security to environmentally induced conflicts helped in two ways; (1) to frame environmental threats in more familiar terms to national security experts and (2) to consider the environment as a legitimate threat thus making it a national-security issue in the twenty-first century (Stone, 2009). The relationship between environmental change, stress, and environmental degradation relative to the issue of security has garnered increased importance since the end of the Cold War. The world is faced with environment-borne challenges ranging from climatic, biological and geological transformations of the Planet. There is the rapid depletion and degradation of ozone layer and soil resources in addition to biospheric pollution, ecocide, desertification, oil spills and toxic dung. These environmental challenges negatively affect the biosphere and impact on all aspects of human life in both developing and developed states across continents (Kurki, 2020; Bayoumi Hamuda, 2022).

This is for example explicated by the 24% of global deaths resulting from dearth of fresh water to drink, clean air to breathe and toxic-free places for man, animal and plants (WHO, 2016). As a result, the environment, human security and peace are inextricably interwoven. Conflicts can arise as a result of resource shortage, environmental degradation and change, leading to human insecurity. Human conflicts and security can also have a negative impact on environmental sustainability. In Nigeria and other regions of the world, this is a common occurrence.

The recognition of a safe biosphere and environment as critical elements in security architecture has received increased multidisciplinary attention in recent years. The question of the relationship between environment and security is now a common interest among both the scientific and policy communities. The fields of Security and Strategic Studies, Policy Studies, Political Science, Human/Urban Geography, Environmental and Natural Sciences, Engineering, and Public Health among others have identified niches which need cross fertilisation of ideas leading to worthy contributions in terms of research and innovations towards an improved national security. With these multidisciplinary intersections, issues of environmental security have deepened the depth and broadened the scope of security discourse. This development further acknowledges the environment as a critical driver of economic growth, both which is essential to national security interest.

Globally, there is growing empirical evidence of establishing the linkage between environmental issues and national security balance (Burke et al., 2016; Kavalski, 2018). In the arid Central Asian region, the source waters of the Aral Sea diverted to irrigate water-intensive agricultural crops led to the destruction of the sea and its ecosystem. It resulted in the collapse of its fishing industry and the degradation of up to 7.9 million hectares of arable land. In another instance, the 1997/98 forest fires in Indonesia which resulted in the loss of at least 8000 square miles of tropical forest was not without its security implications.

A similar case was the destruction of the forests of Haiti and erosion of agricultural topsoil which resulted in untenable economic conditions and an increased number of refugees fleeing to the United States (United States Environmental Protection Agency [USEPA], 1999). The environment has also been an important component of the peace process in crisis ridden regions such as the Middle East. Multilateral working groups in the region developed regional projects dealing with desertification, water conservation and oil spill contingency planning involving scientists, governmental officials, community leaders and business people. In Africa, preponderant environmental problems are exemplified in water scarcity, desertification, air, water and land pollution as a result of industrialisation, poor land use practices, intense population pressure and urbanisation. This is reflective of Nigeria. It has been estimated that between 50 and 75% of Bauchi, Borno, Gombe, Jigawa, Kano, Katsina, Kebbi, Sokoto, Yobe and Zamfara States in Nigeria are being affected by varying degrees of desertification (Olagunju, 2015; Audu & Adie, 2017).

The resulting pressure of human and livestock migration from these areas are felt in buffer states such as Adamawa, Kwara, Kaduna, Niger, Plateau, Taraba and the Federal Capital Territory. This forced movement has not only intensified use of fragile and marginal ecosystems resulting in progressive degradation but also occasioned crises of food, human and national insecurity. The biospheric pollution and environmental degradation of the Niger-Delta region in Nigeria's south also have far-reaching security implications for the ordinary citizen, the Nigerian State as well as regional stability of the Gulf of Guinea. There is a plethora of studies examining Nigeria's national security question.

Most of these studies are statist in nature, with copious volumes focusing on non-state actors such as bandits, terrorists, Boko Haram, militants, farmer-herders among others. There is, however, a dearth of studies that looked at the national security puzzle from an environmental standpoint. As a result, this paper therefore, seeks to establish the security import of the "environment" as underlining to addressing (in)security challenges in Nigeria. The paper examines the development of security concept from purely military thinking to the post-Cold War thoughts on security. It presents Nigeria within its geopolitical and strategic environment with focus on desertification in the north and biospheric pollution in the south (among others) as instances of environmental degradation which constitute Nigeria's environmental challenges. The paper examines the linkage between these environmental insecurities impacting other factors to accentuate communal crises, such as farmer-herder crises, banditry, cattle rustling and the cumulative of these on food and human security.

Engaging the Security Concept

New thinking on security has evolved from the preponderant threats in the post-Cold-war period. These differing sources of non-military threats have come to be acknowledged domain of security-what needs be secured. These include; food security, human security, environmental security, national security, economic security, political security, regional security among others. With the multiplicity of these sub-security concepts, the imperative to clarify meanings of key concepts in other to identify limitations becomes compelling. Two broad conceptions of security have emerged in the literature; the military conception of security and the non-military conception of security. The classic definitions of security fits into the military category while the non-military domain of security is comprised of the expanded post-Cold War sub-security concepts.

Military Conception

National Security

National security is the safekeeping of the nation as a whole. Its highest order of business is the protection of the nation and its people from attack and other external dangers by maintaining armed forces and guarding state secrets. National security entails both national defence and the protection of a series of geopolitical, economic, and other interests, which affects not only defence policy, but foreign and other policies as well. Since the end of the Cold-War, an expanded definition of national security has emerged. National security concerns encompass focus on military threats to national interest as well as those of non-military sources. Key among these are concerns about the environment; its (mis)management, degradation, natural resources depletion, overpopulation as well as the environmental consequences of previous wars.

Non-military Conception

The concept of national security was for most of the 20th century military biased. The concept has, however, expanded over time beyond what armed forces could do (or not do as the case may be). Today, there are all kinds of "national securities." They include economic security; energy security; environmental security; and even health, women, and food security. This proliferation of definitions has not always been for the good (Holmes, 2015).

Food security

Physical and economic access to food for all people at all times. Hundreds of millions of people in the world remain hungry either through local unavailability of food or, more often, through lack of entitlements or resources to purchase food.

Human security

It broadly encompasses peoples' safety from hunger, disease, and repression, including harmful disruptions of daily life. Human security is characterized by the absence of particular deprivations as well as the absence of specific imagined fears (United Nations Trust Fund for Human Security, 2009). The evolution of the concept is traceable to the efforts of the United Nations to better human life in the wake of the Cold War. Its basic assumptions are that (1) protection of individuals is a strategic concern for national as well as international security and (2) security conditions for people's development are not bound to traditional matters of national defence, law and order, but rather encompass all political, economic and social issues enabling a life free from risk and fear. Despite the consensus on the foundations of this concept, there is no single generally accepted definition of human security. While realists have focused attention on the state as the prime referent object of security, idealists have argued that people, that is, individuals, are what really matters in the final analysis. Accordingly, seeking the security of the state is worth striving for, only to the extent that it contributes to the survival and well-being of people (Olaniyi, 2019).
Human security concept has expanded to include economic security, environmental security, food security, health security, personal security, community security, political security, and the protection of women and minorities. Its distinguishing feature is to focus on social and economic causes of insecurities and an assumed international "responsibility to protect" peoples from violence. The concept of human security challenges the traditional scope of security and insecurity noting that it is by no means limited to violent conflict or its absence but includes the roots of sustainable livelihoods, health, and well-being. Human security is a critical component of the global political and development agenda.

Environmental security

Environmental security (ES) constitutes the body of process and solutions to environmental problems within the national security objectives. The environment, according to Bayode et al., (2011), is made up of biophysical components and processes of the natural environment of land, water and air. It encompasses all layers of the atmosphere, inorganic and organic matter, socio-economic components and processes of human endeavours as well as the symbiotic relationship among these elements which could affect economic activities. Environmental commons such as water sources, community forests, and village pasture areas, among others, are also vital components of the environment. Any deficiency, deprivation, or destabilization in one or more of these areas could result in unrest and conflict, increasing insecurity. ES is thus a means of responding to conflicts caused by imbalance in the environment (USEPA, 1999). These include problems such as desertification, water shortages, energy disruptions, biospheric pollution, severe climate changes and ecocide. Environmental security views ecological processes and natural resources as sources or catalysts for conflict and as barriers or limits to human well-being, environmental impacts of conflict, environmental recovery and post-conflict peace building and conversely as a means to mitigate or resolve insecurity. This has required the need to maintain the earth's life-supporting ecosystems generating water, food, and clean air, improving resource governance and social resilience to natural resource shocks and stresses (Scientific and Technical Advisory Panel [STAP], 2018). Environmental security has been classified into four major dimensions; these dimensions aid better understanding of the role of the environment in preventing, managing and resolving violent conflicts and boost cooperation among groups and stakeholders in relation to resources available. STAP, (2018) highlights four dimensions of ES which were particular to the Global Environment Facility (GEF);

- First, ecosystem goods and services fundamentally underpin human well-being and human security. Human beings depend on the earth's ecosystems and the services they provide. The degradation of these services often causes significant harm to human well-being.
- Second, conflict, irrespective of its source, affects the viability or sustainability of investments in environmental protection and their outcomes. Violent conflict often results in direct and indirect environmental damage, with associated risks for human health, livelihoods and ecosystem services.
- Third, ecosystem degradation, resource competition, or inequitable distribution of benefits increases vulnerability and conflict risk. Environmental degradation is a cause of human insecurity and can aggravate other sources of social division based on ethnicity, class, religion, or economic position. While rarely the simple or sole cause of conflict and insecurity, environmental change (including climate change) is increasingly characterised as a "risk multiplier."
- Fourth, environmental cooperation can increase capacity for conflict management, prevention, and recovery. Managing shared natural resources sustainably and equitably can motivate greater cooperation, and can also help build institutions that moderate and reduce the disruptive impacts of conflict, or aid post-conflict reconciliation and rebuilding.

ES apologists combine the theory of environmental determinism with the promises of integration cooperation theory as advanced by Robert Keohane, Ernst Haas and Thomas Franck among others (Olson, 1965; Ostrom, 1990 2010; Roemer, 2015; Carattini et al., 2019). They argue that solutions proffered by ES are predicated on the idea that cooperation among nations and regions via treaties and international governance can effectively address environmental problems. It is cooperative institutional networks that advance political stability, economic development and global peace. In addition, by addressing the environmental components of potential security 'hot spots,' threats to international security can be prevented before they become a threat to political or economic stability or peace. Environmental security mutually reinforcing other critical non-military spheres of security. It is broadly a foundation for food security which is also essential to human security, sustainable livelihoods, health, and well-being among households and communities (GEF).

The relationship between the environment and security is complicated. Environmental disputes have a wide range of causes and expressions all around the world. The links of physical scarcity of resources, environmental deterioration and human-made environment change with destabilizing intervention in the ecosystem's balance can be interpreted as the causality conflicts and insecurity (Dalby, 2006; Okon & Ojakorotu, 2021). Greenhouse warming, stratospheric ozone depletion, acid deposition, deforestation, deterioration of agricultural land, overuse and contamination of water supplies, and loss of fish stocks are just some of the environmental issues that developing countries face (Yıldız, 2015; Dalby, 2022). People require land, water, energy sources such as coal and oil, wood, and so on in order to survive. Absolute shortage of any of these resources, as well as unequal distribution across distinct groups of people and places, frequently leads to disputes and insecurity. As a result, impoverishment spreads across groups and areas, disparities widen, and unrest and conflict loom on the horizon. For example, a substantial number of Nigerians rely on land and agriculture for a living and for their well-being. Inequitable distribution among farmers and herders not only results in impoverishment, but also in the concentration of better lands in the hands of a few, making many poorer and more vulnerable.

Environmental (in)security in Nigeria

The Nigerian state has a geo-political definition which is strategic for political, economic and military purposes in the Gulf of Guinea, Lake Chad Basin, Sub-Saharan Africa and the African Continent as a whole. Olaniyi (forthcoming) aptly captures the country's strategic position:

> Nigeria is on the western coast of Africa, geographically lying between latitude 40N and 140N and longitude 30E and 150E meridian. Also officially known as the Federal Republic of Nigeria, the country occupies a total land area of about 910,000 km2. It is bordered on the North by Niger with an area extending into the Sudano-Sahelian belt and Chad in the northeast. It is flanked on the west by the Republic of Benin and Cameroon in the southeast. Nigeria being a littoral has its coast in the south located in the Gulf of Guinea along the Atlantic Ocean.

The Nigerian enjoys a warm tropical climatic condition influenced by the interaction of two air masses: the relatively warm and moist tropical marine air mass (mT) which originates from the Atlantic Ocean and is associated with Southwest winds in Nigeria; and the relatively cool, dry and relatively stable tropical continental air mass (cTs) from the Sahara Desert and is associated with the dry, cool and dusty North-East Trades (Harmattan). Its environment is an admixture of mangrove and freshwater swamps, rain forest, Sudan Savanna, Guinea Savanna and the Sahel. Between the rainforest and the Guinea Savanna is a modified vegetation transition consisting of light deciduous forest and derived savanna (Federal Ministry of Environment [FMENV], n.d.). Unfortunately, Nigeria continues to face serious environmental degradation which is damaging not only to its environment but its people- the security of their lives, livelihoods and estates as well as national security. Environmental degradation is an undesirable disturbance or change in the natural balance of the ecosystem. It is noted for 3 Ds namely; deterioration, depletion and destruction of the environment and its resources. Environmental degradation broadly covers environmental issues such as biodiversity loss, animal extinction, climate change, biospheric pollution, deforestation, desertification and global warming. The degradation of the Nigerian environment is evident in desertification, drought, biospheric pollution (air, water and land) as well as ecocide. These environmental concerns are partly products of counterproductive human interactions (especially urbanisation, industrialisation and development) with the environment. The dynamic interplay of these ES indexes has implications on human and food security, while the trio dimensions mutually reinforce one another and combine to impact on national security. This interconnectedness makes the security or otherwise of Nigerian geopolitical construct is a reflection of its environmental security.

The Northern Region

Nigeria's northern region is situated in the semi-arid areas bordering the Sahara Desert and is characterised by desertification and drought, which are not exclusive to the region. The duo are environmental threats to security which affect the region. The rapid and expansive desert encroachment in Nigeria has been accentuated by a combination of climatic variability of an average annual rainfall of less than 600 mm, urbanisation and anthropogenic activities. Continued deforestation (for agricultural purposes, urbanisation and fuel wood extraction), indiscriminate bush burning, extensive cultivation (especially of marginal land) and overgrazing have been identified as causes of desertification in the region (Figure 1). Out of the 909,890 Km^2 of the country's land area, desertification has claimed about 580,841 Km^2 accounting for 63.83% of total land. This statistics accounts for less than fifteen northernmost states in Nigeria, almost one-fifth of the country's total land area (Medugu et al., 2008; Olagunju, 2015).

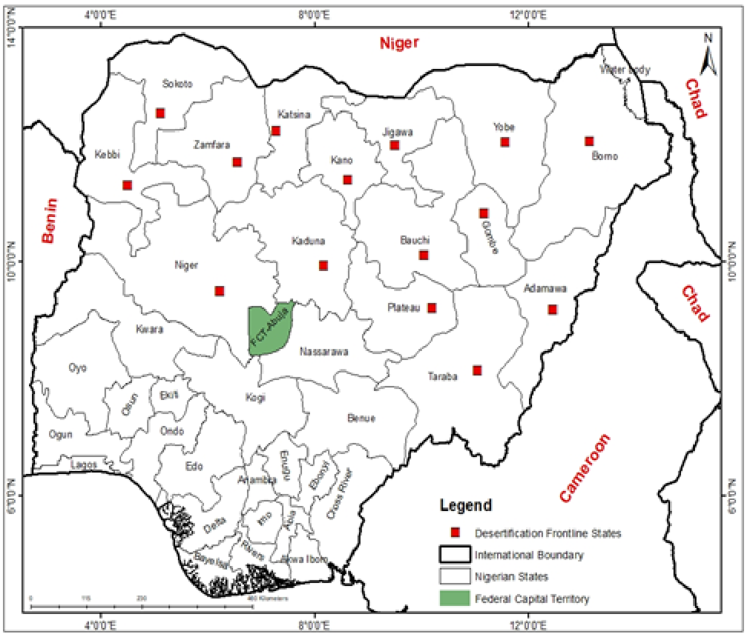

Figure 1. Political Map of Nigeria showing desert encroachment in the frontline states
***Source*:** GIS Lab, Nigerian Army College of Education, Ilorin

Desertification involves the degradation of fertile land through long term changes in soil, climate and biota resulting in reduction in the natural potential of the land and depletion of its surface and groundwater. Despite the recognition that desertification is a global issue gaining attention like climate change and loss of biodiversity, the degree of its impacts varies from one part of the world to another. Nigeria is one of the countries south of the Sahara faced with a rapid desert encroachment, with notable effects on the northern part of the country (Brottem, 2021). Earliest report of this environmental issue in northern Nigeria dates back to the 1920s. It however was not recognised as an issue of national concern until the famine of 1971 to 1973 which was a direct effect of the desert encroachment (Medugu et al., 2008). Desertification has impacts across socio-economic and health aspects of human life as well as the ecological, geo-chemical, hydrological facets of the environment (Emodi, 2013; Jibunor 2014; Olagunju, 2015). It is thus a non-military threat to National security but with negative impacts on human security, economic security and food security.

The Niger Delta Region

Nigeria's south popularly named the Niger-Delta region is located at the apex of the Gulf of Guinea on the west coast of Africa with a population of about 31 million people occupying a total land area of about 75,000 which accounts for 7.5% of Nigeria's land mass (Bodo & Gimah, 2020; Aniefiok, et al., 2013). The region stretches from Ondo in the west to Cross River in the East, comprising 6 other oil–producing states; Edo, Rivers, Abia, Akwa Ibom, Bayelsa, Delta and Imo which account for a total of 185 LGAs. The formation of the Niger Delta is as a result of the breaking away of the 4,100km-long Niger River connecting estuaries from where it flows into the Atlantic Ocean at the Gulf of Guinea (Fagbeja et al., 2008). Table 1 reveals that 43% of natural gas was flared into the biospheric environment over a period of 25 years (1990-2014). Gas flaring involves the burning of natural gas which could be refined into other usable petroleum products usually via towering pipes. Nigeria held the record of flaring over 14% of gas that was flared globally in 2004 ranking the country as the second to Russia which accounted for 16% of global gas flared (Federal Ministry of Environment, 2006; Otene, Murray & Enongene, 2016; Oka, 2017). While the economic loss associated with the gas flaring is roughly put at 4.9 million USD/day, also important in its damaging effects of the flaring on human and animal health, safety and livelihoods of the people. Over two decades, gas flaring alone has contributed to emission of greenhouse gases leading to increasing incidence of global warming and heat waves. Gas flaring is also linked to acid rain in the Niger Delta, which is harmful to both vegetation and crops.

Table 1. Comparative data on crude oil production, oil spillage, natural gas production and gas flared

Year	Total Crude Oil Produced (Barrels)	Oil Spillage (Barrels)	Total Gas Produced	Gas Flared	Percentage of Gas Flared
1990	630,245,500	14,940.816	1,004,385,817	791,708,975	78.8
1991	630,245,500	106,827.98	1,111,430,806	871,197,828	78.4
1992	716,262,000	51,131.91	1,133,475,714	868,194,916	76.6
1993	695,398,000	9,752.22	1,189,859,807	910,412,329	76.6
1994	664,628,500	30,282.67	1,189,859,807	950,686,680	79.9
1995	672,549,000	63,677.17	1,240,026,105	953,371,638	75.0
1996	681,894,600	46,353.12	1,252,391,038	939,381,599	65.2
1997	855,736,287	59,272.30	1,312,449,282	856,147,988	63
1998	806,443,999	98,345.00	1,308,527,832	834,880,254	8
1999	774,703,222	20,000.00	1,541,589,148	790,013,212	51.3
2000	828,547,638	30,100.00	1,509,652,294	856,889,834	56.8
2001	865,173,584	76,960.00	1,853,079,467	945,352,096	51.0
2002	729,190,940	19,980.00	1,651,591,488	753,801,906	45.6
2003	831,775,504	9,916.00	1,828,541,855	844,978,886	42.2
2004	910,156,489	8,317.00	2,082,283,189	886,540,196	42.6
2005	918,966,736	11,921.00	2,093,628,859	811,315,777	38.8
2006	869,196,506		2,182,432,084	803,661,823	36.8
2007	803,000,708	32,000.00	2,415,649,041	759,688,726	31.5
2008	768,745,932	100,000.00*	2,287,547,344	619,398,854	27.1
2009	780,347,940	104,000.00*	1,837,278,307	509,351,905	27.7
2010	896,043,406	17,658.19*	2,392,838,898	581,568,354	24.3
2011	866,245,232	67,906.84	2,400,402,880	619,032,858	25.8
2012	852,776,653	17,526.37	2,580,165,626	588,666.724	22.8
2013	800,488,096	4,066.20	2,325,137,449	409,311,430	17.6
2014	798,514,589	10,302.16	2,524,268,444	289,600,014	11.5
TOTAL	**19,731,884,225**	**775,236.95**	**44,218,335,225.00**	**19,045,154,752.00**	**43.0**

Source: Oka (2017)

The region with its over 800 oil–producing communities and over 900 producing oil wells, is significant in two ways; (1) it is classified as tropical rain forest and it is the largest mangrove forests in Africa and the third largest in the world (2) it is Nigeria's maritime domain with about 84, 000sq nm containing strategic natural resources located in the heart of the Gulf of Guinea (GoG) (Asanebi, 2016; Aniefiok, et al, 2019; Bodo & Gimah, 2020; Olaniyi, forthcoming). It is no gain saying that a significant portion of Nigeria's economic mainstay is in the Niger-Delta. A descriptive statistic of this fact is given by the President, Muhammadu Buhari when he noted that the region together with its adjourning exclusive economic zone (EEZ) houses the 'country's hydrocarbon resources which remain the mainstay of the nation's economy account[ing] for 55% of the Gross Domestic Product (GDP), 95% of export earnings and about 70% of government revenue' (Ndidi, 2021). Nigeria's Niger Delta remains the best known, most exploited, and richest hydrocarbon basin in the GoG region, with proven reserves of 36.8 million barrels of crude oil (Etuonovbe, 2009; Campbell, 2019).

Despite the economic and strategic importance of the region to Nigeria, its environment is heavily degraded with air, water and land pollution in the area reaching unbearable heights. The Niger-Delta faces environmental degradation which is the deterioration of the environment through human activities resulting in the depletion of resources, contamination of air, water and soil, destruction of ecosystems and the extinction of flora and fauna (wildlife). Environmental degradation in the context of the Niger Delta is viewed as involving the high rate of oil exploration and other human activities in the oil rich Niger Delta beyond the carrying capacity of the ecosystem. Most of the exploratory activities have less regard for human health and welfare of the inhabitants which has also caused damage to the flora and fauna of the region. The ND environment is continuously being depleted with pollution which destroys arable lands, water resources and vegetation supporting an immediate population of 25.1million (Oka, 2017). The repeated incidence of oil spillage and leakages, toxic waste dumping and gas flaring has put the environmental security of the region in jeopardy. A combination of these ancillary exploratory activities constitutes a threatening burden of biospheric (air, water and land) pollution which is as heavy as nuclear holocaust (Kadafa, 2012; Ugboma, 2015).

Oil spillage and leakages constitute a major threat to environmental security in the region. It was reported that 546 million gallons of crude oil were spilled from 1958-2010, averaging about 300 spills or nearly 10.8 million barrels per annum (Kalejaiye, 2015). During exploration, oil is transported through pipelines in the refineries some of which are corroded and worn-out valves. Rusted pipelines occasion oil leakage.

Asides equipment failure during either conventional or local process of drilling and refining, these spillages are also due to human error and sabotage or theft (pipeline vandalism, oil bunkering and smuggling). Bodo (2020) revealed that oil spillage caused by sabotage and theft rank highest accounting for more than half (59.7%) of total oil spillage between 1998 and 2007. The FMENV (n.d.) observed that oil spill is experienced weekly in the Niger Delta region which has grave damage in the environment. Oil spillage has led to the destruction of about 50,000 acres of mangrove forest between 1986 and 2003.

Counterproductive oil exploratory activities have led to the damage of mangroves, fishing grounds and tropical rainforest of the ecologically rich Niger-Delta. Through oil leaks and spillages drinking water is directly contaminated which often accounts for water-borne illnesses among the people (Ogbija et al., 2015). It is also linked to instant death of aquatic life and terrestrial life as well as of human persons especially when there is explosion and fire incidents. Its immediate effect is also seen in depletion of soil nutrients and general damage of the ecosystem. Farmers are thus forced to abandon their farms which could barely support crop cultivation as a result of oil spillage and leakages.

The direct and indirect effect of this on food security has largely been negative. These dire consequences have been long standing everyday life realities of the Ogoni community and many others in the Niger Delta. Oka (2017) aptly captures the ripple effects of oil spillage and leakages of oil pipelines in the region:

> leaking pipelines, running through villages, farms, creeks and rivers in the Niger Delta, are a major source of pollution, sickness and economic ruin for the people of the Niger Delta. Farmland polluted by oil is rarely rehabilitated, [thereby] destroying livelihoods. Fish contaminated by oil cause sickness among the people and further economic ruin as fish stocks decline. The spillages are a regular feature of life in the Delta. They are rarely dealt with promptly. In some cases, minor leaks are left for months; resulting in major pollution... oil spillage has implications for marine life and coastal vegetation. In some cases, the groundwater supply of the local inhabitants becomes polluted.
>
> The chemical compound from industrial polluted areas causes respiratory and chromosome damage in women. Moreover, it causes stillbirths and cancer in women...There is also the problem of tremendous heat as a result of continuous flaring of natural gas, which produces gaseous emission and contaminants.

Toxic waste is the third force (after gas flaring and oil spillage) against environmental security in the Niger-Delta. These wastes contain radioactive components such as mercury, cadmium, and arsenic lead which cause severe health complications to human and animal life when exposed to the atmosphere and inhaled, ingested or absorbed through the skin. In addition, such wastes are capable of polluting underground water as a result of waste permeation of the ground especially in a tropical region of high rainfall.

Toxic waste dumping manifests in two ways namely; (1) from industries sited within the country and (2) from transnational waste merchants. Industrial wastes channelled or dumped into water bodies are injurious to the immediate aquatic lives and then terrestrial lives that depend on such water and resources in them (Etuonovbe, 2009). The effective enforcement of environmental safety frameworks in Europe and North America vis-a-vis poorly administered frameworks and under-protected shores in West Africa, positioned the ND for risks of hazardous radioactive wastes.

It was reported that toxic wastes in large quantities were dumped in some remote Africa communities which included; Koko, Kssa & Annobon. Witnessed dumping of tens of thousands of tons of toxic waste in quick successions as a result of the penalty on industrial waste (Bodo & Gimah, 2020). Koko which is an isolated Nigerian port town with a population of about 5,000 people who are predominantly fishermen and farmers, suffered untold environmental stress as a result of the toxic waste.

This raises the need to safeguard Nigeria's territorial waters from the waste merchants of Europe and any other part of the world. The intense exploration, exploitation and consumption of these non-renewable energy resources have gone above the carrying capacity of the environment and its renewable potential.

Additionally, population increase and the use of sophisticated technology coupled with spillages, leakages and gas flaring, the environment is threatened and ecocide is imminent. Nigeria from the north to the south is no doubt in a state of imbalance with the safety of its environment threatened. As discussed in the foregoing section, desertification and drought are peculiar environmental challenges in the north while the biospheric pollution resulting from oil spillage and leakage, gas flaring and toxic waste dumping are perennial environmental problems in the Niger Delta which is Nigeria's southern region. These environmental crises cannot be divorced from the increasing unrest, farmer-herder crises, kidnapping, banditry, militancy and other illicit maritime crimes termed "blue crime " which embodies piracy, armed robbery, hijacking and kidnapping.

Impacts of Environmental Insecurity

The issues of the environment have entered the agenda-setting domain of public policy with policy outputs in the form of legal framework, institutions and policy. The Nigerian government via Decree 58 of 1988 established the Federal Environment Protection Agency (FEPA) with the mandate to protect the Nigerian environment and address its multifaceted environmental problems. FEPA was replicated as State Environmental Protection Agencies (SEPAs) in the 36 states of the Federation and the Federal Capital Territory (FCT) to manage environmental issues at state level. Nigeria is also signatory to a number of international conventions and protocols in this regard, such as the Desertification Convention. In same year the Wastes Criminal Provision Acts was enacted by the federal government to criminalise the indiscriminate disposal of toxic wastes.

In the wake of the 21st century, emerging environmental issues necessitated the creation of Federal Ministry of Environment (FMENV) by former President, Olusegun Obasanjo. The ministry was to fill Nigeria's environmental objective according to the provisions of section 20 of the 1999 Constitution. However, the positive impacts of these remain minimal as the Nigerian people continue to bear the brunt of environmental, human and food insecurity in the country (Figure 2).

Impact on Human Security

Extant studies have explored the influence of environmental factors on human security (Umar et al., 2015; Daukere et al., 2020; Daukere et al., 2021). Here the discourse is taken further by examining the impacts of environmental (in)security on human security. At the core of human security is safety from violence and every form of disruption to human development. These are, however, fairly impossible in events of intra and inter-conflicts and violence within the country. A good number of conflicts that erupted in the north and middle belt of Nigeria can be linked to environmental issues.

Desertification and the attendant drought play a major role in forced migration of a group to the domain of another in search for resources such as water for herds and cultivation, forage for herd and land for cultivation. The objects of the search have made most of the ensuing conflicts mainly between farmers and herders. Struggles and rivalry over the limited available land and water resources had triggered communal clashes. This has been well established in the literature with the evolution of debate about environmentally induced conflicts (Trombetta, 2008). Findings of these studies have pointed that such conflicts are often subnational, low intensity but recurrent.

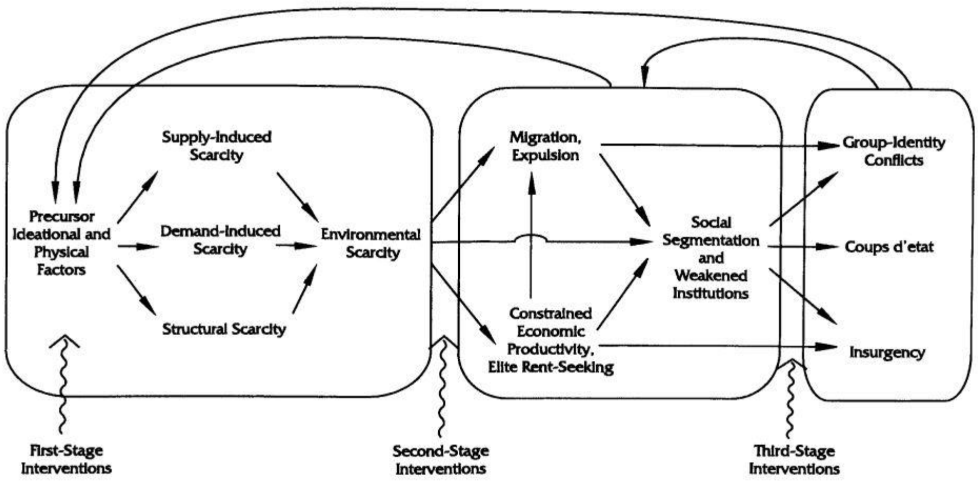

Figure 2. Homer-Dixon's model of environmental insecurity and conflict

Desert encroachment affects not only pastoralists and crop farmers but also hunters and fishermen. These livelihood activities, save hunting to a greater extent, are water-intensive. This demand for water resources becomes intense whenever alternations in annual rainfall are experienced as rainy season continues to shrink. In the last three decades, rainy season has reduced from 150 to 120 days on average owing to climate change (CDD, 2022). Studies by Arifalo (2005) and William (2007) independently found that the absence of organic matter to bind the desert soil and its vulnerability to wind erosion make the dessert area less appealing for agricultural activities. Since plants hardly grow in deserts, its implication is farmers engaged in crop farming have to turn southwards where viable/arable lands can be assessed. Incidentally, nomads also turn southward where they can access forages and water for their herds. This supposed forced southwards migration has further implications. While the host population together with the immigrant farmers (plant and animals) depend on the limited water resources available, conflict often ensues when a group arises to disadvantage the other. These may be for reasons such as; entitlement of indigeneship, population ratio and/or capability to fight which often leads to violent problems?

The southwards movement of herders from the north in search for forages and grazing land for their cattle are often accompanied by encroachment on other people's farms which also often call for reprisal attacks. This is underlining to Benue State's recurring conflict between the Agatu and Fulani, the Biroms and Hausas in Plateau state, Ngamo Maitatsine and Boko-Haram over farm lands and grazing areas in Yobe State, the Okeogun and Fulani in Oyo State (Olagunju 2015; Olaniyi, 2019; Brottem, 2021). Some of the herders of sub-Saharan origin having migrated southwards and having been accommodated by different communities had cohabited for decades with significant mutual benefits. However, this settler population also do cause damage to crops of their hosts by grazing their cattle on farmlands. The reprisal attacks that follow are in most cases, to register displeasure over injustice the host communities feel after seeking redress through traditional and state institutions with no reprimand. This is what Olaniyi (2019) has argued as "herdsmenism in the SouthWest". This is in tandem with the position of USEPA (1999).

Conflicts also evolve as a result of rapid changes occasioned by urbanisation and development processes that negate sustainability of the environment and its people. This is environmental insecurity arising from the conflictual dimension of the development process. Activities of oil and gas exploration resulting in environmental insecurity such as biospheric have necessitated involuntary complete resettlement of some communities in the ND. This becomes necessary owing to the loss of ecological resources with the attendant loss of livelihood, occupational uncertainties and sociocultural effects of displacement of ancestral homes, religious and cultural artefacts (Trombetta, 2008; Oka, 2017).

This environment-conflict perspective partly explains the trajectory of insecurities in the oil-rich Niger Delta.

Studies have also established relationships between environmental and socioeconomic factors and insecurity. For example, Daukere et al., (2021) found that the resulting loss of livelihoods from environmental insecurity in the ND accounts for involvement of young people in a wide range of criminal acts. These included theft, assault, false pretense, forgery, cheating, kidnapping, armed robbery, murder, burglary, rape, vandalization of oil pipelines, bunkering, bombing, thuggery, killing, destruction of property and suicide.

The situation has also led to the formation of armed groups among competing groups. The formation and intervention of such self-help groups evolved because of official corruption, ineptitude in the criminal justice system, unprofessional conduct of security agents and breakdown of traditional conflict resolution mechanisms among other factors (Centre for Democracy and Development, 2022). This accounts for the attacks and reprisal attacks herders armed with guns are resisted by farmers groups with similar weapons. The farmer-herders conflict which is often denoted as ethnic conflict is largely rooted in disputes over use of land and water resources. The designation of Fulani in many studies as generic herdsmen while there are herders of other origin such as the Kanuri and the Tuaregs affirm this ethnic colouration of the conflicts.

Armed groups from the Agbekoya, Vigilante in South-west to Movement for the Emancipation of the Niger Delta (MEND) in the South, efforts have been made to resist intruding groups while the state remained largely indifferent. A corollary to the evolution of such armed groups is the proliferation of small arms and light weapons (SALW) across the country (Olaniyi, 2021). This also explains the increased radicalisation and violent extremism that constitute major security challenge to the Nigerian state.

Environmental insecurity has also negatively impacted on human development index in the country. The rapid surge of rural banditry in the northwestern region for instance has affected the education of children in the region. The region has been reported to have a higher poverty rate than the national average of 40.1%, it also accounts for three of the four states with the lowest literacy rates in the country (Amzat, 2017; National Bureau of Statistics [NBS], 2014; 2019). Environment-induced insecurity continues to exacerbate this low human development index in the area as about a million Nigerian children are out of school due to insecurity in the northwest (CDD, 2022).

Impacts on Food Security

From the north to the middle belt and the down south of Nigeria, agricultural activities in form of crop cultivation, fishing and animal production are common. Agriculture remains the economic mainstay of most households in Nigeria and a significant sector of Nigeria’s economy. Availability of food and the access of all to it constitute a basic requirement for a healthy and productive human population. Food security is thus all efforts at guaranteeing availability and access of all people to the food needed for healthy life at all times. Climate, land and water resources as well as labour and capital are primary factors in food production and their scarcity leads to food shortages.

Environmental security is critical to strengthening the nation's food security system (FMEN n.d.).

A combination of factors rooted in environmental issues and human (in)security affect agricultur al production especially in regions hitherto known for large scale active participation in the value chain of staple food and other agricultural products such as the north east and north central (Olaniyi, 2021). This insecurity complex heightens reliance on importation as a result of reduced national food production. Establishing the linkage between human (in)security and food (in)security is no doubt compelling after giving an exhaustive trajectory of how environmental (in)security translates to human (in)security. Such will however, be a too ambitious effort if the immediate impact of environment on food security is disregarded. Desertification and drought have direct impact on food production. A report of the situation is aptly captured by Audu & Adie (2018);

> Farmers have complained that their low crop production and versatility in crops produced have been hampered by ebbing water supply caused by the encroaching desert. They spend a lot of money on water and farm inputs and at the end incur losses. The frustrations in farming have made many peasant farmers to abandon farming…activities like commercial motorcycling. Some of the famers in the border areas have moved into the neighbouring country of Niger [Republic] where they claim that government provides water for farmers and they pay a token after harvest.

As Figure 3 reveals, food insecurity has become a reality with twelve (12) states in Nigeria facing acute food crises ranging from stressed to famine. It also shows that states with notable insecurity challenges are the most affected as there is evident food insecurity at emergency and famine levels. The northeast which has in over a decade been under the siege of Boko Haram insurgence is the most affected as Borno and Yobe states rank worst in food security matrix in the country.

Similarly, bandits' activities in the northwest have affected food production and distribution within the region. Especial mention is Zamfara and Sokoto states which studies have also established as sanctuaries for a greater number of bandits in the country (Rufai, 2021; CDD, 2022). This further confirms that insecurity negatively affect food security.

Audu & Adie (2018) argued the inextricable nexus between environmental degradation (especially, desert encroachment) and food insecurity.

Deforestation for industrial and agricultural activities on marginal lands has stressed the ecological capacity of the arid regions. It has been reported that the annual land loss of Nigeria to desertification stands at about 350,000 ha (Emodi, 2013; Olagunju, 2015).

Desertification is associated with perennial features such as loss of biological diversity, alterations in geochemical composition of the soil, soil salinization, worsens water scarcity and over-exploitation of groundwater (Olagunju, 2015; FAO, 2016). The overdependence of Nigeria's agroeconomy on rainfall has also compounded issues as rainfall recedes. It has also been reported that some farming communities have been displaced as a result of dunes covering their farms and homes.

It is estimated that about 50,000 farmers in at least 100 villages in Yobe State alone are likely to abandon their farms due to meagre agricultural output caused by dunes. With these it becomes difficult to have substantial agricultural output which will first cater for the subsistent need of the producing population, thereby contributing to food insecurity (Figure 4).

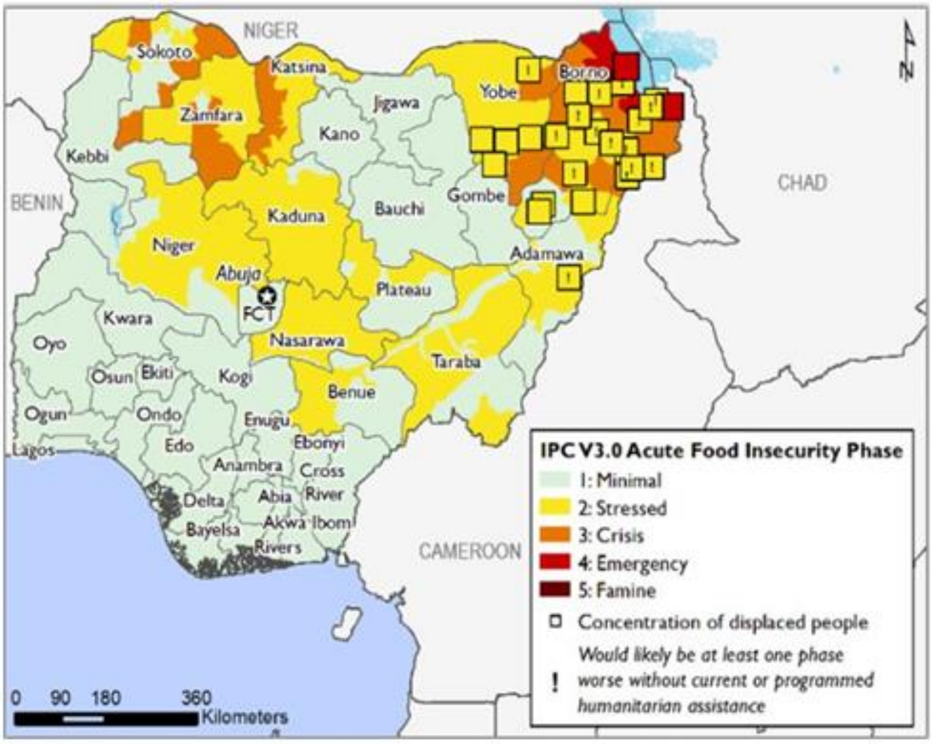

Figure 3. Political Map of Nigeria showing level of food insecurity
***Source*:** https://fews.net/west-africa/nigeria/food-security-outlook/february-2021

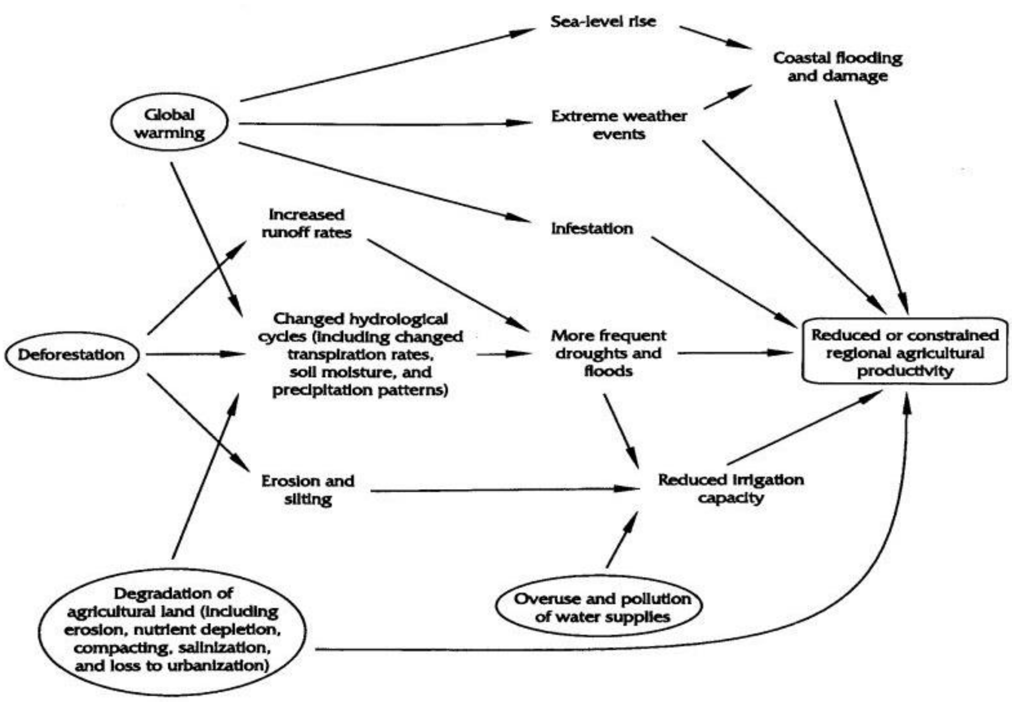

Figure 4. Impacts of environmental factors on food production
***Source*:** Homer-Dixon, T. F. (1999) *Environment, scarcity, and violence.* Princeton University Press

Food and Agriculture Organisation (2021) reported Nigeria alongside Burkina Faso and South Sudan as countries where sharp conflict related increases in acute food insecurity have been observed. This confirms conflict and insecurity constitute primary driver of food crises which degenerates into food insecurity. While these factors are not exclusively responsible for food insecurity, conflict and insecurity frequently interlink with – and sometimes exacerbate – other factors such as environmental and political situation.

In the northeast alone, about 8.7 million people face food insecurity. This is due to the Boko Haram insurgency leading to massive population displacement in Adamawa, Borno and Yobe especially. These staggering statistics of food insecurity in Nigeria is a consequence of both immediate impacts of environmental insecurity as well as the second order impacts of the environmental issues.

Nigerians have become vulnerable to food insecurity as a result of forced migration from farming area as well as human insecurity evident in violent clashes between rival groups in the struggle for control of land and water resources, banditry, insurgency and militancy.

In the ND, oil spills and leaks often lead to explosion which also becomes bush fire in vegetated areas. Such fires disrupt the ecosystem and destroy some elements such as the organic matter content of the soil, plants as well as animals.

Okoli & Ifeakor (2014) reported that 25% of carbon dioxide emission in Nigeria owes to bush burning which contribute greenhouse gases. These all have serious implications for food security in the region. Loss of arable land resulting from bush burning hampers crop production and farmers are forced to abandon farming for other livelihood activities. Also, oil spills has had a significant influence on the Niger Delta’s mangrove forests and fisheries resources. This loss of arable land and fishing grounds has increased criminal engagements.

Similar consequence of bush fire results from gas flaring. The burning thick smoke that billow from the different flaring sites constitute environment-damaging components capable of destroying vegetation, suppressing plants’ growth and flowering (Oka, 2017). An area of such becomes inhabitable for farmers, fishermen and hunters just as other dwellers owing to excessive perspiration and increased temperature of human metabolism caused by excessive heat. This means, food production is threatened as more people change job from farming which is the bedrock of food security. Gas flaring also makes the environment less productive for food production ventures, especially farming and fishing.

Gases flared into the biosphere contains carbon dioxide and chlorofluorocarbon which cause greenhouse effect and also cause acidic rain which pollutes water resources needed for lucrative farming and fishing activities. It needs no reiteration that fishing in the Niger Delta has also been affected by air and water pollution which is not unconnected to oil spillage and leaks as well as toxic waste dumping in water bodies in the area. Agricultural output is thereby reduced due to loss of arable lands and water resources to toxic wastes.

CONCLUSION

The security or otherwise of the Nigerian geopolitical construct is a reflection of its environmental security. Underlining most insecurity challenges such as banditry, farmer-herders crisis, cattle rustling, oil theft and bunkering are unaddressed environmental issues. Desertification in the north is claiming arable lands and shrinking water resources for pastoralism. It has occasioned migration down south and heightened competition for limited land and water resources in the middle belt and southern regions. Biospheric pollution in the oil-rich Niger Delta has also led many into criminal activities that threaten human security. The intricate interconnectedness of environmental security with human and food security cannot be overemphasised. Hence, addressing the man-made and nature induced environmental issues constitute the roadmap to a strengthened national security as well as global peace.

RECOMMENDATIONS

This study recommends that;

a. ministries of environment and defence should collaborate to develop an environmental security concept within the larger debate that redefines traditional conception of national security
b. government agencies and private sector should keep to the goal 8 of Sustainable development
c. government should provide water resources through irrigation and dam system for competing pastoralists and farmer groups in the north, middle-belt and south of the country
d. relevant agencies should ensure industrial and extractive activities especially oil exploration is carried out within the carrying capacity of the environment to enable renewal
e. protection of buffer states from desert encroachment
f. policing of territorial waters to prevent access to transnational merchants of waste
g. enforce environmental protection protocols
h. government should see to the due compensation of Niger-delta people by oil multinationals owing to loss of livelihood from degraded environment
i. government should divestment from non-renewable energy and invest heavily in renewable energy
j. people should contribute to *global* efforts in abating environmental challenges such as climate change and loss of biodiversity through environmental protection and sustainable practices.
k. people should embrace alternative sources of energy for domestic use especially in dessert prone areas so as to conserve forest resources and reduce biospheric pollution.

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Article submitted to the Proceedings Book of the VIth. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

AN ASSESSMENT OF THE PRESENT CONDITION OF A WETLAND IN A DEVELOPING CITY: THE CASE OF PALLIKARANAI MARSH, CHENNAI, INDIA

Mythili MADHUSUDHAN[1*], N.K.AMBUJAM[2]

[1]School of Architecture, Meenakshi College of Engineering, Tamilnadu, India
Email: mythili.m@mce.edu.in, [2]Centre for Water Resources, Anna University, Chennai-25, India, Email: nk.ambuj@gmail.com

The impact of human habitation on ecosystems in developing countries, while studying the case of a wetland situated in the city of Chennai, India, is the focus of this paper. City growth resulted in increased attention towards the wetland site and simultaneously, an influx of population in this area. This also resulted in shrinking of the marsh accompanied by deterioration of nearby water bodies. Highlighting the need for appropriate monitoring of environmental resources, the region could be viewed from the perspective of sustainable management and tools for the same are called for. Time series data from Landsat images and historical cadastral maps from the same time period are used for analysis. Trend analysis, studies from secondary sources, field observations and key-informant interviews have culminated in this research. The primary losses were found to be in terms of landscape value, changes in hydrology, biodiversity and anthropogenic impacts. The authors have found that in this transformation of the water-landscape, the problems characterizing the resultant urban unit such as inundation and storm water conveyance are a direct consequence of the loss of natural resources, and this emphasizes the need to save the water body. The present condition of the marsh is thereby evaluated, the major issues examined and recommendations for the governing authorities and the public are made.

Keywords: *Impacts of urbanization, Eco-social, Water bodies and Wetlands, Land use Land Cover changes, Mapping of Water bodies, Chennai, Pallikaranai marsh*

INTRODUCTION

The transformation of eco-social landscapes (1), its drivers and consequences have caught the attention of ecologists, landscape architects, urban planners and engineers alike. Cities often prioritize economic growth over the environment, and in the case of Chennai, India, one can see the city boasting of 'Lakeview roads' on reclaimed land, once water bodies. Incidentally, land reclamation is not an uncommon occurrence in many cities in India, such as Mumbai (2), Kolkata (3), Bengaluru (4), Hyderabad (5) besides Chennai (6). This paper addresses and approaches urban water bodies and wetlands, giving due attention to recent research which highlights the possibility of the emergence of 'novel ecosystems' (7) or 'hybrid ecosystems'(7) through dialectic interaction of competing human occupation and natural processes.

Wetlands have biological and sociological implications on the lives of people. Wetlands may be inland or coastal, including human-made wetlands (such as rice-paddies, dams, reservoirs and fish ponds). Wetlands are central to water and food security of the region. On a global scale, the aggregate value of the ecological services generated by wetlands has been estimated to be $4.9 trillion/year (8). In all, these comprise the various ecosystem services provided by wetlands, which are of provisioning, regulating, cultural and supporting types (9,10). The Millennium Ecosystem Assessment identifies 14 ecosystem services (11), though certain other sources give larger numbers.

Wetlands are a coalesce of land and water, combining the characteristics of terrestrial and purely aquatic ecosystems. The primary characteristics of wetlands include the presence of water at or near the surface at least for part of the year, plants sensitized to wet conditions (hydrophytes), and soils that are saturated or flooded long enough to develop anaerobic conditions (hydric soils) (9). Management of wetlands is not given adequate attention in the national water sector agenda (12). At an international scale, it has been seen that the city wields greater power for the promise of economic growth and increased prosperity. In China, (13,14) in spite of establishing more than 550 National Wetland Nature Reserves and 100 National Wetland Parks the annual rate of disappearance of wetlands is still around 1%. In certain parts of the USA, wetlands are being conserved by mitigation in alternative sites (15) or by 'habitat conservation plans' (16). In Canada (17); population and industry are found to be responsible for wetland loss in spite of conservation agencies like Ducks Unlimited Canada. In Brazil, the inclusion of wetlands in the Ramsar list has ensured wise-use of wetlands (18). In Bogota (19), Kakadu wetlands, Australia (20), biodiversity has garnered attention and in Lagos (21), Zimbabwe (22), Dhaka (23) and SriLanka (1,24), there are instances of encroachment or myopic development plans on the part of the government. At this juncture, one may need to recall Henry Lefebvre's theory of the production of space and right to the city, in which he argues that urbanization is a significant part of the changing world which may generate conflicts over land (25).

The Pallikaranai marsh, one of the few and last-remaining natural marshes of southern India (26), extended to more than 5000 hectares 60 years ago (6,26,27) and now stands reduced to one-tenth of its original area. It was subjected to various human-centric activities like development of roads and urban infrastructure, establishment of a dump yard on its surface water, due to its non-recognition as a wetland. Though the marsh has evoked some public awareness, the inhabiting community continues to face negative consequences. The drivers of these changes, extent of losses and possible mitigative solutions need to be identified at the earliest.

This study illustrates the use of remote sensing and GIS techniques in the analysis of wetland catchment (28–30) as a prerequisite for outlining restoration measures. The methodological focus of this paper is the utilisation of cadastral maps worked with Arcgis software (31) and Landsat satellite images used to perform a study of land use conditions over four decades. Even though scientific studies of the Pallikaranai marsh by various individuals and agencies exist, they primarily deal with water quality, environmental impacts, and biodiversity, whereas this study is of a socio-spatial kind and is based on an understanding of the existing conditions from documented sources and field conditions.

In this paper we address the following research questions investigating the social and land use drivers and consequences of ecological transformation of the wetland under question.

- What are the kinds of eco-social changes occurring in the wetland?
- What are its drivers and consequences?
- How did incremental ecological changes add up over time into an overall transformation of ecological and social character of the wetlands?
- How can we enable the present financial capital and social capital to enhance ecological capital in the study area?

The paper is structured as follows: firstly, the introduction and statement of objectives followed by description of study area, followed by the methodology adopted, which is followed by an explanation of results obtained and discussion based on issues relating to the eco-social changes and environmental drivers, concluding with recommendations.

MATERIALS AND METHODS

Study Area

Pallikaranai Marsh, situated on the geo-coordinates of 12.949371°N latitude and 80.218184°E longitude, is among the last existing natural wetlands of Chennai City, India. Locally known by the generic Tamil name 'Kazhuveli' which translates to 'marsh' or water logged area (6), the marsh is bound in the east by Old Mahabalipuram Road (OMR), in the west by Tambaram-Velachery road, Velachery village and Velachery lake in the north and by Medavakkam-Karapakkam road on the southern side. It drains about 250 km^2 area through two outlets viz., Okkiyam Madavu channel and the Kovalam creek and empties into the Bay of Bengal (Figure 1). The marsh area had spread to an extent of 6000 ha (60 km^2) around the 1906s, of which there is a 90% loss of habitat resulting in the presence of only 593 ha of marsh at present (26). In 2007, the State Government, in response to an advocacy programme of a concerned NGO (Non-governmental organization) and civil society network (26), known as 'Save Pallikaranai Marsh Forum', notified the southern portion of the marsh spanning 317 ha initially, as reserved land which was later upgraded to Reserve Forest.

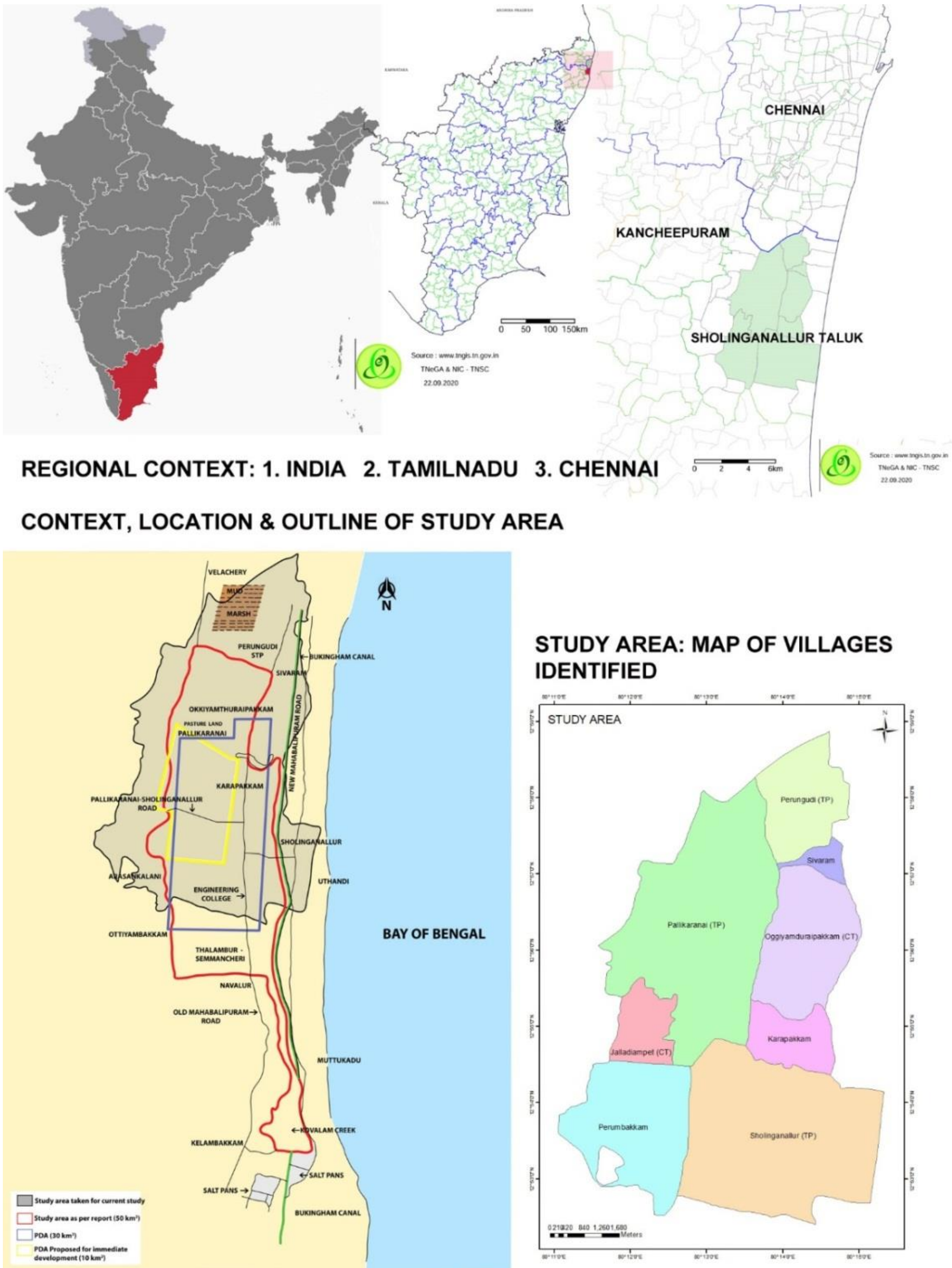

Figure 1. Study area, **Image source: Author**

The first master plan for Chennai Metropolitan Area came into effect in 1975 for a period of 20 years till 1995 (32). The much-delayed second master-plan was approved by the government only in 2008 (32,33). In 1993, Chennai Metropolitan Development Authority (CMDA), the predicated planning authority of the state, engaged consultants to study Pallikaranai and propose measures for drainage of the region. They facilitated a Flood Relief Storm Water Drainage Master Plan Study (34,35) which recommended that the ‘Pallikaranai Development Area’ ‘could be developed as a light/medium scale industrial area without much adverse environmental impact’. This sums up the planning history of the Pallikaranai region from the governmental perspective.

As for the public perspective, this part of the city achieved a hitherto unforeseen popularity as a real estate destination for buyers big and small, following the construction of the road, hereafter referred to as 200 ft Radial Road, the Mass-rapid transit system (MRTS) and a series of grandiose residential projects in the early 2000s (36,37).

With reference to the CMDA study on drainage and the subsequent Environmental Impact Assessment (EIA) (35) addressing the wetland area and its catchment, it is intended to address this associated wetland area in our work. Thereby, a study area surrounding the Pallikaranai village (village is the term for the unit of administrative boundary) including seven villages, comprising an area of 5657.032 hectares has been identified. The villages identified include, Perungudi, Seevaram, Okkiyamthoraipakkam, Karapakkam and Sholinganallur on the eastern side and Pallikaranai, Jalladampettai and Perumbakkam along the west. Pallikaranai village includes most of the present extent of the marsh.

Analysis by geospatial methods

In an effort to study the available records relating to water bodies from older revenue maps, the maps dating to the year 1985 were obtained from the Survey and Settlement Department, Survey House, Chennai. These maps were scanned to a resolution of 300 dpi and joined and stitched together using Adobe Photoshop software.

The tiff layer comprising the merged maps was then georeferenced. These maps were used to create a layer comprising of the water bodies in Arcmap, following Madry et.al., (31). This layer of water body polygons was digitized in a scale of 1:8500 from the cadastral maps. It gives the location, exact outlines, areas of the water bodies in vector format and acts as a database for the period before the present spate of urban development. The numbers and areas of water bodies in the abovementioned eight villages were obtained from the Arcmap attribute table.

In order to determine extent of various land use changes and to obtain changes in water extent, remote sensing methods were used. Using the boundary described in the introduction, Land Use Land Cover (LULC) classification was performed. Landsat images were acquired from USGS Earth Explorer and processed. Post-monsoon imagery from the month of February for all four decades was used. The images date to, 6 February 1988, 17 February 1998, 29 February 2008 and 25 February 2020. The first three are Landsat 5 “TM” images and the fourth is Landsat 8 “OLI_TIRS”. All of them are of spatial resolution 30m and sourced from USGS Earth Explorer.

The images were classified with the help of Erdas imagine software and processed in Arcmap 10.0 (38). An appropriate number of bands were classified in each case, including visible and near infra-red (and in Landsat 8, SWIR 2 also) to obtain a land-urban false color composite showing vegetation, water and built-up areas. To obtain changes in land-cover dynamics, NDVI and NDWI were also mapped for the four years.

Classes identified for LULC

For the LULC, five classes were identified in the images which decreased to four classes in the more recent images. The classes include vegetation (including vegetation covering water, urban, mangrove and scrub vegetation), water body (including wetlands, tanks, canals, streams and shallow water), marshland (seen in some imagery around water bodies), sand (mixed barren land and along the coast) and built-up cover class (including residential, commercial, industrial, transportation and mixed-use and utilities).

The watershed basin of the study area is also delineated with the help of Arcmap software using the DEM file from the National Remote Sensing Centre (NRSC) Bhuvan source. The basin profile for the study area is thereby provided in the map. A comparative study of the existing water bodies from the 1985 revenue maps, and the state of the corresponding water-bodies in latter period, viz., 2008, sourced from the CMDA masterplan maps, exhibits certain trends (39). The water bodies were identified by comparing their survey numbers and their areal extents were determined by Arcmap software.

RESULTS AND DISCUSSION

The results demonstrate that Pallikaranai wetland and its associated regions were impacted both by government decisions to develop the region and encourage industrial growth and subsequent urban development, and public behavior, viz., population dynamics, migration and occupation of lands in proximity to the water body, encroachments by public and private bodies and lack of attention.

Changes in wetland and watershed land-use

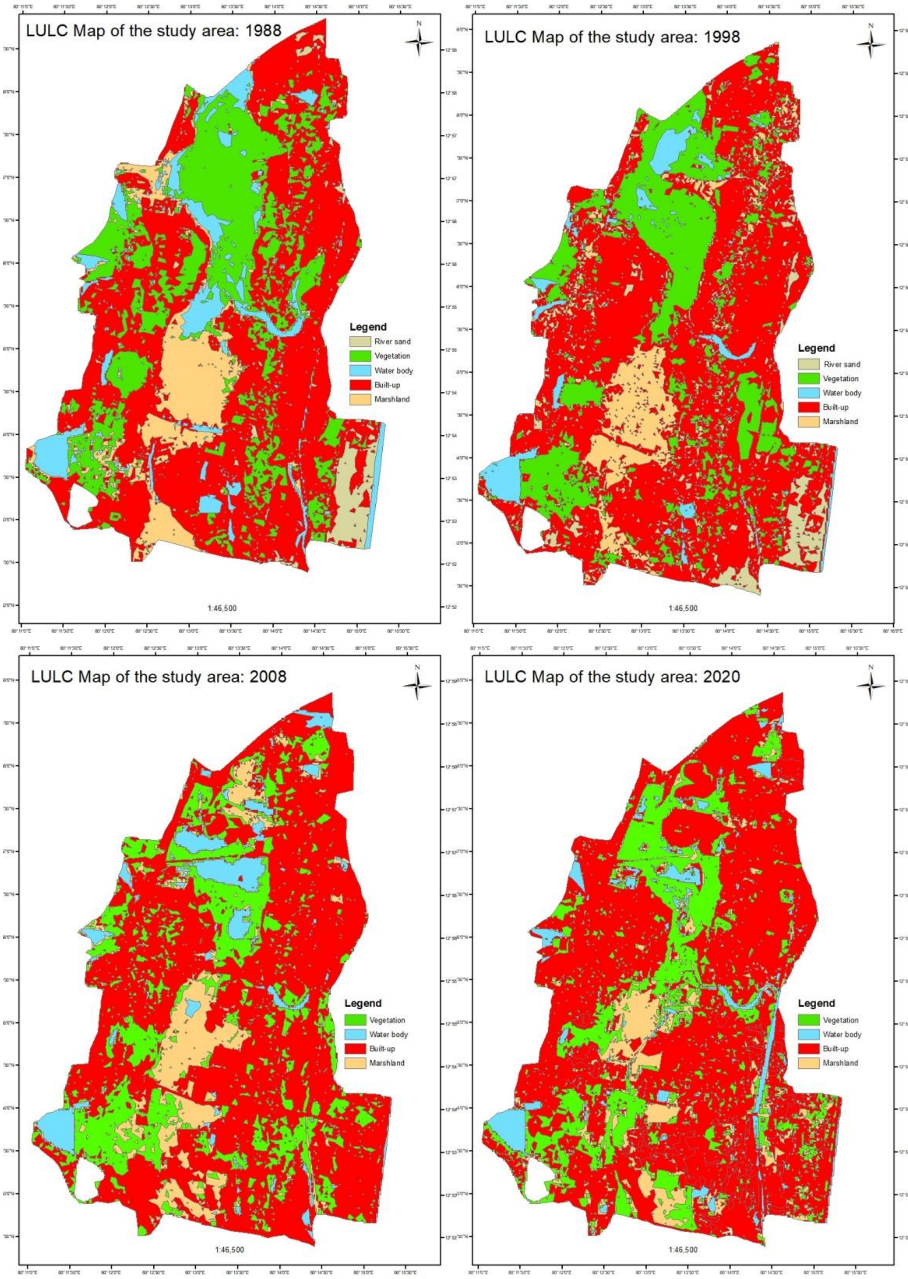

Figure 2. Land Use Land Cover analysis maps. **Image source: Author**

LULC change status 1988

The findings of the 1988 imagery classification are as follows. Vegetation is present both covering the water bodies and in the land area. A number of water bodies are also seen in this stage. A fair extent of marshland and sand cover class is visible all over the extent. Built-up cover class is seen

occupying the rest of the area to an extent of 51.68% of the total area. Vegetation area totally occupies 25.91% of the total area.
The prevalent landscape comprised of numerous water bodies as studied from the revenue maps, including the marsh and the channel, and wetland vegetation including grasses and other varieties were supported by it. These features predominated and further, marshland and sandy soil were present and only the rest was built-up cover class occupying 51.68% of the area boundary. In 1985, Pallikaranai was not very much urbanized, agricultural villages were present and water availability was copious. Numerous canals were found in the revenue maps in some villages and correspondingly the water extents as seen in the LULC analysis are higher.

LULC change status 1998
The findings of the 1998 imagery classification go to show that vegetation is present covering both the water bodies and the land area. This is indicated by the extent, and may include both deep and shallow water areas. The extent of marshland and sand has decreased compared to the 1988 extents. Built-up cover class occupies the rest of the area and has gone up to an extent of 58.57% of the total area. Vegetation, in this analysis, occupies 22.32% of the total area. The extent of water body appears to have decreased.
The marked change in the 1998 study happens to be the introduction and growth of the dump yard on the water body, seen in the north-eastern side of the marsh boundary. Vegetation has begun to disappear on the western side of the marsh and water bodies and vegetation on the eastern side of the marsh have also disappeared and are replaced by built-up areas. Subsequently the marshland area has also been thinning along the edge. This may be the effect of the 'Pallikaranai Development Area' policy mentioned earlier.

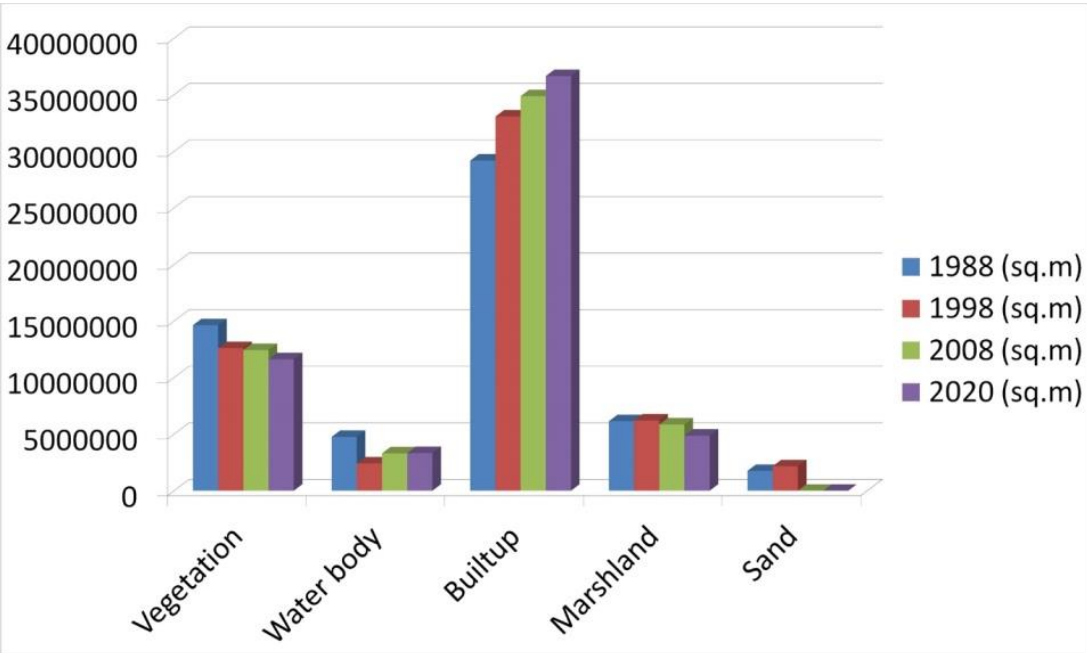

Figure 3. LULC analysis data

LULC change status 2008
The findings of the 2008 imagery classification show that the extent of vegetation has come down to 22.02%. The major difference in this decade is the introduction of the 200ft Radial Road, dividing the marsh, running along the east-west direction. This road was added in the early 2000s and it divided the marsh physically, with a number of culverts beneath, to convey storm water flow. It has led to a plethora of inundation issues and with the passage of time, sedimentation and accumulation of deposit, there has been a reduction in availability of water. In this map, more water extent is visible and is exposed (less covered by vegetation), suggesting an area greater than in 1998, but it may be shallower

water. Built-up area has increased compared to 1998, to 61.77% and marshland is still present, exhibiting a decreasing trend. Areas which were classified as sand in the previous years have become urbanized in this stage and hence its value is zero.
This is the period succeeding the introduction of the east-west 200-ft Radial Road, which divides the marsh into north and south fragments. The growth in the dump yard is visible in this map. Connectivity between east and west has seen an improvement because of this road and hence urban development (to an extent of 61.77%) and subsequent disappearance of water bodies and vegetation.

LULC change status 2020

The findings of the 2020 imagery classification are: vegetation extent in this map covers an extent of 20.58% and has come down. The proportion of water body also has decreased compared to 2008 and built-up area exhibits a drastic increase to the extent of 64.94%, post economic cum infrastructural development which forms part of the region.
The IT (Information Technology) Expressway, which is home to a number of multistoried commercial and residential buildings, the 200ft Radial Road mentioned earlier, and the Velachery-Tambaram Road, which connects to the south-western part of the city, have spurred a city expansion at a relatively rapid scale. Incidentally, the Old Mahabalipuram road (IT expressway) and the Velachery-Tambaram Road were identified from as far back as 1975 in the topo sheets that were digitized and surveyed. Built-up cover class has taken over completely and vegetation (20.58%), water body (5.89%) and marshland have dwindled. The dump yard also seems to have grown as seen from its enlarged outline.

Accuracy assessment of Land covers classification

To assess the accuracy of the LULC classification, around 600 raster cells were randomly selected, converted into polygons and transferred to Google Earth. The predicted classification, as obtained from ArcGIS was compared with actual land cover classes for these cells numbering approximately 600. Based on this error matrices was computed and overall accuracy was estimated to 95.5% for the year 2008 and 93.2% for the year 2020 (40). Since Google Earth images were available only for these periods, we have used this methodology for those years only.

Disappearance of water bodies and related issues

Simultaneously, the water bodies covering the whole study area were mapped for the years 1985 and 2008 from cadastral maps and second master-plan land use maps from the portal of the CMDA (41) respectively. The changes in the water extent according to this data are presented below.
The various types of water bodies in the study area date back to much earlier times, and bear historical names, with generic names like ‘kulam’ (for bathing), ‘kuttai’ (for rainwater collection), ‘thangal’ (other types of water bodies) (42) and also ‘natham’ referring to commons.
The water bodies were both of natural and manmade types and though many occurred in common lands, some were privately owned and some were registered in recent times by individuals. The information on status of water bodies, land use and ownership was sourced directly from the Public Relations Officer of the Collectorate by filing an RTI (RTI stands for Right to Information Act, 2005 which enables citizens to access data which is not directly available) application.
Information obtained reveals that in the village of Okkiyamthuraipakkam, 14 water bodies still exist out of the 32 identified in from the 1985 map all of which are found to have been converted to other land uses in the masterplan.
In Pallikaranai 6 water bodies out of the 14 numbers identified from the 1985 map are still existing while other water bodies have transformed into built-up areas (it is interesting how the streets in these built-up areas follow the shape profile of the water body formerly in existence), and in Karapakkam, 3 water bodies out of 10 are still existing all of which are shown as other land uses in the master plan.

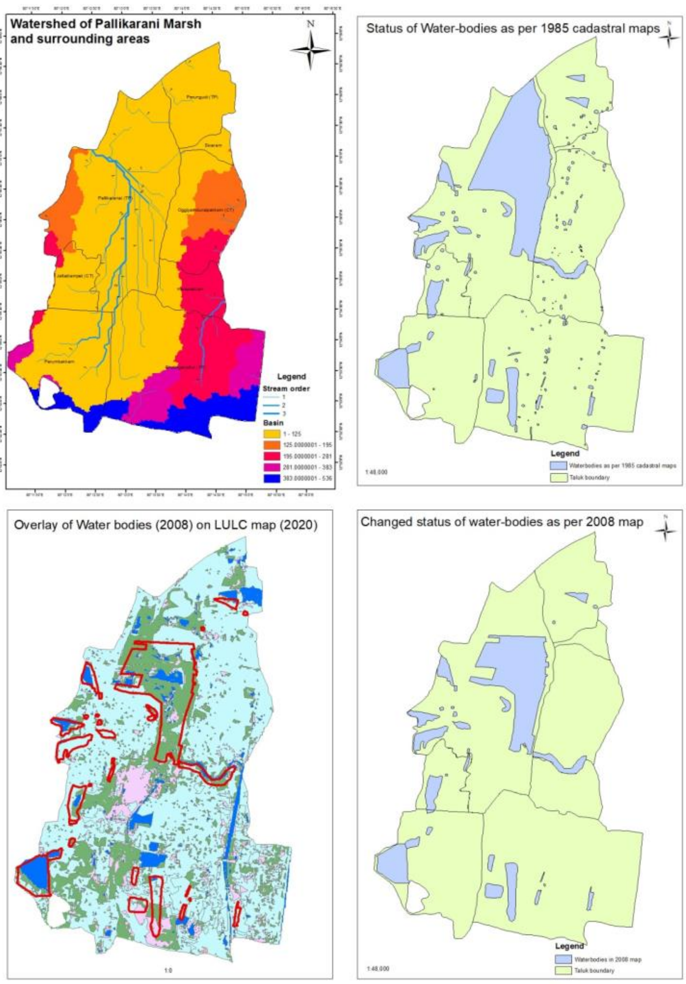

Figure 4. Water body analysis maps, **Image source: Author**

This could also be because the concerned department records were outdated, but an observation from Google Earth engine reveals that these parcels are existing as shrunken water bodies or regions which get inundated in monsoon and remain dry otherwise. Further, the webportal data from the CMDA was examined to collect details from the available dates viz., 2001 onwards, for the villages under study. Predominantly in the cases of Perungudi and Jalladampettai, and also in Pallikaranai, Perumbakkam, there are mentions of land registration to residential use and rarely to other uses, adjacent to water bodies as can be ascertained from the survey numbers of parcels (41).
Also in Perungudi village one of the water bodies extending to an area of 6.23ha has now physically transformed into a residential area known as 'Ambedkar Nagar'. This was noticed while comparing the historical revenue maps and later land use maps and this became the empirical motivation of this paper. Land use change is one of the most important influential factors in wetland condition according to Zhang (14).
The water body analysis maps show the hydrology of the region, analysed from DEM source (top left, Figure 2).
The ArcMap shapefiles of 1985 (top right) and 2008 (bottom right) and the overlay of the Arcmap 2008 shapefile layer on the LULC classification of 2008 (bottom left) are seen in Figure 2. This analysis details the loss of water resources and magnitude of the loss with data that is 23 years apart. The pie-charts in Figure 3 indicate the change of water bodies to various land uses for each village.

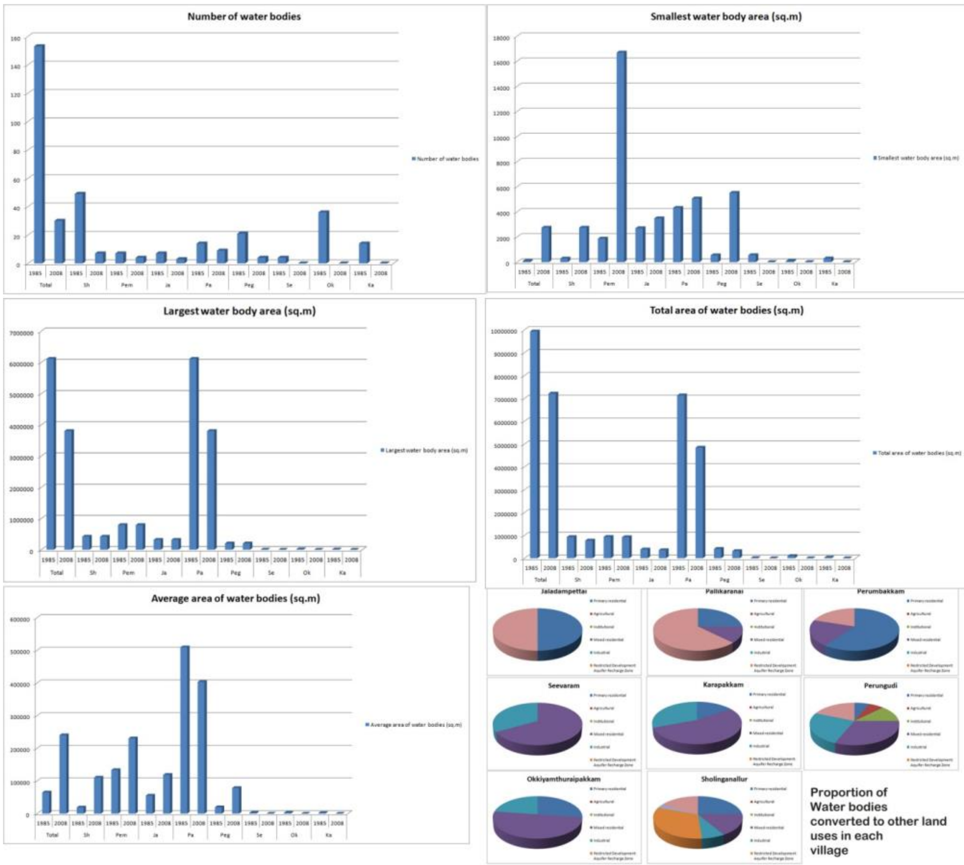

Figure 5. Water body analysis data, **Image source: Author**

The (bottom-left) map in Figure 2 shows the overlay of the outline of water-bodies layer from the 2008 delineation on the LULC classification of the most recent data. From this we can observe the extent of water-bodies as per both datasets. The revenue maps outline shows the remnant water-body outlines and the classified data show the extent of available water as per recent data. How the two correlate is a direct visual observation. It can be observed that there is no coincidence of data in some places implying as we have been observing, that water bodies have disappeared, and in some places, water bodies have shrunk either marginally or grossly.

History of land-use and other changes in the wetland area and associated regions

As early as 1985-86 Pallikaranai was identified by the Government of India as one of the 94 wetlands under the National Wetland Conservation Programme (NWCMP) (43,44). In 2007, the state government (26,44) declared (Gazette notification GO. Ms. No. 52, Environment dated 9th April, 2007) a portion of the Pallikaranai marsh (3.17 sq.km) as a reserve forest under Section 4 of the Tamil Nadu Forest Act, 1882 after understanding the ecological importance of the marsh in the city context (6). In 2012, 115 wetlands were listed under the National wetland conservation programme by MoEF (Ministry of Environment and Forests) and this list includes Pallikaranai (45).

Public movements like the 'Save Pallikaranai Marsh Forum' gained a lot of attention and attracted media support and also response from the government. In 2011, an Adaptive Management plan for the Pallikaranai marshland was prepared by a Chennai-based NGO Care Earth, in order to ecologically conserve the marsh. In the same year, the process of handing over the marshland following a request from the forest department was initiated and the forest department plan was to undertake restoration of the marshland. In 2018, the state government announced that it would commence the restoration of 695 hectares of the wetland under the National Adaptation Fund for Climate Change over 5 years from 2018 to 2023 (46). But there are shortcomings in the pertaining law particularly with the 'wise-use of wetlands' as stipulated by the Ramsar convention. The Wildlife (Protection) act of 1972 provides for the establishing of sanctuaries, and wetlands which fall within the protected area are protected. But grazing is strictly banned within a sanctuary, and this reduces human impact and influences the wetland ecosystem once it is declared as a national park. This and other aspects of the functioning of the forestry department imply that the areas with highest protection are not capable of protecting in the manner of 'wise-use of wetlands' (47).

Hydrological changes and history of flooding

As discussed, the 200ft Radial Road divides the marsh into two fragments and constrains the flow of water from north to south. There are primarily two instances where it has been felt that storm water flow is constrained and needs to be improved. One is with respect to the culverts beneath the 200ft Radial road, which amounts to only 2.6% of waterway provided compared to the total length of the road dividing the marsh (48). In the past 2 years, construction of drains and widening of waterway has been underway, to regulate the man-made impediments and allow for better conveyance of flood waters. Encroachments in the northern half of the marsh also impede flow towards the south.

The other instance is the channel which is historically a salient feature of the Pallikaranai marsh, the Okkiyam Maduvu channel, flowing in a south-eastern direction which helps in draining the marsh into the Bay of Bengal. It also permits flow from the sea, which sustains the partly saline ecosystem of the marsh. Widening of the Maduvu has been discussed, and recommended by a few. For instance, Andimuthu et.al., (49) have studied flooding impacts in the region at various hotspots and recommend deepening and widening of the Okkiyam Maduvu channel in order to improve its carrying capacity. But ecologists have expressed concern about the impacts of such physical interventions.

Changes in vegetation and ecological characteristics

The landscape surrounding the Pallikaranai marsh was a predominantly agricultural landscape. Local people who have been over time a part of these villages, have stated they grew paddy and horticultural crops using only water that inundated the area, without dug-out wells or ponds in the vicinity. The wetland habitat constitutes aquatic grass species, scrub, marsh and water-filled depressions. The abundantly growing Typha and other aquatic macrophytes have been found to serve as bio filter for the wastes discharged into the wetland. The species inventory carried out in the preparation of the report by Centre for Climate Change and Advanced Research (CCC & AR), Anna University (50) states that 90 species belonging to 77 genera of 36 families are found to be present in the marshland. The marsh being a source of livelihood to many locals has been discussed in a 2007 report which explains that inhabitants of seven villages partially depend on the wetland for subsistence. Of these some ethnic groups are highly reliant, including for fishing and reed-gathering, grazing and agricultural groups (36).

Demographic and Socio-economic changes

The population density of Chennai city changed from 186.65 P/Ha in 1981 (51) to 265.53 P/ha in 2011 (52). The population density of Pallikaranai town panchayat (Town panchayat is the current administrative status of Pallikaranai which lies within the Chennai corporation) changed from 2.225 P/ha in 1981(51) to 25.05 P/ha in 2011(52). According to the 2020 data, the population of Chennai as a percentage of India's population is 0.312%. The population of Pallikaranai as a percentage of the city population has increased from 0.12% in 1981(51) to 0.613% in 2011(52) which implies that the average decadal increase in population of Pallikaranai town panchayat is 0.164%. Key-informant interviews including technological experts and about 55 residents in surrounding the marsh from a radius of 1-5km from the marsh edge revealed that there has been a huge migration into this region since 2000 onwards. The interviews covered a range of topics including topography, sociological status and occupations, infrastructural improvements, policies and changes in administration, changes in flora and fauna and the public view of the marsh, in terms of their perception of ecosystem services. The images in Figure 4 from Google Earth historical imagery show the southern portion of the marshland including the channel, Okkiyam Maduvu, the extent of urban growth and nature of the water body on 17-09-2002 (above) and 28-11-2020 (below).

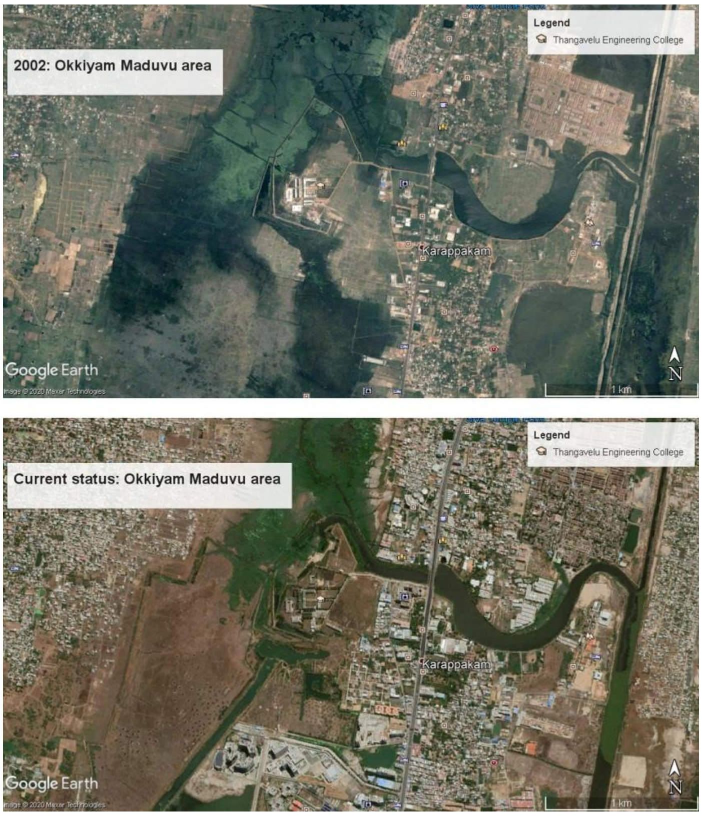

Figure 4. Change in Marsh condition 2002 and 2020, **Image source: Google Earth**

State of anthropogenic changes affecting the environmental quality of the wetland: whether to the extent of an emerging 'novel' or 'hybrid' ecosystem

Severe environmental degradation especially in terms of water quality, both groundwater and water in the marsh has been noted since the late 90s. The challenge involved with respect to this marsh is that the aquatic grasses or reeds may eventually transform into a terrestrial ecosystem which is part of the evolution process. As such, the influx of saline water from Okkiyam Maduvu and its mixing with freshwater is sustaining the marsh. Inundation, siltation, pollution of land and water are having an impact on the soil-water-vegetation interaction which is peculiar to the marsh and these effects may have compounded into the evidences of a 'hybrid' ecosystem (1,7), acknowledging the data on environmental quality from studies (6,43,53,54). How stable the ecosystem can be and to what extent will the impact of negative uses and activities be overcome is hard to predict.

CONCLUSION

In this context, one needs to dwell upon certain key aspects resulting from this discussion. These aspects may be listed as (i) the Society-Nature Cartesian divide which has come about from western philosophy and engulfs our thinking where society is the one and nature is the 'other' and turns nature into merely a passivity (55). (ii) there needs to be a complete thinking through or rethinking or rather, unthinking of our convention-based understanding of the natural sciences and its relationship to sociology, and hence to society. This will emphasize the fact that the crisis we are witnessing is to be seen not as an environmental crisis but as a crisis of society or a crisis of modernity.

As outlined in the introduction, from our analysis we have tried to bring out and discuss the eco-social changes in the region and drivers that led to the environmental and social modifications in the marshland and associated regions. Over the period from 1985 to the current times, incremental changes have compounded into an ecological transformation and this has led us to ponder how to address this region for developing policies and to what extent the damages resulting from anthropogenic activities will be acknowledged in the context of decision making for the future. The development agenda typically deals with water resources from a sectoral perspective, and like we have mentioned earlier, wetlands do not find a mention in the National Water Sector agenda. In these circumstances bottom-up measures can be given priority, and it is essential for planners to acknowledge the needs and stewardship of the resident community. Community engagement is needed (25) while social capital and financial capital need to reinstate the benefits of a flourishing ecological capital. Studies that promote a pro-wetland governance, and making such information available in the public domain and spreading the ideas for the benefit of all are the need of the day.

Authors contribution: Conceptualization: Mythili Madhusudhan & NK Ambujam; Methodology: Mythili Madhusudhan & NK Ambujam; Formal analysis and investigation: Mythili Madhusudhan; Writing (Original draft preparation): Mythili Madhusudhan; Writing (Review & editing): NK Ambujam; Resources: Mythili Madhusudhan; Supervision: NK Ambujam

Biographical notes:

Mythili Madhusudhan, B.Arch., M.L. Arch., is a landscape architect and professor in School of architecture, Meenakshi College in Chennai, India. Her interests include landscape design, urban ecology and landscape urbanism theory. She is currently pursuing her doctoral studies.

N.K. Ambujam is a professor in Centre for Water Resources, Anna University for over 35 years. She is a pioneer in the field with many publications in international journals and fellowships.

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Article submitted to the Proceedings Book of the VIth. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

PROSPECTS AND GEOTHERMAL POTENTIAL OF MILA

Rima KIFOUCHE*, F. BOUAICHA, H. BOUSBAA, H. SHOUT

Geology and Environment Laboratory, University Constantine 1, Constantine 25000, Algeria
**Corresponding author: kifouche.rima@gmail.com / rima.kifouche@student.umc.edu.dz*

That work deals a determination the geothermal potential and prospects of the Mila region. Thermal baths in Algeria are characterized by a high concentration of hot springs in the North-East of the country. At the last census, more than 282 thermal resurgences have been inventoried in northern Algeria, with temperatures varying between 30°C and 96°C. Geothermal resources in Algeria are of the low-energy type. Three geothermal zones have been delineated according to some geological and thermal considerations: the first: the Tlemcenian dolomites in northwestern part of Algeria, the second: is the carbonate formation in the northeastern part of Algeria and the third: the sandstone Albian reservoir in the Sahara in southern Algeria. Our study area is Mila, is located in the North-East of Algeria, 50km from Constantine, which is part of the Kebir Rhumel watershed, it is characterized by a rugged relief. The geothermal resources of Mila region emerge in favor of tectonic conjugate directions N-S, E-W and NW-SE. Mila region is characterized by a Mediterranean climate, sub-humid in the north and semi-arid in the south. All types of geochemical facies are found: bicarbonate, sulphated and chloride from carbonate formations, gypsiferous and evaporate. Exploitation of geothermal energy remains very limited given the existing geothermal potential, crenotherapy is the main use. Except for a few cases in the south of the country

Keywords*: thermal, geothermal potential, low-energy, Mila, crenotherapy.*

INTRODUCTION

Today, geothermal energy is the third most widely used renewable energy in the world after biomass and hydro. The use of geothermal energy is expanding rapidly; it is developed in about sixty countries, such as the United States, Japan, Iceland, New Zealand, the French Antilles and Switzerland. In Algeria, more than 280 springs have been identified in the North, of which more than 50% are located in NE Algeria.

The emergence temperature varies between 30°C and 96°C. The highest temperature is located in Guelma (Hammam Debagh). These resources would generally come from geothermal reservoirs of Mesozoic age of limestone, sandstone and sandstone type. At depths between 1500 and 2500m [1], their temperature at depth can reach 120°C. The so-called high-energy geothermal resources are characterized by a temperature higher than 150°C and are mainly used for electricity production.

The medium and low energy geothermal resources are characterized by a temperature between 30°C and 150°C and are intended for housing heating (60°C to 80°C), heating of greenhouses, fish farming, etc.

The geothermal resources in Algeria are of low energy type. The first study of the geothermal exploitation program in Algeria began in 1852, M.Ville published his work on "Research on rocks, waters and mineral deposits of the provinces of Oran and Algiers", followed in 1888, J.Bails by a notice on "Thermal and mineral springs of the department of Oran", in 1889 M.Ville publishes a notice on "

Thermal and mineral springs of Algeria". In 1911 Professor Hanriot with the collaboration of Dr. Trolard published his work "The mineral waters of Algeria"; In 1923, 1926 Pouget.I and Chouchak.D published a detailed study on the radioactivity of Algerian waters for the three provinces of Oran,

Algiers and Constantine; In 1940 and 1947 S. Guigue published "The main thermal springs of Algeria". Guigue publishes "the main thermal springs" within the framework of the geological map of Algeria (35 springs and 75 griffons) concerning the geochemistry of the thermo-mineral springs; we can also quote the works of Cornet 1964, in 1966 the company (EURAFREP 1966) with the participation of Cormy. G, Demians D'aurchimbaud. J (Cormy & Demians d'Archimbaud 1970), Jacqmin. M.A, Facca. G in 1966, Marinelli. G and Tonani. F under the direction of the national company of hydrocarbons SONATRACH really begins the research related to the geothermalism in the Algerian North-East; In 1974, the works of the doctor B. Laissoub on the thermalism in Oranie; In 1982 the national company of electric energy SONALGAZ undertook the study of geothermal recognition of the Northern and Eastern part of the country in association with the Italian company ENEL. In the first stage, the geothermal studies concerned mainly the North-East part of Algeria. From 1983, the geothermal work was continued by the Center for Renewable Energies of Algeria (CDER) and the program was extended to the entire northern part of the country; In 1985, H. Dib-Adjoul " Le thermalisme de l'est algérien " ; 2008, Fekraoui 1988; Rezig 1991; Bouchareb-Haouchine 1991).
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Three geothermal zones are delimited according to geological and thermal considerations: the first: the dolomites of Tlemcen in the North-West of Algeria, the second: is the carbonate formation of the North-East of Algeria and the third: the sandstone reservoir of the Albian in the Sahara in southern Algeria
The exploitation of geothermal energy remains very limited in view of the existing geothermal potential, balneology is the main use. Except some cases in the South of the country. This study aims to determine the geothermal potential and prospects of the Mila region. The study area is located in the NE of Algeria, it is characterized by the presence of numerous thermal springs known since the Roman era whose vestiges are always witnesses, the case of the source of Beni Guechat.

Geological and hydrogeogical settings

The wilaya of Mila is located in the North-East of Algeria (Figure 1), at 464m of altitude, being part of the Constantinois tell and belongs to the Kebir Rhumel watershed. It is located 370km from the capital Algiers, 100km from Jijel and 50km from Constantine.
It is bordered in the North and in the South by the parallels of 36°34'33"N to 35°53'08"N and in the East and in the West by the meridians of 5°44'41"E to 6°30'02"E. It extends on a surface of 3480.45km^2, that is to say 0.14% of the surface of Algeria.
The orographic system of the Mila region is complex; it is represented by three types of reliefs: massifs, depressions and high plains.

- A zone of high mountains limiting the wilaya in its northern part which covers 20.8% of the total area of the wilaya. These massifs of WSW-ENE orientation, constitute a rocky barrier which divides the small Kabylia of El Milia in the North and the North Constantinois in the South
- An area of foothills and hills that cover the central part of the Tellian foothills, on an area of 28.8%.
- A zone of plains in the South, covering 50.4% of the total area of the wilaya.

The region of Mila is essentially agricultural, cereals and livestock are the main activities.

Figure 2. The study area situation

The region of Mila is defined by a Mediterranean climate, sub-humid in the North and sub-arid towards the South, with an average annual precipitation of 600 mm and temperatures that are close to 40°C in summer and that fall below zero in winter (Figure 2).

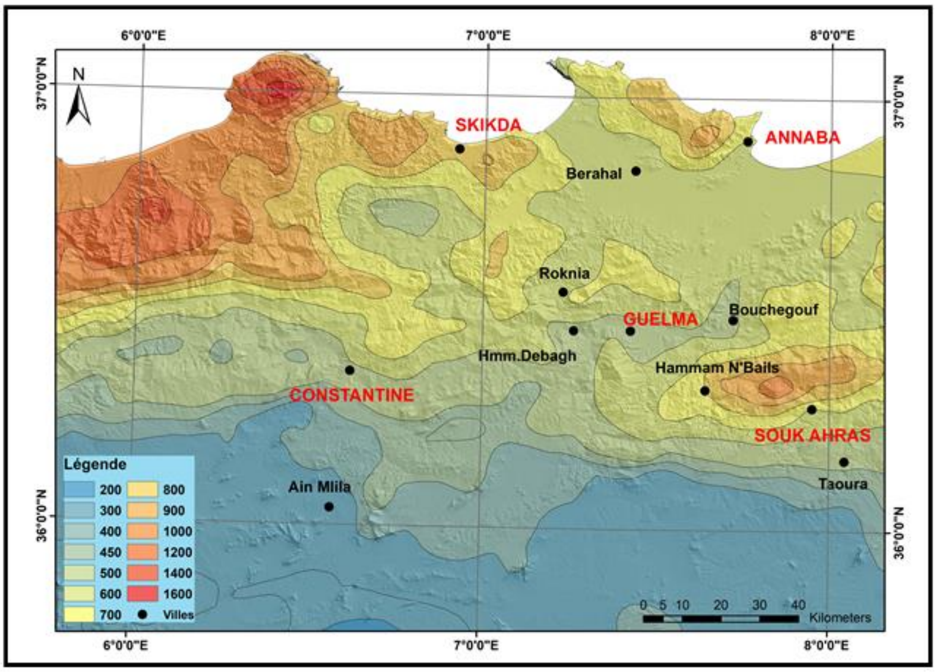


Figure 3. Rainfall average annual map in eastern algeria (ANRH,modified in Bouaicha [4])

A fairly dense hydrographic network, Oued Rhumel which merges with Oued Endja to form Oued El Kebir, Oued Cotton, Oued Seguen, Oued Bou Slah, Oued Smendou... and dams (Oued Athmania Dam, Hammam Grouz Dam and Beni Haroun Dam with a capacity of 960 million m^3 which supplies the neighboring wilayas (Constantine, Batna, Khenchela, Jijel, Mila and Oum El Bouaghi) (Figure 3)

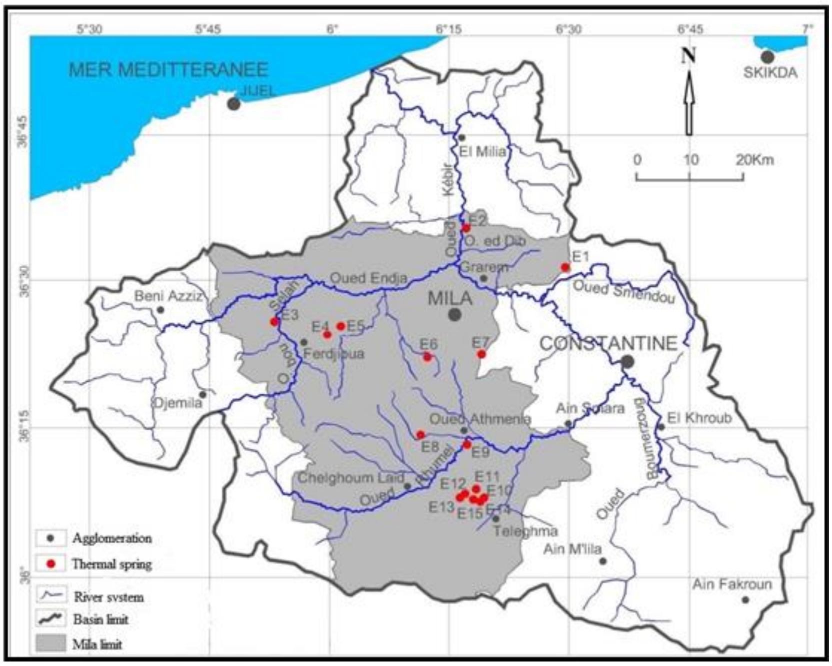


Figure 4. Hydrographical network and inventory of the thermal resources maps studied in the mila region (in Mammeri [5])

The geology of the study area is very complex; it belongs to the Tellian domain which constitutes the external zones of the alpine chain of North Eastern Algeria [3] (Figure 4). It is constituted by formations which spread out from the Trias to the Quaternary, and subjected to the various tectonic phases, in particular the neotectonic which are responsible for the current geological structures and even the emergences of the hot springs.

The lithostratigraphic analysis reveals water deposits with great hydraulic potential constituted essentially by the fissured and/or karstified carbonate formations of the Néritique Constantinois, formed by massive limestones of the Jurassic and limestones and marlstones of the Cretaceous, the nappe pénitellienne and the nappe de Djemila. The Constantine Neogene Basin is represented in the Mila area mainly by Neogene detrital and evaporitic deposits. The Triassic deposits injected along the tectonic faults or outcropping in the form of diapirs have a direct influence on the geochemical facies of most of the hot springs studied.

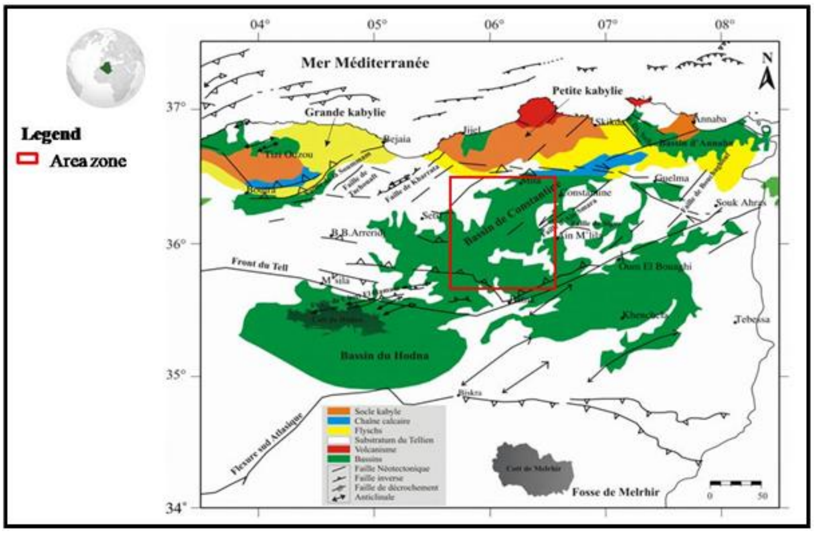


Figure 5. Geological map of study area (in Abacha, modified [6])

MATERIALS AND METHODS

Sampling and analysis

Fourteen main hot springs were inventoried in order to determine their hydrogeochemical composition, these samples were collected in different places in the province of Mila, including Hammam Beni Haroun, Source of Dar Fouini, Hammam Ouled Achour, Hammam Beni Guechat, Hammam Dar Echikh, Hammam Bouhama, Source Ain Tinn, Hammam Etouama, Hammam Grouz, Hammam Ain El Minan, Hammam Ouled Aissa, Hammam Menchar, Hammam Chaouch and Hammam Safsaf [7] (Figure 3).

Physical parameters such as temperature (T°C), electrical conductivity (EC, µS/cm), total dissolved solids (TDS), pH and dissolved oxygen are measured in-situ with a multiparameter type Water Quality Meter AZ86031. The determinations of major elements (Ca, Mg, K, HCO_3, Cl, and SO_4) were analyzed by volumetric titration.

STATISTICAL ANALYSIS AND GRAPHICAL PRESENTATION

Table 1. Values of the parameters of each sample (in Mammeri) [5]

ID	Sample	T (°C)	pH	EC (µS/cm)	TDS	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	HCO_3 (mg/l)	Cl (mg/l)	So_4 (mg/l)
E1	S Dar Fouini	32	6.8	1593.90	1020.09	252.50	40.98	19.40	414.80	106.50	340.00
E2	H. B Haroun	40	7.08	5229.00	3346.56	180.36	36.26	151.70	252.54	340.80	235.00
E3	H. O Achour	39	6.7	4312.68	2760.12	200.40	52.56	180.80	581.94	344.35	145.00
E4	H. Beni Guechat	56.1	6.19	21700	13888	781.56	117.60	5870.29	888.16	10171.87	1155.00
E5	H. Dar Echikh	35	7.47	1338.66	856.74	72.95	33.51	127.69	207.40	223.87	110.00
E6	H. O Bouhama	43.5	6.8	3706.29	2372.06	513.83	70.90	247.83	237.90	276.90	1410.00
E7	S. Ain Tinn	32	7.35	819.18	524.28	92.18	32.05	2.86	355.02	31.95	125.00
E8	H. Etouama	37	7.28	1700.00	1088	189.98	27.13	119.97	390.40	213.00	247.50
E9	H. Grouz	45	6.65	2151.36	1376.87	236.47	52.04	124.31	272.06	259.15	377.50
E10	H. Ain El Minan	45	7.66	1155.36	739.43	84.97	32.06	87.55	274.50	163.30	80.00
E11	H.O Aissa	50	7.11	1156.36	752.20	80.16	46.46	71.07	268.40	166.30	85.00
E12	H. Menchar	48	7.08	1175.28	752.18	88.98	31.09	89.49	278.16	170.40	75.50
E13	H.Chaouch	51	7.06	1165.32	745.80	84.17	32.06	87.70	269.62	166.85	75.50
E14	H. Safsaf	44	7.05	1349.12	863.44	109.82	36.35	80.96	279.38	163.30	137.50

RESULTS AND DISCUSSION

The temperatures of the thermal waters vary according to the geological conditions and the geographical situation, in Algeria the hottest waters are those of Hammam Debagh with 96°C. In the region of Mila the source of Beni Guechat is the hottest with 56.1°C, on the other hand the lowest corresponds to the source of Ain Tinn with 32°C.

Water is said to be thermal when its temperature exceeds the average annual air temperature by 4°C. The classification of waters according to (Verdeil; 1976) [8] is given as follows:

- Hyperthermal water T > 45°C
- Orthothermal waters 37°C < T < 45°C
- Mesothermal waters 22°C < 37°C
- Cold water T <22°C.

In our study area, the temperature values oscillate between 32 and 56.1°C, out of 14 samples, six are classified as hyperthermal (T > 45°C), five are classified as orthothermal (37°C < T < 45°C) and three are classified as mesothermal (22°C < T< 37°C) (table.1and Fig.5). For the conductivity of water depends, this parameter depends mainly on the presence and concentration of major elements and its temperature.

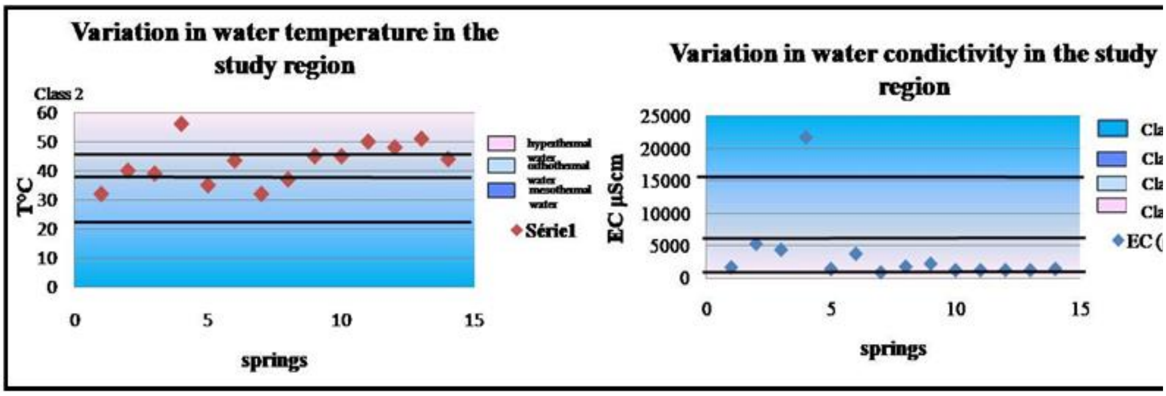


Figure 6. Spatial variation of chemical elements in the study area

In 1992, A. Issaadi [9] grouped mineral and thermal springs into four classes:

- Class 1: EC < 2000 µS/cm;
- Class 2: 2000 < EC < 7500 µS/cm;
- Class 3: 7500 < EC < 15000 µS/cm;
- Class 4: EC > 15000 µS/cm.

The measured values vary from 819.18µS/cm of Ain Tinn, low mineralized water, and 21700 µS/cm of H Beni Guechat water extremely charged in salts testifies of the leaching of the triassic evaporite levels. This variation of values allows us to have an idea on the origin of the waters and the state of mineralization of the studied mineral and thermal springs (Figure 4). 65% of the waters have conductivity lower than 2000µS/cm, which [8] qualifies as weakly mineralized; the majority of the springs that fall into this class are strictly related to carbonate reservoirs. Thus, the mineralization of the waters of this class can be enriched by limited leaching of evaporites or by condensation of waters in karst cavities. 28% of the springs are classified in class 2 where the electrical conductivity is between 2000 and 7000 µS/cm whose mineralization is affected to various degrees by the evaporite formations. For Hammam Beni Guechat (class 4) which is considered as extremely charged water directly linked to the triassic formations. The pH values measured at the springs revealed that 65% have a slightly alkaline pH; the maximum value is recorded at H. Ain El Minan 7.66. The remaining 35% have an acidic pH, the lowest value of pH is 6.19 characterizes the waters of the source of Beni Guechat. According to A. [9]"it is obvious that these pH measurements are influenced by the presence of gas, especially carbon dioxide.

In aquifer systems, the mineralization of water is related to the origin of chemical elements (cations, anions) they contain, the content of the latter depends on two factors: the type of reservoir and the speed of chemical reactions that are directly related to the time of water-rock contact.

According to the work of M. Mammeri [5]

- Calcium (Ca^{2+}) its presence is mainly related either to the dissolution of carbonate formations, or the dissolution of gypsum formations. The low values of Ca^{++} indicate that these waters are less influenced by the dissolution of carbonate and gypsum formations. The higher values are related to the existence of dissolution of these formations. The values of calcium vary between 72.95 mg/l (Hammam Dar Echikh) and 781.56mg/l (Hammam Béni Guechat).

- Magnesium (Mg^{2+}): its origins are comparable to that of calcium because it comes from the dissolution of carbonate formations. The values obtained are between 32.06 mg/l (Hammam Chaouch) and 117.6 mg/l (Hammam Béni Guechat).
- Chlorides (Cl^-) and sodium (Na^+): the origin of these elements is mainly related to the dissolution of salt formations. For chlorides, the values obtained by chemical analysis vary between 31.95 mg/l (Source of Ain Tinn) and 10171.87mg/l (Hammam Béni Guechat). Concerning sodium, the values are between 2.86 mg/l (Source Ain Tinn) and 5870.29 mg/l (Hammam Béni Guechat).
- The presence of sulphate elements in water is linked to several origins, either to the solubility of gypsum in clay sediments, calcium sulphates and magnesium sulphates, or it is linked to the oxidation of sulphur or the oxidation of sulphide minerals. The concentrations of sulfates in the analyzed waters vary from 75.50 mg/l (Hammam Chaouch) and 1410mg/l (Hammam Béni Guechat).
- The presence of bicarbonates in water is due to the dissolution of carbonate formations by water loaded with carbon dioxide. The values of bicarbonates in the analyzed hot waters are between 20740 mg/l (Hammam Dar Echikh) and 888.16 mg/l (Hammam Béni Guechat).

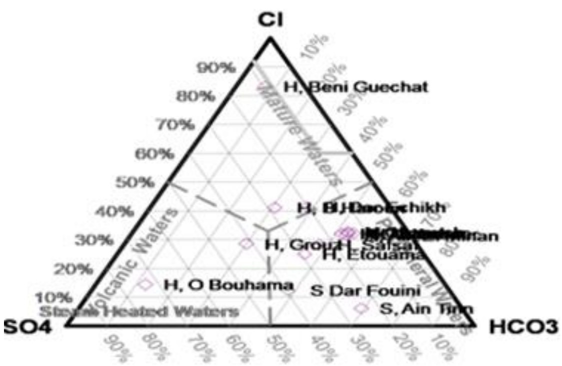
CHEMICAL FACIES

For the classification of waters, the Piper diagram was used, it allows visualizing the spatial geochemical evolution (several water samples from the same aquifer) or temporal (several water samples from an aquifer in different climatic seasons). The representation of the physico-chemical data on the piper diagram shows several chemical facies that depend on the geological nature of the aquifers. The transfer of 14 samples taken at the level of thermal springs and Hammams on the piper diagram (Figure 6) shows a variability of the chemical facies of the waters. These are divided into two poles:

- The saliferous pole: which is characterized by a sodium chloride facies and is represented by H. Béni Guechat and H. Dar Echikh, this is explained by a leaching of evaporite formations of the Triassic which outcrop along the deep tectonic accidents N-S and E-W at the level of Djebels Oukissène, Bou Charef and El Hadid;
- The gypsum pole, characterized by calcic sulphate waters, they are represented by the emergences: Dar El Fouini and H. Ouled Bouhama springs and the calcic sulphate waters of Ain Tinn spring, rich in bicarbonates and weakly concentrated in sodium chloride.

The triangle of cations allowed us to distinguish the calcic sulphate facies with a percentage of calcium exceeding 70% for the Dar El Fouini spring and 60% for H. Bouhama and H. Grouz. The diagram of anions allowed us to separate the sodium chloride facies (Cl superior to 90%) and the calcium sulphate facies rich in bicarbonates (HCO^{3-} superior to 50%). The water points that are grouped between these two poles represent a zone of mixtures; this is the case of the hot waters of Hammams Teleghma (from 10 to 15).

The Cl-SO_4-HCO_3 ternary diagram confirms the existence of a saliferous contribution of evaporitic origin represented by the Triassic formations that outcrop in the region.



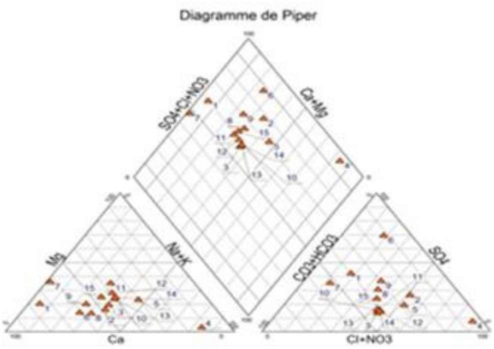


Figure 7. ternary plot and Piper diagram

Principal components analysis (PCA)

PCA is a descriptive statistical method, its objective is to represent in graphic form the essential information contained in a table of quantitative data, in this table of data with 9 variables (T, pH, EC, Ca, Mg, Na, HCO3, SO4, Cl), the individuals (the 14 emergences studied) are in a 14-dimensional space.

The correlation matrix (Table 2) allows us to distinguish a very good positive correlation between conductivity, which expresses mineralization, with Cl and Na and to a lesser degree Mg, HCO3 and Ca. Cl is well related to Na, but less so to Mg and Ca. HCO3 is bound with Mg and Na and to a lesser degree with Ca. SO4 correlates well with Ca and less well with Mg. These various correlations between the chemical elements constituting the mineralization of waters allow the following mineral associations: CaSO4, NaCl, and $CaCl_2$. These associations indicate that the mineralization of the majority of the waters takes place in contact with gypsum and saline formations.

The principal component analysis allows us to extract three main factors that express 93.33% of the total variance of the data table. 75.92% for the first factor, 10.30% for the second and 7.11% for the third. The factorial axis F1 is strongly correlated to the variable pH in positive value, and CE, HCO3, Cl, Ca, Mg, Na and to a lesser extent SO4 in negative value. The proximity of (Na, Cl) and (Mg, HCO3) shows strong correlation between these variables, while the correlation between temperature T and SO4 is almost null. The factorial axis F2 is correlated with the variable T. According to the factorial plane F1-F2 (table 3) we observe that the majority of the statistical units are arranged on the right of the factorial axis F2, they are waters with pH values higher than 7. We can distinguish four groups: The first group includes the boreholes of Teleghma which are characterized by very high temperatures (over 45°C). The second group is made up of statistical units located near the intersection of two axes; this group is characterized by waters rich in Ca, HCO3, and Mg with temperatures below 40°C. The third group is represented by the sulphated waters of Hammam Bouhama (E6) and the spring of Dar El Fouini (E1). The fourth group is characterized by hyperthermal waters very rich in chlorides and sodium, corresponding to Hammam Béni Guechat (E4). On the F2-F3 factorial plane, all the variables are centered at the intersection of the two axes, which helps us to understand the poor correlation between the F3 factor and the different variables, with the exception of SO4 and T, which have some correlation with this axis.

Table 2. Correlation between physico-chemical parameters of water (in Mammeri) [5]

	T°C	pH	CE	Ca	Mg	Na	HCO_3	Cl	SO_4
T°C	1,0000								
pH	-0.3285	1,0000							
CE	0.4147	-0.7109	1,0000						
Ca	0.2961	-0.7888	0,8712	1,0000					
Mg	0.4562	-0.8056	0.9057	0.9392	1,0000				
Na	0.4686	-0.6384	0.9682	0.8251	0.8804	1,0000			
HCO_3	0.3069	-0.8119	0.8778	0.8102	0.8525	0.8528	1,0000		
Cl	0.4665	-0.6385	0.9684	0.8190	0.8761	0.9998	0.8544	1,0000	
SO_4	0.2300	-0.6432	0.6464	0.9196	0.8175	0.5902	0.5428	0.5788	1,0000

On this plan we observe a distribution of emergences in two orthogonal directions according to temperature, SO_4, HCO_3, Cl and Na where we have distinguished: Waters with high temperatures and high chloride contents and relatively low concentrations of sulfates. Orthothermic to mesothermic waters with bicarbonate or chloride character rich in bicarbonates and calcium. According to the F1-F3 plan, a good negative correlation appears between the F1 axis and the majority of the variables (Cond, HCO_3, Cl, Ca, Mg, and Na), the strong link between conductivity and chlorides, sodium and bicarbonates is explained by the richness of the thermal waters studied in these ions. The good correlation noticed between Ca and Mg is explained by the same carbonate origin of these ions. The axis F3 groups in negative value the variables SO_4 and T quite well correlated to F3. The first set of emergences concentrated at the intersection of two axes is characterized by orthothermic to mesothermic waters rich in Cl and HCO_3 concentrations with high Ca concentrations. The second set constitutes the springs outside the first set characterized by waters richer in sulfates, with an acid pH. The hyperthermal and very charged waters of Beni Guechat represent the third set characterized by very high concentrations of Cl, Na and a conductivity reaching 20.000 µS/cm.

Table 3. Correlation between variables and factors

Variables	F1	F2	F3
T°	-0.467206	0.771155	-0.426295
pH	0.822241	0.174011	0.127374
CE	-0.959200	-0.072913	0.195335
Ca	-0.946845	-0.261353	-0.135990
Mg	-0.974378	0.180664	-0.103469
HCO_3	-0.903741	-0.030145	0.269299
Cl	-0.936063	0.185709	0.241059
SO_4	-0.773307	-0.397115	-0.437071

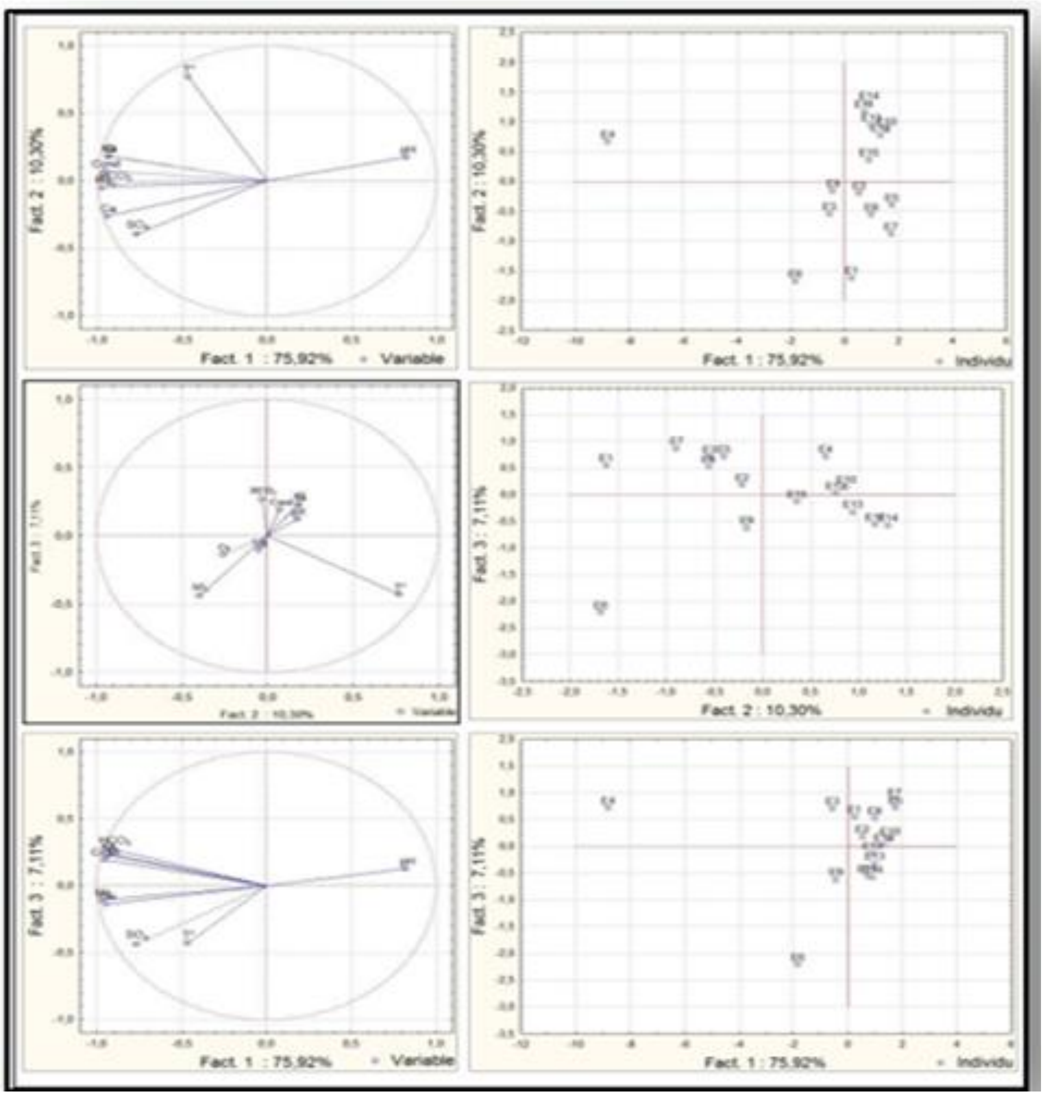


Figure 8. Principal component analysis of the thermal waters of the Mila region

CHEMICAL GEOTHERMOMETRY

Chemical geothermometry is an important tool to estimate reservoir temperatures of hydrothermal systems. We will use the approach of (Giggenbach 1988) [10] to evaluate the temperature of the reservoirs and identify waters that have reached equilibrium with the host lithologies.
All the samples analyzed from the thermal springs of the Mila basin were represented on the Giggenbach diagram (Figure 7). This geothermal technique suggested by (Giggenbach 1988) [10] separates between immature and fully equilibrated waters in deep reservoirs.
Thermal water represents a mixture of notably warm waters with surface or near-surface seepage waters with Jurassic-Cretaceous dolomitic and limestone formations that contain high concentrations of Mg, except for the case of H Beni Guechat which is in the partially balanced water domain. This is located near the mature water zone

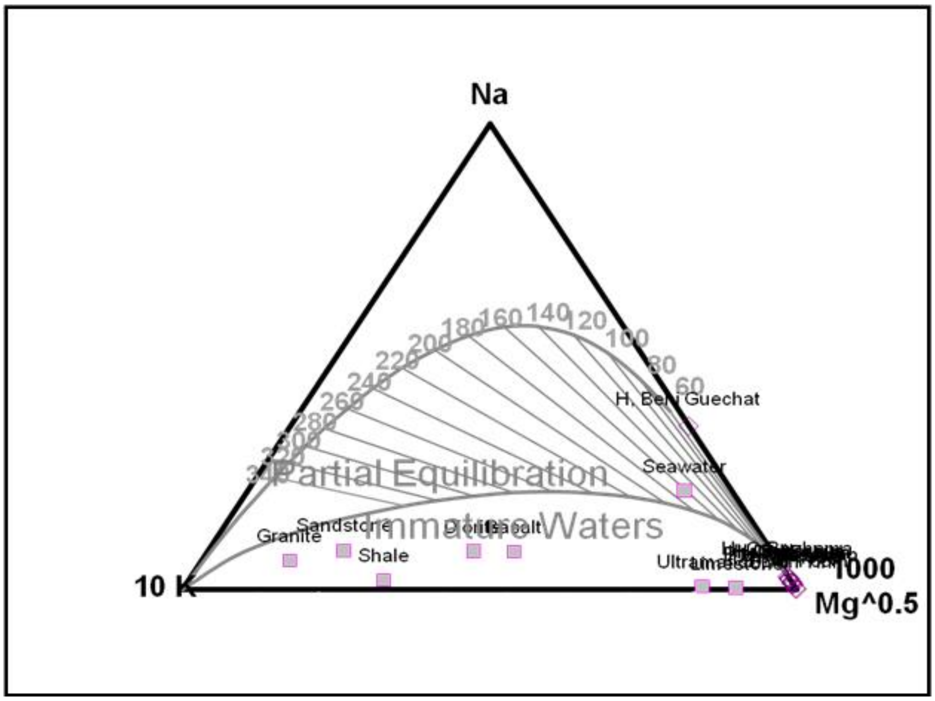


Figure 9. Giggenbach diagram for Mila geothermal waters

For the geothermometers used (Giggenbach and Mg/K) the results are close
For Giggenbah: Hammam Beni Guechat is individualized with a temperature close to 100 ° C, for the other sources the temperature of the reservoir varies between 40 ° C and 60 ° C.
For the geothermometer Mg/K gives the following results:
Beni Guechat (80°C), Bouhama and Dar Fouini enter (70°-75°C), Beni Haroun and H Grouz and O Achourla temperature varies between (70°-60°C), and the rest the reservoir temperature between 50°-40° C) it seems therefore. It seems that the waters of Ouled Achour, Ouled Bouhama are in the reservoir of the albo-cenomanian limestones. The waters of Beni Guechat can circulate in a deeper reservoir; it would be the neritic limestones of Constantine. The variations of temperatures at the emergence as well as the mineral load make it possible to suggest a contribution of the higher aquifers (penile-tellian) and a contamination of the waters by the Triassic evaporites.

POTENTIAL AND PERSPECTIVE

Renewable energy is becoming a major issue in many countries around the world. The direct use of hot water has existed for a long time and continues to grow in various different fields of application. The first geothermal district heating system was inaugurated in the 14th century in Chaudes-Aigues, France, and the first geothermal well was drilled near Reykjavik, Iceland, in 1755 [11].

Geothermal systems are located in areas with a normal or slightly above normal geothermal gradient, creating low to medium enthalpy geothermal reservoirs (less than 150°C).
Mila has a non-negligible geothermal potential. It has about twenty springs and Hammam, 11 Hammam are located in Mechta Smara (Teleghma) with a flow Q = 20 l/s, can create more than 100 direct jobs, as well as indirect employment (depending on the season).
Some cases of use: we can quote the fish farm of Saida (a drilling provides 60l/s of hot water 30°C), Ouargla (drillings provide 44l/s of water at 21°C) and Ghardaia (150l/s of water at 28°C) in the Sahara (in the south). Saïda is the first site in Algeria, which uses a geothermal heat pump. This 34KW reversible heat pump is used to heat and cool 12 classrooms, the library and the restaurant of an elementary school. The hot water (46 °C) first passes through the heat pump before being used for swimming. The water comes out at 39 °C. This system allows comfortable temperatures of about 30°C during the cold period and 15°C in summer [12] Currently, balneology (crenology) is the main use; it can be used to treat a variety of diseases. The most serious diseases that use balneotherapy to relieve symptoms include cardiovascular disease, fibromyalgia, chronic fatigue syndrome, depression, anxiety, insomnia, osteoarthritis, rheumatoid arthritis, psoriatic arthritis, ankylosing spondylitis, spinal cord injury, spasticity, stroke, acne, dermatitis, psoriasis, eczema, lichen and scleroderma. Other benefits of balneotherapy treatments include pain reduction, increased collateral blood flow, elevation of cellular fluids, muscle relaxation as well as many curative benefits from the absorption of minerals and botanical substances. Many spas in the Mila region base their treatments on balneotherapy, which offers an additional health benefit due to their mineral-rich compositions.
The wastewater of these thermal centers are directly rejected in the nature without preliminary treatments, these hydrothermal effluents are waters very rich in mineral salts, active tension products and organic matters, which constitutes a threat for the environment whether it is on the human health or on the fauna and the flora. The purpose of this approach is to make a quantitative and qualitative evaluation physico - chemical of the level of contamination of the surface and ground water by the hydrothermal effluents; a durable management (economic, social and environmental) of the hydrothermal water discharges. A valorization of these effluents by building a heating system for the thermal stations of the Mechtat Smara area.
As an example (Table 4): a capacity of reception of curist of a minimum 100 rooms of water, all the rooms of water can be used on average ten (10 times/day) and each time, the basin must be filled and emptied after use, this bathtub has a capacity of 1600 liters without counting the water used directly of the tap, we arrive at quantities of notable annual water charged of tensio-active [13]

Table 4. Volume of discharged water loaded with Tensio-active

designation	amount of water discharged per day (m^3/d)	amount of water discharged per month (m^3/month)	amount of water discharged per year (m3/year)
volume of water discharged by the thermal centers $1.6m^3\times10$times/d$\times100$ rooms	1600	48000	576000

We would like to point out that these thermal-therapeutic centers work more than 15 hours a day (2 x 8 hours), and that the authorized duration of the bath is 3/4 hours (45 minutes), which allows a use up to (20) twenty times a day and that, and that therefore the volume of water discharged with surfactant currently exceeds 1152000 m³/year, or more than 8064000 m^3 over the fourteen years of operation without any prior treatment.

CONCLUSIONS AND RECOMMENDATIONS

In this present work, we have studied the hydrothermal potential of the region of Mila, located in the NE of Algeria, a very complex geology made up of formations that range from the Triassic to the

Quaternary, and subjected to various recent tectonic phases that are responsible for the current geological structures and even the emergence of hot springs.

The thermal waters have a more or less important mineralization; it is lower than 1g/l in the boreholes of Teleghma, the hot spring of Ain Tinn, and Dar Echikh. It is between between 1 and 2g/l in the springs of Dar El Fouini, Béni Haroun, Ouled Achour, Etouama, Hammam Grouz, it is between 2 and 3g/l for the hot waters of Ouled Bouhama and it exceeded 20g/l with a conductivity higher than 20000µmhos/cm for the source of Béni Guechat spring.

The pH values are generally close to neutral, ranging from 6.19 to 7.66. The low values of pH values are related to the very important release of carbon dioxide of deep origin.

The chemical classification of the waters according to the Piper diagram, has given three dominant facies: calcic and sodic chlorinated waters, calcic sulfated waters and calcic bicarbonate waters.

The study of the limits of the thermality of the waters and the measurements on the ground of the temperatures of 9 springs and 6 boreholes allow us to classify the hot waters as mesothermal, orthothermal to hyperthermal waters with temperatures between 31.5 at Ain Tinn and 56.1°C at Beni Guechat.

The multidimensional analysis by the A.C.P. method leads to the interpretation of the mineralization as probably coming from a gypsum and saliferous environment which often hides the original chemical composition of the saliferous environment which often masks the original chemical composition of the waters.

The thermalism in Mila is a real vein offering real investment opportunities with undeniable economic producers, as long as it is rationally exploited, either in the framework of crenotherapy either in the tourist field and respecting the context environmental.

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THE CASE OF THE SHRINKING PALLIIKARANAI MARSH, CHENNAI, INDIA: ENVIRONMENTAL ECONOMICS TO THE RESCUE?

Mythili MADHUSUDHAN[1]* & N.K. AMBUJAM[2]

[1]*School of Architecture, Meenakshi College of Engineering, Chennai, India, E-mail: mythili.m@mce.edu.in,* [2]*Centre for Water Resources, Anna University, Chennai, India*

The intangible benefits provided by water bodies and wetlands in urban areas often tend to go unnoticed. In order to assess the true values of welfares and benefits to society, social benefit cost analysis (SBCA) presents itself as a useful tool. In this paper, hedonic pricing method (HPM) has been used in apprehending the environmental and aesthetic benefits of Pallikaranai marsh, Chennai, India, and the results are used in analysis of costs versus benefits. We attempt to quantify the impact of the presence of water bodies in urban settings and distance from the Pallikaranai marsh has been found to be the significant variable, and the price rate of residential land decreases by .367/m^2 for every metre distance away from the marsh. Many other smaller water bodies surround the marsh. Another variable, denoted by the component of interaction of distance from the marsh and distance of other smaller water bodies is found to be a significant variable, while the distance from other smaller water bodies is found to be not a significant variable. The results of the analysis describe and demonstrate the role of water bodies in the urban context and provide data for land planners and water managers to make informed decisions in the planning and management agenda.

***Keywords**: Urban water bodies and wetlands; Urban environmental quality; Hedonic Pricing Method; HPM; Social Benefit Cost Analysis; SBCA; Restoration of water bodies; Restoration of marshes; Pallikaranai; South Chennai*

INTRODUCTION

While cities occupy only 2% of the earth's surface, they use up around 75% of the natural resources and generate 70% of all the waste produced on a global scale (McInnes, 2013). Wetlands deliver multiple benefits, such as providing drinking water, mitigating flood risk and regulating local climate. They are also significant contributors to recreation by virtue of their aesthetic quality and improve the quality of life of humans. Unfortunately, too often, wetlands are neglected in city planning, and though cities and towns are human constructs, protection of wetlands is mostly neglected in the planning agenda. Chennai, India is a city where the landscape is dotted with wetlands though there is no perennial river. There are numerous small and large wetlands which characterize the geology and hydrology of the region, though neglected and unrecognized in larger fora. This is due to the fact that awareness among the public and sensitive action on the part of the governing agencies are lacking even though these wetlands play a significant role.

The Ramsar convention, an institutional framework for protection and wise-use of wetlands since 1971, stipulates that "the maintenance of the ecological character of wetlands, achieved through the implementation of ecosystem approaches within the context of sustainable development" is the basis of 'wise-use'. In India, there are 42 Ramsar sites as of the year 2021. Wetlands are coalescing of land and water, combining attributes of terrestrial and purely aquatic ecosystems. They are characterized by the presence of water, the depth of which, at low tide, does not exceed six metres. A study of the ability of urban ecosystems to generate local ecosystem services in Stockholm, Sweden, revealed that of seven ecosystem types (street trees, lawns/parks, forests, cultivated land, wetlands, streams and lakes/sea) only wetlands managed all six of the services assessed (air filtering, micro-climate regulation, noise reduction, rain-water drainage, sewage treatment and recreational or cultural values) (Panel & Convention, 2013). The aggregate value of the ecological services generated by wetlands, on a global scale, has been estimated to be $4.9 trillion/year (Costanza et al., 1998).

The Convention on Wetlands (Ramsar, Iran, 1971) is an intergovernmental treaty which lays down the guidelines for national action and international cooperation for the conservation and wise use of wetlands. Because wetlands are very important for ecological processes as well as for their rich flora and fauna, the broad objectives of the Convention are to ensure their conservation and wise use.

To meet these objectives, the Convention places general obligations on member countries relating to the conservation of wetlands throughout their territory, and special obligations pertaining to those wetlands which have been designated for the List of Wetlands of International Importance (the "Ramsar List").

In many places, wetlands have traditionally been seen as sites to be converted (either to something "useful" or to something more "benign"): the connotation is that there needs to be something more valuable reclaimed from the wetland. While this perception has changed significantly in recent years, there are still residues of its influence in the decision-making processes operating in some places. In Algeria (Samraoui & Samraoui, 2008), Brazil (Ribeiro et al., 2020), China (Mao et al., 2021), Nepal (Siwakoti & Karki, 2009) and Serbia (A et al., 2018) the institutional mechanism and impact of inclusion in Ramsar list have been discussed. Few studies have attempted to quantify recreational and aesthetic benefits of lakes / water bodies in India, namely the study on Bhoj wetland, (Verma, 2001), the studies on Sikkim (Maharana et al., 2000; Uprety & Rai, 2000), the studies on Pallikaranai (Balakumar & Das, 2015; Venkatachalam & Jayanthi, 2015) and various case studies mentioned in the report of The Economics of Ecosystems and Biodiversity India Initiative (TII) (India, 2014). But the topic of quantification of aesthetic benefits of such water bodies is yet to find much scholarship in literature.

Cost benefit analysis (CBA) of conservation projects related to wetlands and lakes becomes a viable tool to justify the expenses incurred by such projects. It is based on welfare economics and is easily understood by the non-economist. Social Benefit Cost Analysis (SBCA) takes into account societal benefits accrued from non-market and aesthetic benefits from the environment and its impact on economics. There are very few studies addressing intangible benefits and here, we aim to justify them in our case, the Pallikaranai marshland.

The main objective of this paper is to obtain market and non-market aesthetic benefit cost ratios for the Pallikaranai marsh, Chennai, India, and justify the expenses towards conservation as taken up in the past ten years. Possibility of revenue generation for further upkeep and improvement of quality of work and the quality of landscape is another objective. The study could prove useful for land planners involved in policy and decision-making towards a better management of resources.

MATERIALS AND METHODS

Pallikaranai was originally a panchayat (the word refers to an administrative unit, originally meaning village council) under the village, St.Thomas Mount in the pre-1970s and then annexed with Chitlapakkam when it became a village panchayat. Later, it came under the Corporation of Chennai. The marshland in the 1970s was much larger than its current extent, and it is a well-known fact that the marsh extended to 5500 hectares according to the 1906 topo sheet and it has shrunk to 593 hectares in recent times (Vencatesan, 2007; Vencatesan et al., 2014).

Pallikaranai village is predominantly along the western edge of the marsh surrounded by Madipakkam, S.Kulathur, Kovilambakkam, Pallavaram, Jalladampettai, Pallavaram and Tambaram further west and Velachery in the north and Perumbakkam in the south, situated on the geo-coordinates of 12.949371°N latitude and 80.218184°E longitude as seen in Figure 1.

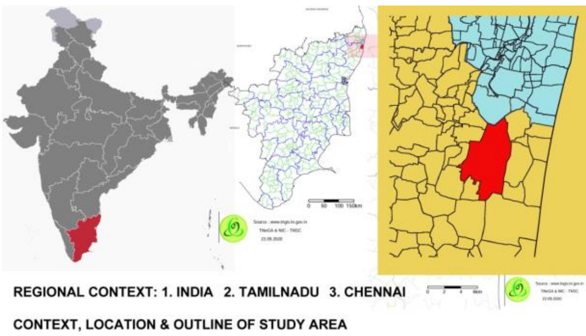

Figure 10. Study Area

The maximum water spread area of the marsh, is less than 695 ha as the water body dries out in summer and maximum depth has been estimated as 6 metres (Vencatesan et al., 2014). After the year 2000, a road across the water body, dividing it into north and south, connecting the eastern and western edges of the marsh (and thus skyrocketing real estate growth on both sides of the marsh) was established. While there are many criticisms regarding the way this road was designed, viz., insufficiency in the culverts' sizes and capacity to permit water flow from the northern half to the southern half, the road is still popular and has facilitated accessibility and a view of the marsh on both sides. On the east, the said 200ft Radial Road, as it is called, connects with the Old Mahabalipuram road or the information technology zone, with a number of multinational companies, major residential and also some commercial development. The development of this road enjoyed the support of the government, as part of the city's economic growth and runs close to the marsh. Hence, in the eastern side, the urban development is powered by the presence of this IT corridor.

On the western side lies the Pallikaranai village and neighbouring villages, comprising a landscape of a large number of tanks. 34 of these tanks lie in this region (Department, n.d.) and the surplus of these tanks drains into the marsh by means of the inlet canals in the northwest. Much of this land remained a landscape of agricultural lands till the onset of development in the late 1990s. The government commissioned studies and Environmental Impact Assessments (Mott MacDonald, Cambridge, 1993; NEERI, 1998) to arrive at the feasibility of a light industrial development in this area and the studies ascertained that the area could support development, which resulted in a burgeoning of population and supporting infrastructural growth.

The study addresses the lands on the western side of the marsh, as we are concerned with the transformed natural landscape and intend to explore environmental economics. Hence, we examine these water-rich regions where peri urban growth and development has occurred. The department of forests has taken over the marsh since it was declared as a reserve forest in 2007.

This department has received funds from the government and data on funds and expenditure towards the upkeep and reclamation was obtained from the department of forests. A study on adaptive management of the marsh was conducted by an NGO (Non-governmental organization), 'Care Earth' and submitted to the government. In 2018, the state government announced that it would commence the restoration of 695 hectares of the wetland under the National Adaptation Fund for Climate Change over 5 years from 2018 to 2023. Hence, other than stabilization by bunds, establishment of an interpretation centre, acquisition of lands and clearance of encroachments, the restoration process is still an on-going process. The forestry department has not promoted or collected any revenues from the citizens and hence declared nil income from the reserved forest area.

For assessing the aesthetic/ recreational benefit of Pallikaranai marsh and other water bodies in the area, Hedonic Pricing Method (HPM) was the tool used (Chaudhry, 2013). HPM estimates economic values for environmental benefits and other goods. In this case, the ecosystem services constitute the environmental benefit, in other words, aesthetic benefit from the water body and other goods constitute residential plot prices in the surrounds of Pallikaranai and the tanks which drain into it. Typically, many attributes jointly combine and influence residential land prices. Statistical techniques have been utilized to separate parts of transaction prices due to each of these attributes (Jim & Chen, 2006).

Data used in this research was collected in December 2020 from the field. The primary data includes specifics on environmental attributes and spatial locations and prices of land. Data on air quality, noise pollution in the region were collected from the Tamilnadu Pollution Control Board, and water quality was measured (with the help of a portable TDS meter and pH solution) and availability round the year was determined by enquiry in the field for every individual sample house.

Garbage disposal and quality of parks nearby was considered. As most of it is an urban area, attributes like distance from workplace and distance from nearby schools were also considered. The distance from the marsh and from nearby water bodies was measured from Google Earth engine using the distance tool and by pinning the locations with geo-coordinates.

The guideline value of the plots in Rupees/m^2 and Rupees/ft^2 were also obtained from the webportal of the land revenue department (www.tnreginet.in) which provides streetwise data for the whole of Tamilnadu.

RESULTS AND DISCUSSION

In this paper we have attempted to quantify ecological benefits by specifying certain variables in the analysis. Statistical Package for Social Sciences (IBM SPSS Statistics Viewer for Windows) was used to perform multiple regression analysis. Market rate of residential plots (PLOTRATE) in Rupees /m^2 was considered as dependent variable.

The relationship between the dependent variable and other independent variables can take several forms. Linear, semi-log and double-log specifications were considered and the results of linear regression are presented as R^2 with standard error estimate (SEE) appearing better in this form. The dependent variables considered were: size of plots (PLOTSIZE), air quality (AIRQLTY), water quality (WATQLTY), noise level (NOISELVL), garbage disposal (GARBDISP), distance from water bodies (DISTWTBODY), and distance from Pallikaranai marsh (DISTMARSH). These were the eight independent variables considered. In regression, one always has to take into account the possible influence of the independent variables on each other and in our case, the distance from the marsh and distance from water bodies are found to have a high correlation. Hence, another variable, which is denoted by the interaction of distance from the marsh and distance from these water bodies (INT_DM_DWB) was also included in the regression.

Five of these variables (airquality, water quality, noise level, garbage disposal and quality of parks) were of dichotomic nature that is, taking values 0 or 1, 0 for bad aspect and 1 for good aspect.

Variables other than plot size are considered hedonic variables as their inclusion in the equation exhibits a relationship with value of residential plots.

The following table (Table 1) gives the descriptive statistics including sample mean, standard deviation, maximum and minimum values of the dependent and independent variables for the plots examined, where data on environmental variables was collected.

Table 1. Descriptive statistics of the variables

	Mean	Standard Deviation	Maximum	Minimum
PLOTSIZE (m^2)	211	48.6	446	111.5
PLOTRATE (Rs./m^2)	15600	5940	36060	2390
DISTMARSH (m)	3770	2610	8650	236
DISTWTBODY (m)	492	291	1730	14
AIRQLTY	0.92	0.27	1	0
WATQLTY	0.47	0.5	1	0
NOISELVL	0.92	0.28	1	0
GARBDISP	0.83	0.38	1	0
QLTYPARK	0.38	0.49	1	0
INT_DM_DWB	3.1x105	8.2x105	40.7x105	-12.2x105

The average plot size considered was 210.85m^2, ranging between 111.5m^2 and 446m^2. The average rate of plots /m^2 was found to be Rs.15600 /m^2 ranging from Rs.2390 /m^2 to Rs.36100 /m^2. The distance of the sample plots from the Pallikaranai marsh was at an average of 3770m ranging from 236m to 8650m. The distance of the sample plots from the nearest water bodies (in some cases if more than one water body is nearby, the significant nearest water body or average of distance of all the nearby water bodies) was at an average of 490m ranging from 14m to 1730m. The interaction between these two variables was also included in the equation as seen in Table 1. The results of the hedonic price regression analysis are given in the following table. The explanatory variables account for 9.8% of the plot rate variance (adjusted R^2=0.098) and the F-ratio test indicates that the model fits properly.

As seen from Table 2, on examination of the student's t-statistics, (t=-3.291) it is revealed that the distance from the marsh is a significant variable influencing plot prices, and the rate of plots decreases by Rs.0.367 / m^2 as one move away from the marsh. Hence, the land value appears to be higher in regions which are in closer proximity to the marsh. The distance from smaller water bodies is not a statistically significant variable but the interaction of the distance from the marsh and the distance from the water bodies is again a significant variable (t=2.027) exhibiting an increase of Rs.0.187 /m^2 as one move away from the marsh and water bodies. Figure 2 shows the graph of rate of plots vs. distance from the marsh. The rate decreases with distance from the marsh. Figure 3 shows the graph of rate of plots vs. interaction of distance from marsh and distance from other water bodies. In this case the rate increases with increase in distances combined.

Table 2. Linear Regression model results

	Coefficients Beta	t-statistic	Significance
(Constant)		4.59	<.001
PLOTSIZE	-.038	-.438	.662
AIRQLTY	-.099	-.880	.381
WATQLTY	-.104	-1.143	.255
NOISELVL	.206	1.748	.083

GARBDISP	-.123	-1.201	.232
QLTYPARK	.003	.031	.975
DISTMARSH	-.367	-3.291	.001
DISTWTBODY	-.022	-.230	.819
INT_DM_DWB	.187	2.027	.045

Dependent variable: PLOTRATE (m^2)

Notes: Adjusted R^2= 0.098 F= 2.566 ($p<0.05$) Dependent Variable: PLOTRATE(m^2) n=130

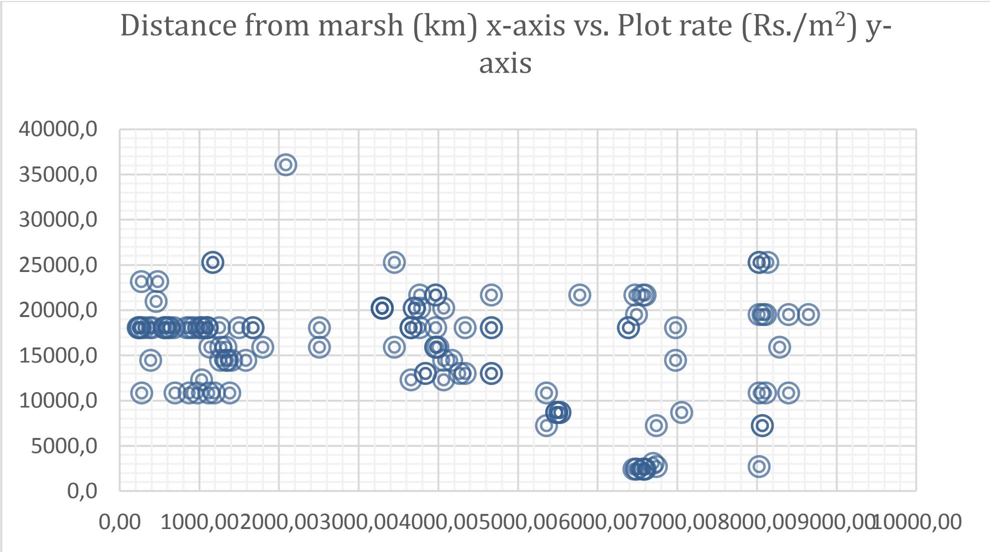

Figure 2. Graph showing price of plots (y-axis) and distance from the marsh (x-axis)

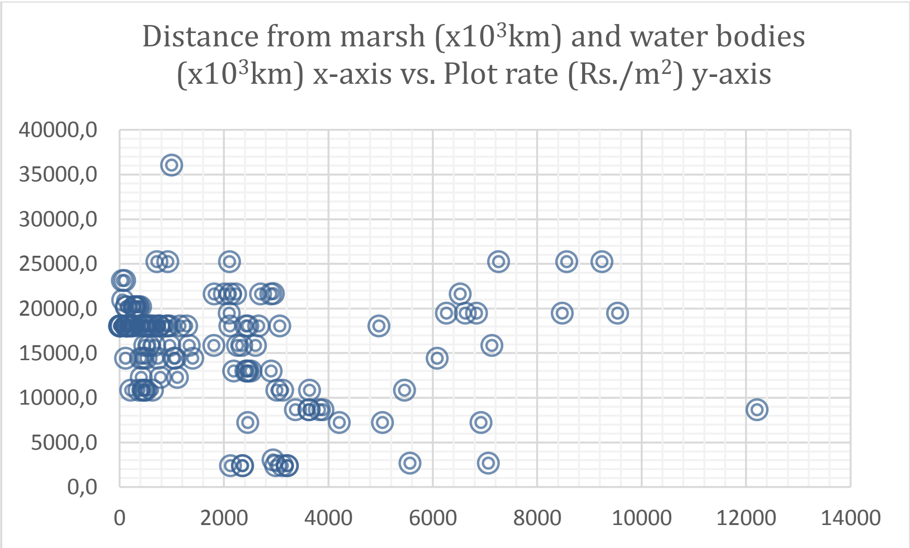

Figure 3. Graph showing rate of plots (y-axis) and distance from the marsh and water bodies (x-axis)

Of the variables used in the regression equation, the independent variables denoting air quality and noise level which were obtained from the Pollution Control Board and are not found to be significant variables. Air quality in terms of suspended impurities, was mostly within permissible limits, except for areas where garbage burning was practised i.e., areas near waste dumps. Traffic noise level was accepted by most residents as it is a highly populated area. Water quality was measured in each sample site, (TDS, pH and availability round the year were considered). The water was mostly alkaline and TDS ranged from 400 to 950 with an average of 550 parts per million. Studies have shown that the TDS should be a minimum of 400 to be considered good quality. Hence, the variables 0 and 1 were applied accordingly.

But this variable is not found to be significant in the equation. Quality of parks was considered and so were distance from nearby school and workplaces. Most people surveyed worked within 3-4km from their residences and many schools were also found to be available in the area. Since this is a small part of a larger city network and mostly uniform in the study area boundary, these variables were not considered.
Distance from the marsh is a significant variable, whereas distance from the tanks/ water bodies in the study area was not found to be a significant variable. However, an interaction component between the two was included in the equation and was found to be a significant variable. To remove multi-collinearity, we have mean-centred the interacting variables and subsequently calculated the interaction component. The graphs show that the plot rates and plot prices decrease as the distance from the marsh increases, which shows that the presence of the marsh and its aesthetic benefit do impact plot prices. However, as the interaction of distance from the marsh and distance from other water bodies increases, plot price increases, which implies that at greater distances from the marsh, the proximity to the smaller water bodies does not necessarily imply higher plot rate. Water bodies proximity has been found to be an influencing factor in residential plot prices in developed countries according to Jim and Chen (2006; 2007). Hence, we can conclude that the aesthetic benefit of the smaller water bodies in our study area, have not been realized in these terms.

BENEFIT-COST ANALYSIS

Benefit Cost Analysis, which takes root from welfare economics, is an analysis that is comprehended by the layman. Three types of Benefit Cost Analysis may be distinguished. Informal, Quantitative and Monetized or Formal Benefit Cost Analysis may be performed. In the informal category, benefits and costs are compared in detail, but not necessarily quantified or monetized. In the quantitative category, benefits and costs are compared quantitatively in terms of m^2, gallons or decibels (for noise level), but not necessarily monetized. In the third, benefits and costs are quantified in terms of their dollar/ rupee value.
Formal Benefit Cost Analysis is dependent on the Paraeto optimality criteria. According to this criteria, social welfare is increased if the given transaction enables that the (living) conditions of some people (the beneficiaries) are improved and nobody suffers degeneration of conditions (Williams, 1979). One way to achieve it is to make the beneficiaries pay for the transaction including the sum necessary to compensate the losers. If at the end of this, the beneficiaries still enjoy the advantage, the Paraeto optimality criteria are achieved. In order to achieve these criteria, the sum of benefits flowing from a given transaction must be greater than the sum of costs incurred, in which case, society has the potential to benefit from it. According to a report by the ministry of Water Resources in India, (2009), Benefit Cost ratio (BC ratio) has to be minimum 1:1 in Special Category States, undivided KBK districts (refers to a backward region) of Orissa, in drought prone, tribal and naxal-affected areas and 1.5:1 in other areas.
To do a benefit cost analysis, we must identify the primary benefits and primary costs. In our case, the primary benefits of ecological restoration of Pallikaranai marsh would be to facilitate the public with a lung-space, which serves the many benefits of air and water purification, ground water recharge, flood moderation, recreational benefits such as biodiversity and birdwatching, enjoying the presence of water and further, tourism benefits if promoted wisely. The primary costs would be the cost of restoration, involving physical measures like demarcating the marshland extent, reclaiming by clearing encroachments, creation of bunds and stabilizing the edges, apart from unexpected costs of disaster management at times of extreme floods, which could be averted by restoration. The secondary benefits may be identified as social benefits derived by commuters, employment benefits for people engaged in restoration works, reduction of inundation risk, by reclaiming the marshland. The secondary costs are the loss of wetland if these efforts are not taken, and the frequent financial and physical damages by flooding, loss of community support because people may vacate and abandon the area if the living conditions are not good enough and hence loss of ecosystem services. Mercy Corps (Okapi & Corps, 2016) and Rajan et.al., (2016) have quantified the damage to Chennai, India, by the major flood of 2015. Rajan et al., have determined that a loss of over Rs.15,000 crores impacting 10-15% of the country's production, was suffered by the industry lobby. Other studies describe Contingent valuation method (CVM) and Travel cost method (TVM) which have been used to study environmental economics with respect to the landscape of Sikkim, Himalayas by Uprety and Rai (2000) and Maharana et al. (2000).
Total Economic Value (TEV) is a methodology adopted in welfare economics for environmental management. The TEV is arrived at by analysing the various direct and indirect uses of the water body. There are active and passive uses, and the community is approached in order to gauge their willingness to pay for the benefits derived, which are, in other words, the ecosystem services or their willingness to accept compensation for the unfavourable conditions. In our case, Venkatachalam et.al., (2015) have conducted one such survey in 2015, in the villages surrounding Pallikaranai marsh, viz., Perungudi, Pallikaranai, Jalladampettai, Perumbakkam, Okkiyamthoraipakkam and Karapakkam with a total voter

population of 155000 and surveyed 733 households, the results of which were that on an average, an amount of Rs.2096/- per annum could be spent per household for the coming five years. They discussed various scenarios and surveyed if the people were willing to pay for the status quo, or for moderate improvements or Option Value of an enhanced future of their living conditions and the marsh. It is also significant that, many people were not willing to participate in this survey because they were afraid they would be evicted.

A way of arriving at the total economic value (TEV), would be, for a water body, the value of the land occupied by the water body. In our hedonic pricing study, the average guideline value of the properties in proximity to the marsh was found to be, Rs.17200/ m^2. The total extent of the marshland, which is designated reserve forest area, is 695 ha and hence the value amounts to Rs. 11.9 $x10^{10}$.

This method of arriving at economic value may have a negative connotation as it should not lead to an inference that more land is available for real estate, as it is not true. The current marsh extent is almost only ten per cent of the original marsh outline. Data on government funds allocated for the restoration of the marshland was acquired from the forestry department. Table below (Table 3) gives the amounts allocated and spent from 2011 till 2020.

Table 3. Expenses towards the upkeep of the marsh

S.No.	Year	Funds received in $x10^5$ rupees	Funds spent in $x10^5$ rupees	Present value of funds spent (2021) in $x10^5$ rupees
1	2011-12	517	271	498
2	2012-13	404	185	319
3	2013-14	341	250	401
4	2014-15	113	113	170
5	2015-16	-	-	
6	2016-17	-	132	172
7	2018-19		417	511
8	2019-20	2030	1460*	836
	2020-21			781
Total present value of amount spent towards the marsh				3688

*Assuming half amount for each period

For estimating the aesthetic and environmental benefit derived from the Pallikaranai marsh, as reflected in property prices of residential areas around the marsh, the city zone has been earmarked as four zones. The zone nearest to the marsh has a property value of Rs.17200/ m^2 (Zone 1) followed by Zone 2 with a property value of Rs.17300/ m^2. Zone 3 exhibits a property value of Rs.10500/ m^2 and Zone 4 exhibits a property value of Rs.13900/ m^2. These results show that the plot prices are significantly higher in the zones in close proximity to the marsh. Refer Table 4 and Figure 4.

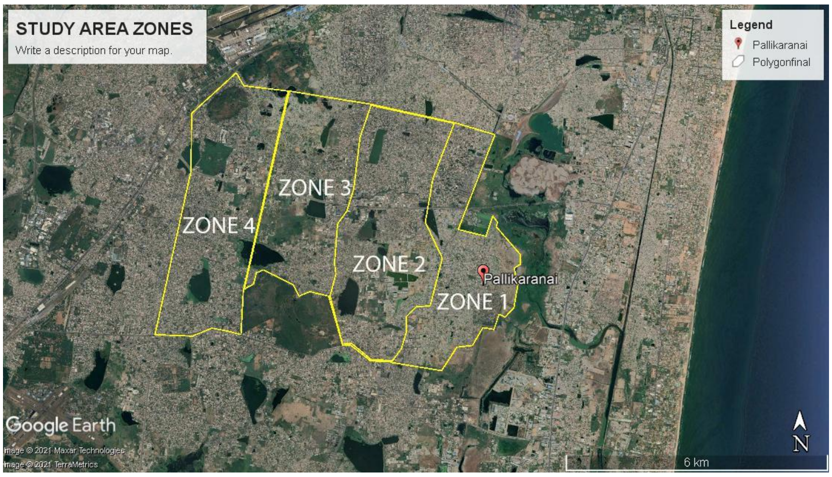

Figure 4. Study area zones

Table 4. Descriptive statistics zone wise

	Zone 1	Zone 2	Zone 3	Zone 4
No. of plots	50	38	21	21
Mean plot size (m^2)	191	214	223	227
Maximum plot size (m^2)	223	446	223	446
Minimum plot size (m^2)	112	112	223	112
Mean plot rate (Rs./ m^2)	17200	17300	10500	13900
Mean Amount (Rs.)	$37x10^5$	$33x10^5$	$23x10^5$	$32x10^5$
Mean distance from the marsh (m)	1000	3915	6130	7800

A one-way ANOVA test, which is generally used to compare means of three or more than three groups was performed between the zones of varying distances from the marsh (Table 5). A higher F-statistic shows that the samples were drawn from populations with different mean values. The respective F-values ($p<0.01$) show that the division of the study area west of the Pallikaranai marsh into four zones of varying average distances from the marsh is statistically correct.

Table 5. One-way ANOVA for division of study area into four zones

	Source	Sum of Squares SS	Mean Square MS	F-Stat	P-Value
Area of residential plots (m^2)	Between Groups	$24.8x10^3$	8260	3.72	0.0132
	Within Groups	$28x10^4$	2220		
	Total:	$30.4x10^4$			
Price of residential plots ($x10^5$ rupees)	Between Groups	$2.7x10^3$	913	4.25	0.0068
	Within Groups	$27.1x10^3$	215		
	Total:	$29.8x10^3$			
Rate of residential plots ($x10^5$ rupees /m^2)	Between Groups	0.09	0.03	9.7	0
	Within Groups	0.37	0.00		
	Total:	0.46			
Average distance from the marsh (km)	Between Groups	847	282	1034	0
	Within Groups	34.4	0.27		
	Total:	881			

Since this part of the city has grown in recent years, the evolution of plot prices (in $x10^5$ rupees) over the past two decades is also studied. This is an interesting aspect relevant to the study and the data is collected from the website of the land registration department of Tamilnadu. The data obtained was from 2002 till current date and a one way Anova test was performed to compare means and the results were found to be as follows (Table 6).

Table 6. One-way Anova for time periods

Groups	N	Mean	Std. Dev.	Std. Error
9/6/2017-current	130	0.16	0.06	0.01
1/4/2012-8/6/2017	130	0.23	0.09	0.01
1/8/2007-31/3/2012	130	0.08	0.06	0.01
1/4/2003-31/7/2007	130	0.02	0.01	0.00
1/4/2002-31/3/2003	130	0.02	0.01	0.00

F-statistic value=364.00563; P-Value=0

Source	Sum of Squares (SS)	Mean Square (MS)	F-Stat	P-Value

Between Groups	4.38	1.1	364	0
Within Groups	1.94	0.0		
Total	6.33			

An observation of the means shows that during the period 1/4/2012 to 8/6/2017, the average plot rate was highest, of a value of Rs.23200/ m^2 and has dipped to Rs. 15700/ m^2 in the period 9/6/2017 to present. The Anova shows that the sample means are from different populations.
The slopes in the regression lines, (Rate vs. distance and price vs. distance) shows distance from the marsh negatively correlates with prices. Other data on the governmental attention towards the marsh which consolidated in the period following 2012 and later stringent action on encroachments following 2017 may be attributed as the cause for the plot prices as per our investigations.
Srivathsan et.al., (Srivathsan et al., 2021) have discussed that, in Chennai, affordable housing is available mainly in the peripheries, especially in the south and west, and even in these areas, the value of land is as high as Rs.1000/- to Rs.2000/- per $ft.^2$ (or Rs. 10,800/- to Rs. 21,500/- per m^2). If this is to be considered a baseline, one reads that the study area has witnessed an escalation in recent times. The difference in mean rates of plots between Zones 1 & 2 is found to be Rs. -70/-, while the difference in mean rates of plots between Zones 2 & 3 is found to be Rs. 6830/- Therefore the magnitude of aesthetic benefit due to lake proximity is arrived at by taking the average of the two, which amounts to Rs.3390/ m^2.
According to Mendonca et al. (2020), property and land tax as well as public transport subsidies play an important role in spatial location, as they affect households' willingness to pay for housing further away or closer to the city centre. They have also studied that, in the city of Aveiro, Portugal, the presence of environmental amenities attracts the wealthy to find housing in close proximity to the amenities. Another study by Scholte (2016) discusses wetland communities' perception of ecosystem services and their relationship to attitudes to restoration. The study by Zhou et al. (2020) discusses methods of quantifying ecosystem services in the rural-urban fringe of Netherlands applying various studies and comparing with CVM results for the same. Hill (2014) and Wang (2018) have used hedonic pricing method in studies on market values affected by environmental externalities. The significance of hedonic pricing studies in this context is further demonstrated by Sylla (Sylla et al., 2019), and discussed by Mendelsohn and Eagle (2004). This reiterates the importance of the hedonic pricing study and it adds value to the economic valuation in our study. Field observations showed us that the regions in proximity to the water bodies have been developed with greenery in the roads and parks and have an attractive quality. The richness in biodiversity makes the marsh a valuable resource. Research has shown that the wetland possesses aquatic grass species (29 sp.), scrubs (18 sp.), climbers (8 sp.) and sedges (9 sp.). The wetland has a great many faunal species including 10 sp. of mammals, 21 sp. of reptiles, 115 sp. of birds, 46 sp. of fish, 10 sp. of amphibians, 7 sp. of butterflies, 5 sp. of crustaceans and 9 sp. of molluscs (Jose et al., 2016; Vencatesan, 2007).
Key-informant interviews revealed that lands bordering the marsh, which were originally belonging to agricultural land use, were converted into residential land use with the help of the development authority (CMDA) and the erstwhile agriculturists have sold those lands. A system of registration, believed to be legitimate and effective, is seen to have encouraged people to encroach on the water bodies and canals, as they were all able to obtain a 'patta' or ownership document for their land. Field observations and observation from Google Earth showed existence of unmetalled roadways very close to the marsh edge coupled with outlier constructions, here and there.
Also, it happens to be a flood-sensitive area that may only partly deter occupants from taking over, as seen from experience. On the eastern edge, many high-rise residential complexes share a border with the marsh, but for our study, we have limited to the western side, which comprises one and two storey residences, tenements and canals and water bodies.

CONCLUSION

Our studies have shown the impact of the water body on land value and hence on the population growth. Similar studies demonstrating in detail, the value of ecosystem benefits for recreation and aesthetics have been examined to draw parallels. The conservation of the wetland will boost the living conditions and ecosystem value and a cost benefit analysis has shown the parameters involved. Hence, this needs to be implemented by all stakeholders for the benefit of the community. Our studies have shown that awareness is present to a limited extent, especially among economically higher sections of the population. Economic justification is an added tool to support restoration and prevent furthe damage to the ecological potential of the region. This paper has quantified environmental values and their economica values for the purpose of generating plans and policies with a pro-environmental attitude for the benefit of living being and other species. Maintaining water bodies is the only way to sustain biodiversity, which is very much called for, in a densely populated country like India.

Though this implies competition for land resources, effective planning and management can show the way for winning both ways, by practising sustainable development, and making it economically viable. Promoting biodiversity and protecting water bodies has longer-range positive impacts, which is often a neglected factor. Education and reworking our mistakes from traditional scientific conventions typically based on western philosophy may go a long way in achieving these goals.

DECLARATION

Funding: Not applicable
Conflicts of interest/ Competing interests: The authors declare no conflict of interest.
Availability of data and material: Not applicable
Authors contributions: Conceptualization:NKA & MM; Data curation:MM; Methodology:NKA & MM; Writing:MM; Research supervision:NKA; Editing:MM

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Article submitted to the Proceedings Book of the VI[th]. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

INNOVATION BY SUBSIDIES IN AGRICULTURAL PRODUCTION IN HUNGARY IN 2010S

Sándor J. ZSARNÓCZAI

National University of Public Service, Faculty of State Scientific and International Studies, Kálmán Széll State Finance Research Workshop, H-1083 Budapest, Ludovika tér 2. Óbuda University, Rejtő Sándor Faculty of Light Industry and Environmental Engineering Institute of Environmental Engineering, Doberdó u. 6, H-1034 Budapest, Hungary, e-mail: zsarnoczai@yahoo.co.uk

One of the main issues is income conditions of agricultural producers for period of 2008 and 2020 in Hungary in order to keep producers in this sector and in rural areas. The analyse method the special program for social sciences. The study analyses the income conditions of agricultural producers based on the total factor income per annual working unit. Total factor income per annual working unit has very strong correlations with gross value added –GVA in current price by 0.988, because of if the agricultural production, as output increased – even with less or little input as current production use – therefore the gross value added also can increase, which can be base for increasing income of annual working unit. This prosperity process can be followed by increase of total factor income per annual working unit (AWU) for period 2008-2020, when this has increased two times more by 210% for this time period. Total factor income per annual working unit has very strong correlation with total factor income by 0.969, when in Hungary the total factor income has increased by 162.7%, which also stimulated increase of total factor income per annual working unit. Gross value added should make considerable influence on the increase of the total factor income per AWU. Therefore, corelations have been very strong between themselves by 0.991 for the same period. The number of AWU should also decrease somehow, in order to increase the total factor per AWU, but it has only strong contradict correlations by Minus 0.585.

Keywords: *Annual working unit, correlation system, gross value added, income conditions, statistical analyse, total factor income*

INTRODUCTION

The case-study aims at analysing the importance of the agricultural industry in Hungary from point of view of *innovation for production technologies* supported by *subsidies provided from public finance* and *increasing the income possibilities for agricultural producers* by the other words agricultural holdings. It is important for all Hungarian economy that the agricultural producers included family farmers, mostly small and medium entrepreneurship not to escape for this economics sector. Because the agricultural sector provides renewable energy resources, mostly food for human society. *There is not sustainable society without sustainable agricultural industry*, because this sector only produces food for supplying demands of the consumers in human society. This condition makes agricultural industry be the first and basic strategic sector. All of these economic-social aims of this study are very actual even for further prosperity of agricultural sector.

The case-study focuses on the emphasizing the correlations of different economic variables, namely ***gross value added on the basic price*** *(GVA1)*, *real gross fixed asset accumulation all (*GFAAcc2), ***taxes*** **(***TAXES3),* subsidies (Subsidies4), total factor income (TFIncome5), number of annual working unit (NumberAWU6), total factor income per annual working unit (TFIAWU7), subsidies per gross fixed asset accumulation (SGFAAcc8). These economic variables are setting up each-others, because

the gross value added (1) is decreased by the gross fixed asset accumulation (2) and taxes (3), but this one is increased by the subsidies (4), which all of these calculations provide total factor income (5). Additionally, to creating total factor income, there is an also important view that how this total factor income is distributed for the annual working units and also, how many AWU-s can participate in share of total factor income. Because the income-able and profitability, finally as efficient agricultural production are depending not only from innovative developed level, but as well as the number of AWUs. Because a greater number of AWUs provides less factor income per each one AWU, or little number of AWUs provide or income per AWU. Therefore, the study analyses the correlations between number of AWUs (6) and income conditions of each one AWU (7).
The study also analyses the possible measure of the subsidies, therefore how the subsidies can be proportionate to the gross fixed asset accumulation (8). Because the gross fixed asset accumulation should include the innovation prosperity as essence of the advanced production technological process. There are two basic elements, which are important to be analysed in this study, namely the *innovation* for interest of sustainable agricultural prosperity and the income conditions by the other words, namely *total factor income per AWU*, who AWUs are responsible for the operating innovative advanced technology for interest of sustainable agricultural prosperity.
Also, the final important issue of the study how the subsidies can be measured for comparing with the gross fixed asset accumulation, naturally the *proportionate of the subsidies* for all of the gross fixed asset accumulation. From these points of views mentioned before some *hypotheses* can be summarised, which are as follows:

1- It can be proofed that the gross value added (GVA1) has very strong correlations with gross fixed asset accumulation (GFAAcc2), total factor income (TFIncome5) and total factor income per annual working unit (TIFAWU7).
2- It can be proofed that the gross value added (GVA1) has strong correlations with taxes (TAXES3), subsidies (Subsidies4) and contradicted correlations with number of annual working units (Minus) (NumberAWU6).
3- It can be proofed that the subsidies (Subsidies4) have very strong correlations with taxes (TAXES3) and strong correlations with gross fixed asset accumulation (GFAAcc2).
4- It can be proofed that the total factor income (TFIncome5) has very strong correlations with total factor income per annual working unit (TIFAWU7).

The analyse of data was needed for collecting main agricultural data base from the Hungarian Central Statistical Offices, which can also be used for the Eurostat of the European Union.
The EU declared about the subsidies concerning reforms as follows (ECA 2016; OECD 2003):
2003 Reform: The CAP reform, which introduced the decoupling of direct aid from agricultural production and payment of land to maintain land, environmental protection, food safety, animal and plant health and animal welfare (also known as mutual matching). The 2003 CAP reform has emphasized the promotion of production ("a support from production ") and an income support scheme which was largely based on the level of subsidies received by each agricultural growers during the given reference period.
2013 Reform: CAP Reform for the 2014-2020 period. Its purpose is to provide a more balanced distribution of available support and rewarding farmers with sustainable management practices through a specific "more environmentally friendly support". It also strives to improve the market orientation of EU agriculture, while farmers with external uncertainties and aims to further support rural development in the Member States. In the 2013 reform, payments were even more separated from their previous background, while gradually moved to payments per hectare in all Member States. The structure of direct payments has also been transformed and since 2015, for all farmers, a hectare-based basic payment, the "more environmentally friendly support for the agricultural practice, which is a result of the agricultural practice, which is a result of the agricultural producers, which is considered to be affected by economic producers" and composed of payments for young farmers. Member States, within certain limits, have a significant room for manoeuvre and to manage payments to address specific policy problems.
Although from a financial point of view, direct payments are the most significant; this is not the only tool that affects farmers the income of your income. More rural development measures at EU level, and a number of market and promotion measures for specific agricultural sectors. The Commission can intervene in a crisis situation by opening restricted access to intervention public or private

storage in specific markets, which affects market prices and thus agriculture producers' income. (ECA 2016; OECD 2003).
Subsidies for holdings concerning Hungarian fiscal practice, which developed from it, built on the application of non-conventional instruments of active government regulation and fundamentally based on the Fundamental Law (Hungary's constitution) adopted in 2011, particularly its chapter on Public Finances and the cardinal laws pertaining to public finances (see more detailed in Lentner, 2020 and Lentner 2021).
Some expert declared that the countries in Central and Eastern Europe (CEE) and the Newly Independent States (NIS) are a diverse group in terms of their economic and social structures, and technology and innovation profiles, as well as in their patterns and extent of resource use. Many of them still require industrial growth to realize their national development objectives and to reduce the income gap with industrialized countries. The challenge for them is to find and implement a model of industrial growth that is more resource and energy efficient, and is low carbon and low waste (Ürge-Vorsatz et al. 2006; McKane et al 2009; Buchan 2010; Mostert 2010).
In spite that the agricultural prosperity in Hungary has realized a considerable increase, there are *some important difficulties, which have remined for the researched period.* The subsidies were considerable for Hungarian agricultural holdings and their share was - in the real gross fixed asset accumulation, by the other name consumption of fixed capital - more than share of total subsidies in field of consumption of fixed capital in all of the EU, namely by about 88%, while in Hungary this was 185% by the end of the same year, as 2016. The main problem was that the Hungarian agricultural producers by the other name *holdings were very separated* in the examined – analysed period. Therefore, *number of the AWU-s* in Hungary was higher than in the former15 EU-member states, which led to *less total factor income per AWU* in Hungary than in cases of former EU member states. The *weak capital force* of Hungarian holdings could ensure somehow backwardness for them and less competitive positions in single market of the EU, even the international market competitiveness in fields of mechanization, food manufacture. The Hungarian holdings need more for the *extension services* and supervisory for creating the planning, making projects and to become more competitive, increasing qualified demands to balance their less competitive backwardness comparably with competitiveness of farmers of former EU-member states. The *lack of capital* and somehow *lack of knowledges* need more extending activities to mitigate their backwardness accompanying with *improving the bank services* to supply credits for holdings. Also, it is important to develop the *product channel systems* in fields of each different kinds of agricultural and food products. Improving the mechanization should be realised even for small and medium scale farms in Hungary.

MATERIALS AND METHODS

The actual statistical method is based on the SPSS system (Special Program for Social Sciences) including eight economic variables accompanying with different years included in the time period. The SPSS statistical analyses are based on the works of Sajtos - Mitev (2007).
This analyses method includes calculation of the total factor income based on gross value added, fixed capital, other taxes and subsidies, and also, changes of gross value added (GVA1) *on basic price (output-input*), gross fixed asset accumulation (GFAAcc2), taxes (TAXES3), subsidies (Subsidies4) and real total factor income (TFIncome5) in agriculture of Hungary in value in Million HUF (Hungarian Forint) between 2008-2020 (HCSO 2021), (mez0002), (mez0005). The SPSS analyses focus on the correlation matrix among economic variables, and finally the Dendrogram using ward linkage, rescaled distance cluster combine concerning the SPSS owned calculation based on the data-bases coming from HCSO (2021).

STATISTICAL ANALYSIS AND GRAPHICAL PRESENTATION

In this part of the case-study there are short describes about tables and figures demonstrating the data-base. The Table 1 includes the Abbreviation of economic variables either by short names or their meanings for determining the time-length and source of data bases, which the analyses are connected. The other tables and figures demonstrating the analysing process following data base.

Table 1. Abbreviation of economic variables

Variables Abbreviation	Variable names	Period	Source/Data base
GVA1	**Gross value added on the basic price**	2008-2020	HCSO, 2021
GFAAcc2	*Real gross fixed asset accumulation all*	2008-2020	HCSO, 2021
TAXES3	**Taxes**	2008-2020	HCSO, 2021
Subsidies4	Subsidies, in Million HUF	2008-2020	HCSO, 2021
TFIncome5	Total Factor Income	2008-2020	HCSO, 2021
NumberAWU6	Number of Annual Working Unit	2008-2020	HCSO, 2021
TFIAWU7	Total Factor Income / Annual Working Unit	2008-2020	HCSO, 2021
SGFAAcc8	Subsidies/ Gross Fixed Asset Accumulation	2008-2020	HCSO, 2021

Source: System of agricultural accounts at current basic prices, in %, in current basic price, in Million HUF, HCSO (Hungarian Central Statistical Office), 2021, Budapest, Hungary
https://www.ksh.hu/stadat_files/mez/hu/mez0002.html
https://www.ksh.hu/stadat_files/ara/hu/ara0051.html
https://statinfo.ksh.hu/Statinfo/haViewer.jsp?wcf15eb7a36=x
https://statinfo.ksh.hu/Statinfo/haDetails.jsp

Table 2. Calculation of the Total Factor Income based on gross value added, fixed capital, other taxes and subsidies during period of 2008-2020 (2008=100) in percent based on Million HUF

Title/Years	2008	2010	2012	2014	2016	2018	2020
GVA1	100	-20	110	147	158	163	178
GFAAcc2	100	-4	114.5	141	112	172	204
TAXES3	100	133	187	182	202	218,2	266
Subsidies4	100	117	143	164	137	147	158
TFIncome5	100	-10	121.6	155.4	161.4	153.8	162.7
NumberAWU6	100	102	-0.4	106.4	-0.2	-10	-22.4
TFIAWU7	100	-12	122.2	146	162	171	210
SGFAAcc8	152	183	190	177	185	129	117

Source: HCSO (Hungarian Central Statistical Office, 2021): System of agricultural accounts at current basic prices, Budapest, Hungary, (mez0002), (mez0005)

In case of Table 3 the correlation matrix provided data, which can be titled as values for the correlations among the economic variables by two different kinds of levels, namely if the value as correlation among economic variables are between 0.800 and 1.000, this means that the correlation is very strong, if this value is between 0.500 and 0.800, in this case the correlation is strong, or if the value is under 0.500 the correlation is not important for the aims of the researches and analyses.
The sign “Minus” is not a negative value, but the correlations are contradicted among the economic variables. The negative economic variables have contradicted correlations with all of other variables, which are not negative.

Table 3. Correlation Matrix[a]

	GVA1	GFAAcc2	TAXES3	Subsidies4	TFIncome5	NumberAWU6	TFIAWU7	SGFAAcc8
GVA1	1.000	**.941**	**.706**	**.638**	**.991**	**-.617**	**.988**	-.483
GFAAcc2		1.000	**.762**	**.675**	**.906**	**-.625**	**.964**	**-.681**
TAXES3			1.000	**.831**	**.671**	**-.816**	**.781**	-.475
Subsidies4				1.000	**.656**	-.459	**.666**	-.188
TFIncome5					1.000	**-.585**	**.969**	-.370
NumberAWU6						1.000	**-.687**	.387
TFIAWU7							1.000	-.547
SGFAAcc8								1.000

a. This matrix is not positive definite.

Source: SPSS owned calculation based on the HCSO (Hungarian Central Statistical Office, 2021): System of agricultural accounts at current basic prices, Budapest, Hungary, (mez0002), (mez0005)

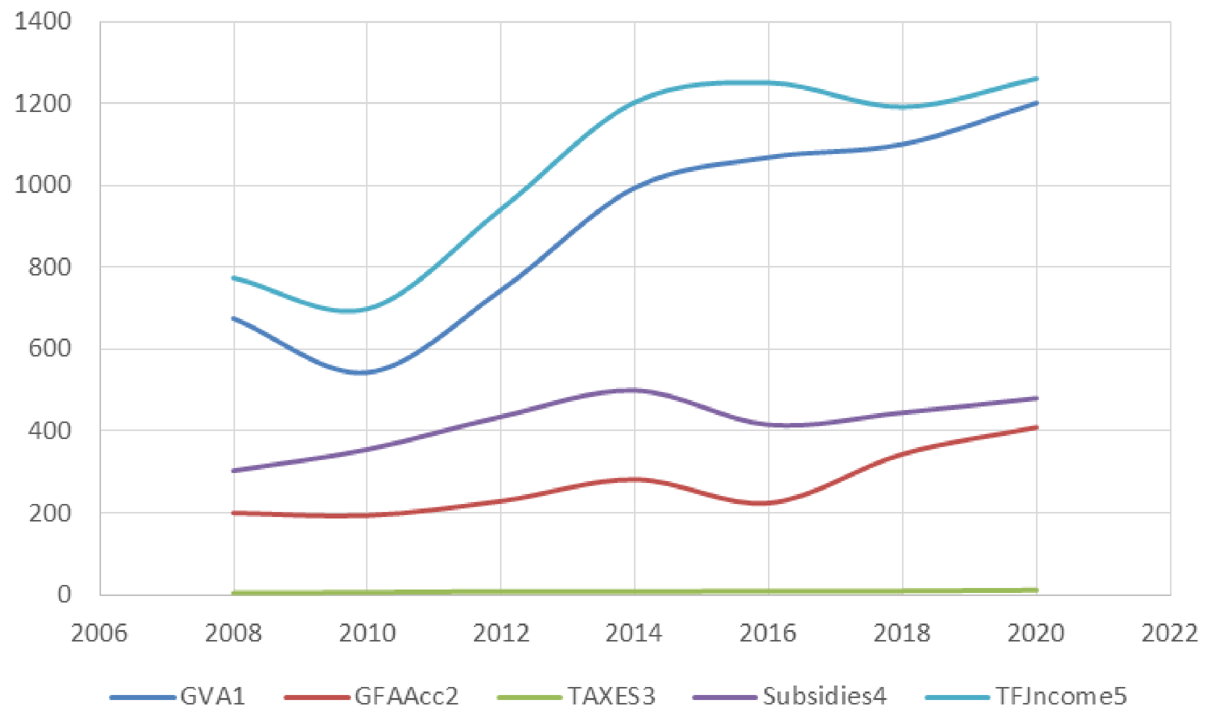

Figure 1. Changes of gross value added (GVA1) *on basic price (output-input)*, gross fixed asset accumulation (GFAAcc2), taxes (TAXES3), subsidies (Subsidies4) and real total factor income (TFIncome5) in agriculture of Hungary in value in Million HUF between 2008-2020

Source: HCSO (Hungarian Central Statistical Office, 2021): System of agricultural accounts at current basic prices, Budapest, Hungary, (mez0002), (mez0005)

Total Factor income (TFIncome5) = {*GVA1– GFAAcc2 – Taxes3} + Subsidies4*

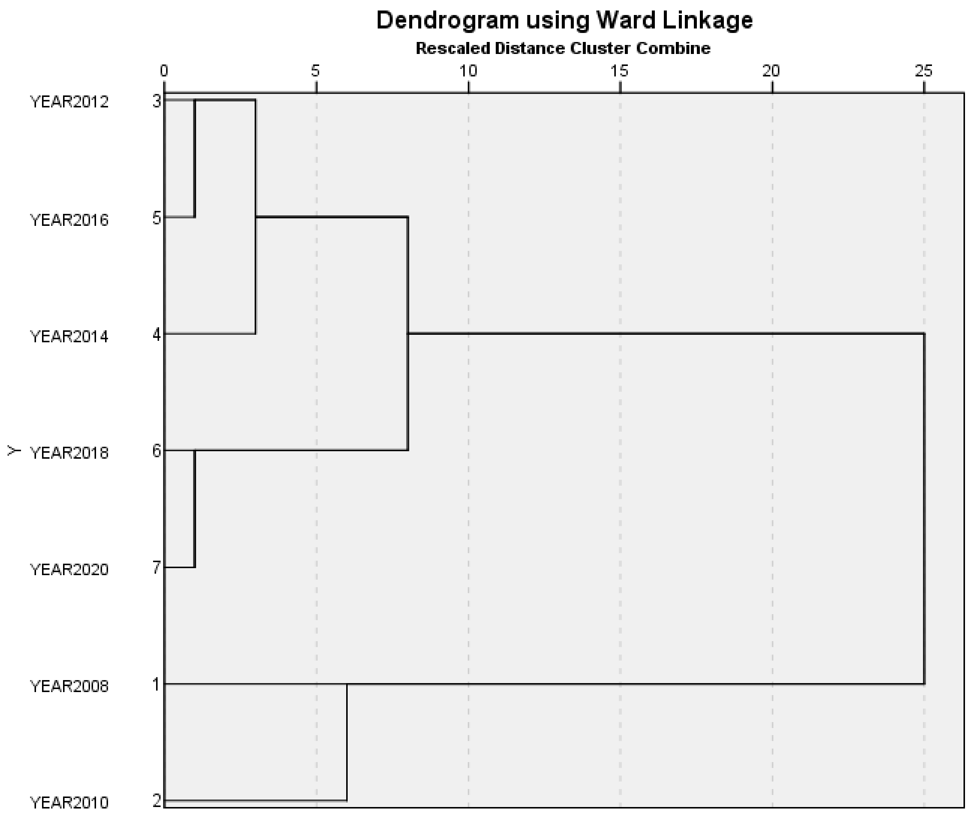

Figure 2. Dendrogram using Ward Linkage, Rescaled Distance Cluster Combine

Source: SPSS owned calculation based on the HCSO (Hungarian Central Statistical Office, 2021): System of agricultural accounts at current basic prices, Budapest, Hungary, (mez0002), (mez0005)

RESULTS AND DISCUSSION

TFI (total factor income) per AWU (annual working unit) (TFIAWU7) has very strong correlations with *gross value added* (GVA1) in current price by 0.988, because of if the agricultural production, as output increased – even with less or little input as c*urrent production use – therefore the gross value added also can increase, which can be base for increasing income of annual working unit. This prosperity process can be followed by the increase of total factor income per AWU for the period of 2008 and 2020, when this has increased two times more by 210% for this time period. Also, the total factor income per AWU (TFIAWU7) has very strong correlation with total factor income (TFIncome5) by 0.969, when in Hungary the total factor income has increased by 162.7%, which also stimulated increase of TFI per AWU. Naturally the GVA also should make considerable influence on the increase of the total factor income per AWU. Therefore, correlations have been very strong between themselves by 0.991 for the same period. The number of AWU (NumberAWU6) should also decrease somehow, in order to increase the total factor per AWU, but it has only strong contradicted correlations by (Minus) 0.585.*
The number of AWU has decreased only by moderate level as 22.4%. Their number has decreased from level of 435 thousand to level of 337 thousand for the twelve years. The difficulty of the Hungarian agriculture is little land used concentration, which shows a relatively large number of AWU. This can be proofed by the little average measure of holding in Hungarian agriculture, for example by the end of 2016 the utilised agriculture area per holdings was averagely hectare land, while the 81% of the holdings had less than five hectare utilised agricultural areas (EC 2021; Table 3; Figure 1; HCSO 2021).

Also, the real gross fixed asset accumulation (consumption of fixed capital) *(GFAAcc2), has very strong correlations with the total factor income per AWU (TFIAWU7) by 0.964* between 2008-2020, *because the increasing trends of the gross fixed asset accumulation have been by 204% for the same period.*
The investment for the agricultural production in Hungary stimulated to introduce new innovative advanced technology – even highly developed technology (hightec), which also can provide favourable production conditions for obtaining better income possibility for holdings.
Additionally, to the total factor income per AWU, the gross fixed asset accumulation has also very strong correlations with increasing or decreasing *total factor income* (TFIncome5) by 0.906, which also are very closed to 1.000 value or 100%. This means that the more innovative favourable conditions of the gross fixed asset accumulation provide adequate bases for the better price income with producing price level. Therefore, the *total factor income* conditions can increase more.
If the adequate investments can be realised in the Hungarian agriculture by increasing volume of gross fixed asset accumulation, this can stimulate increasing more selling products for consumers with accompanying increasing incomes of holdings and by increasing capital strengthen, agricultural producers will be stimulated to realise *more investments, as fixed capital by creating more jobs* even in agricultural sector to strengthen the rural development.
The number of annual working units (NumberAWU6) also should decrease in order that the total factor income per AWU could increase, therefore total factor income per AWU (TFIAWU7) has strong negative correlation by the other word contradict correlation with changes of number of annual working unit by (Minus) 0.687. But concentration of agricultural production by decreasing number of annual working units can concentrate or increase the investment as real gross fixed asset accumulation, which means that this last economic variable has strong contradict correlations with number of AWU by (Minus) 0.626.
The *real gross fixed asset accumulation* is also depending on changing taxis by 0.762 and subsidies by 0.675 strong correlations. In case of Hungarian agriculture, the value of taxes is not so considerable amount, therefore the real gross fixed asset accumulation can increase, accompanying with the little increase of taxes. The little increasing amount of taxes does not restrict the investment process even in fields of gross fixed asset accumulations. Therefore, the increasing trend can be in fields of either taxes or gross fixed assets in the same time. Also, the subsidies (Subsidies4) stimulate to increase the real gross fixed asset accumulation by strengthening the capital force of holdings and to introduce more innovative investments in the agricultural sector.
In order to overview the importance and measure of *subsidies* (Subsidies4) given by *public financing resources,* the *share of the subsidies can be measured comparably to the gross fixed asset accumulation* (GFAAcc2 by the other name as the consumption of fixed capital, as 100%. In this case the share of subsidies was 152% in 2008; 183% in 2010; 190% in 2012; 177% in 2014; 185% in 2016; 129% in 2018; 117% in 2020. These data show that the measure of subsidies comparably to gross fixed asset accumulation has been fluctuating between 117% and 190% for the researched period of 2008-2020. Most of the cases measure of subsidies was averagely one and half times more than the value of the gross fixed asset accumulation, which means that the *subsidies mainly focused on the innovative technological development in the agricultural industry*.
The agricultural holdings can only develop the agricultural innovative technology and production by subsidies, otherwise the agricultural industry cannot develop to supply demands of the world market and single market of the European Union, therefore the Hungarian agricultural holdings will lose their market-share and will be backwardness in the international competition even in the Hungarian domestic market.
The Table 3 shows the correlations between the *gross fixed asset accumulation* (GFAAcc2) and *share of subsidies in gross fixed asset accumulation* (SGFAAcc8), which means that the correlations are strong between both of them, but contradicted by (Minus) 0.681, namely by one hand if the gross fixed asset accumulation increases the share of the subsidies decreases in fixed asset accumulation. By the other hand if the gross fixed asset accumulation decreases the share of the subsidies increases in fixed asset accumulation.
These correlations can be true, because the measure of subsidies for holdings (agricultural producers, companies, family farms) is somehow determined by the common agricultural policy of the European Union for longer time-lengthen, as seven-year period based on the common budget of the EU.

Naturally the national budget of the EU-member states can contribute more financial subsidies for the agricultural production additionally to the subsidies coming from the common budget. From this point of view, the share of the subsidies can be somehow fixed comparably to measure of the gross fixed asset accumulation, therefore, if the gross fixed asset accumulation increases the share of subsidies can decreases or increases in case of decreasing measure of fixed asset accumulation. This is generally true in case of agricultural industry in Hungary, but some branches of this sector can be different from these correlations between these two economic variables.
The gross fixed asset accumulation can mostly be depending form the willingness of agricultural companies and family farmers (agricultural holdings) and incentives of the agricultural policy from the EU level and national economic levels of the EU-member states in direction to make agricultural investment activities be more ambition. Naturally the willingness of agricultural producers in direction into the investment is based on the national and international backwardness. For example, price level of agricultural and food products in the single market of the Eu and in the world market; price level of the agricultural input accompanying with income conditions for agricultural holdings can make influences on the performance of agricultural holdings either in Hungary or in the EU.
Also, the *share of the of subsidies* in gross fixed asset accumulation (SGFAAcc8) is important, because from these correlations of these two economic variables, these subsidies are important to increase extending innovative production technologies by investment in field of the agricultural production. The share of the subsidies shows their importance and efficiency for the increasing trends of investments.
Also, the share and *measure of the subsidies can be compared the measure of the total factor income* (TFIncome5), namely this was 41% in 2008; 55.4% in 2010; 48% in 2012; 41.5% in 2014; 35% in 2016; 37% in 2018; 36% in 2020 (Table 1; Table 2; Table 3; Figure 1; HCSO 2021). In these cases, the share and measure of the subsidies has considerably been less than measure of the total factor income for the researched period comparably to the measure of the gross fixed asset accumulation. The reason generally is that the aim of the subsidies was not just only to complete the total factor income for annual working units, but subsidies wanted to increase the developed level of the agricultural engineer mechanizations and mechanical equipment including agricultural machines, irrigation system, veterinary means and milking machines, cereal-corn drying stores, closed-concrete animal manure stores and others.
Logic of the subsidies, as public finance that the innovative development financed by subsidies, therefore, more yields and output resulted by innovation can lead to more price income even by the same level of producing price as in earlier. This can be titled as *intensive agricultural development* in EU, which means increase of yield per hectare and per animal unit, which this last one is one milking-cow. Therefore, the subsidies aim first at developing agricultural production by intensive innovation and then to increase the total factor income even per annual working unit.
The *subsidies (Subsidies4) also have very strong correlations with taxes (TAXES3)* by 0.831, because both of them have had consequent and prosperity increasing trends for the whole researched period. Naturally if the taxes increase, the subsidies obligatory should increase in order that farmer and agricultural holdings must not have income-looses.
In the same time increasing trends of the subsidies are accompanying with increase of the gross value added, which provides proof that the subsidies first aim at increasing level of the innovative advanced technological development. Therefore, the subsidies have strong correlations with the gross value added (GVA1) by 0.638. Additionally, to above mentioned correlations the subsidies have strong correlations with increase of total factor income by 0.656 and total factor income per AWU by 0.666, because the subsidies have positive influences on the increasing trends of total factor income in any cases.
The *taxes (TAXES3)* have contradicted correlations with increasing or decreasing number of annual working unit (NumberAWU6) by (Minus) 0.816 in Hungary, because if the number of AWU increases the taxes are decreasing, which can be experienced in the data base (Table 1; Table 2; Table 3; HNSO 2021). Naturally if the total factor income or total factor income per AWU increase the taxes should also increase in the same time, therefore taxes have strong correlations with total factor income per AWU (TFIAWU6) by 0.781 and with total factor income (TFIncome5) by 0.671 within the researched period.

The gross value added (GVA1) has also very strong correlations with real gross fixed asset accumulation (GFAAcc2) namely by 0.941, which means that investment intensity can make considerable influences on the increasing output and even decreasing input, as production cost by using more efficient technologies probably closed to the innovative technologies. Also, more gross value added can stimulate more income for realising further more intensive advanced investment. In the case of little increase of taxes (TAXES3), the gross production, as output and within the output the gross value added can increase.

Mostly the low level of the taxes can basically stimulate the agricultural production, therefore, increase of the output and gross value added, finally this low level of taxes can ensure more supply the demands of domestic and international markets. It can be seen, that the gross value added has strong correlations by 0.706 with the level of taxes.

The gross value added (GVA1) has strong contradicted correlations with economic variable namely number of AWU (NumberAWU6) by (Minus) 0.617. From this point of view, this means that the efficient use of AWU, as an input can be implemented, then a smaller number of AWU can provides more gross value added. Naturally if one element of input can be cheaper – even by decreasing number of AWU – the gross value added, as result of output-input = GVA, can increase. In case of Hungarian agricultural industry this trend can be followed. But also, the negative trend can happen in case of some economic difficulties, which can make cost of AWU be higher level, therefore the gross value added can be declining.

In case of Hungarian agriculture after 2012 the positive trend of gross value added could realise by little decrease of number of AWU, which can also be followed in Figure 1, where the gross value added could increase by the same rate accompanying with growing rate of total factor income concerning the better income position of the AWU. This could also be realised by the similar or closed growing rates of subsidies and gross fixed asset accumulation. Either favourable growing rate of gross fixed asset accumulation can provide better possibility to use advanced innovative production technologies or consequent increase of subsidies providing more income possibility for holders to increase their fixed assets as investments at low level of taxes - can contribute to the highly level increase of total factor income (Figure 1; HCSO 2021).

From the finds of the study how much the subsidies can have sensitive role in the agricultural innovative production development, which either provides more financial resources or the innovative technologies can be invested by more financial support into gross fixed asset accumulation.

The gross fixed asset accumulation (GFSScc2) decreases value of the gross value added (GVA1 = output-input) with value of taxes (TAXES3) together, but the subsidies (Subsidies4) contribute to increase the total factor incomes (TFIncome5). At agricultural industrial level this total factor income is distributed to all of annual working units (AWU) (NumberAWU6), which will be finally as total factor income per AWU (TFIAWU7).

The *Figure 2* shows the dendrogram using ward linkage; rescaled distance cluster combine based on the SPSS owned calculation and concerning system of agricultural accounts at current basic prices (HCSO 2021), (mez0002), (mez0005).

Figure 2 shows that in the different years how the economic variables changed therefore based their changes they distribute years into different clusters. This means that in the year2012 and year2016 and period between themselves with year 2014 were successful, while the year2008 and year2010 were not successful. Naturally the corona virus period could make little decline for the agricultural prosperity in year2018 and year2020.

CONCLUSIONS AND RECOMMENDATIONS

From the finds of the study how much the subsidies can have sensitive role in the agricultural innovative production development, which either provides more financial resources or the innovative technologies can be invested by more financial support into gross fixed asset accumulation.

The gross fixed asset accumulation (GFSScc2) decreases value of the gross value added (GVA1 = output-input) with value of taxes (TAXES3) together, but the subsidies (Subsidies4) contribute to increase the total factor incomes (TFIncome5). At agricultural industrial level this total factor income

is distributed to all of annual working units (AWU) (NumberAWU6), which will be finally as total factor income per AWU (TFIAWU7).

The *subsidies* as themselves cannot be enough for the realising innovative prosperity for agricultural sector, because this needs for the self-capital force of agricultural holdings based on the factor incomes and their continuous improving knowledge to use more advanced innovative technologies based on the favourable national, international markets and single market of EU.

Finally, some *hypotheses* can be proofed based on the finds of the researches and analyses, which are as follows:

1- The gross value added (GVA1) has very strong correlations with gross fixed asset accumulation (GFAAcc2) by 0.941, total factor income (TFIncome5) by 0.991 and total factor income per annual working unit (TIFAWU7) by 0.988.
2- The gross value added (GVA1) has strong correlations with taxes (TAXES3) by 0.706, subsidies (Subsidies4) by 0.638 and contradicted correlations with number of annual working units (Minus) (NumberAWU6) by -0.617.
3- The subsidies (Subsidies4) have very strong correlations with taxes (TAXES3) by 0.831 and strong correlations with gross fixed asset accumulation (GFAAcc2) by 0.675.
4- The total factor income (TFIncome5) has very strong correlations with total factor income per annual working unit (TIFAWU7) by 0.969.

For the further agricultural conditions there some important elements should be followed by agricultural holdings in Hungary to supply adequate and qualified demanded agricultural and food products based possible vertical integrated product channel accompanying with horizontal cooperation among farmers and agricultural producers within given kinds of products as for example crops, animal, animal products and fruit -vegetables and others.

ACKNOWLEDGEMENT

The study was supported by the Kálmán Széll State Finance Research Workshop, Faculty of State Scientific and International Studies, National University of Public Service.

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Article submitted to the Proceedings Book of the VIth. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

A RELATION BETWEEN EXTREME DAILY PRECIPITATION AND EXTREME SHORT TERM PRECIPITATION

Yanina L. ROMERO[1*], J. BESSEMBINDER[2], N.C. van de GIESEN[3], F.H.M. van de VEN[3]

[1]*Beuningen, The Netherlands, p.bronkhorst8@upcmail.nl*
[2]*Climate Services, Royal Netherlands Meteorological Institute, De Bilt, The Netherlands*
[3]*Water Management, Delft University of Technology, Delft, The Netherlands*

The Royal Netherlands Meteorological Institute (KNMI) has published the KNMI'06 climate scenarios in 2006. These scenarios give the possible states of the climate in The Netherlands for the next century. Projections of changes in precipitation were made for a time scale of 1 day. The urban drainage sector is, however, more interested in projections on shorter time scales. Specifically, time scales of 1 hour or less. The aim of this research is to provide projections of precipitation at these shorter time scales based on the available daily scenarios. This involves an analysis of climate variables and their relations to precipitation at different time scales. On the basis of this analysis, one can determine a numeric factor to translate daily projections into shorter time scale projections.

***Keywords**: correlation, extreme, precipitation, ratio, urban, variables*

INTRODUCTION

Rising temperatures are generally expected to be accompanied by increases in rainfall intensities at mid- and high latitudes (Meehl et al. 2005 & 2007). Urban areas are especially vulnerable to increased rainfall intensities, especially during convective summer storms (Smith et al. 2002; Water et al. 2003; Kundzewicz et al. 2007). Regional impacts will differ from average climate predictions, which make regional studies necessary, such as this one for The Netherlands. The goal of this study is to examine the impact of possible climate change on rainfall intensities at a time scale of 1 h.
The Royal Netherlands Meteorological Institute (KNMI) developed four KNMI'06 climate scenarios that provide information on projected changes in daily precipitation. These scenarios are based on a large number of global and regional climate models. For urban drainage design, daily precipitation is less relevant; critical response times of storm sewerage and surface drains are in the order of minutes to hours (Smith et al. 2002; Ntelekos et al. 2008). Regional climate model output on peak precipitation for shorter time scales is not (yet) reliable enough to allow for a publishable estimate. Therefore, a new method was developed to study the relation between daily and shorter time interval precipitation from historical data. The objective is to use variables available in the KNMI'06 scenarios to obtain conditional relations between daily and shorter interval precipitation. If it can be assumed that these relations will remain more or less the same in the future, estimates could also be made for short term peak precipitation in the future.

MATERIALS AND METHODS

The applied methodology involves selection of climate variables that are likely to affect rainfall intensities at the desired short time scales, acquisition and selection of historical data, and the analysis of correlations between variables available in the KNMI'06 scenarios and the ratio of 1 h and daily precipitation. The selection of the KNMI'06 scenarios is based on two steering parameters: change in global mean temperature and change in air circulation pattern. This resulted in four scenarios shown in Figure 1. The scenarios span a large part of the uncertainty about our future climate, and they are a translation of larger scale climate change projections to climate change in The Netherlands. It was first assumed at KNMI in 2007 that extreme hourly rainfall would change in the same way as the extreme daily rainfall. This research aimed at checking this hypothesis and providing a further elaboration of the KNMI'06 scenarios with information about hourly precipitation extremes and quantification thereof. Explanatory climate variables that could be linked to the steering parameters in the KNMI'06 scenarios were selected to this end. These variables were then analyzed with hourly and daily precipitation.

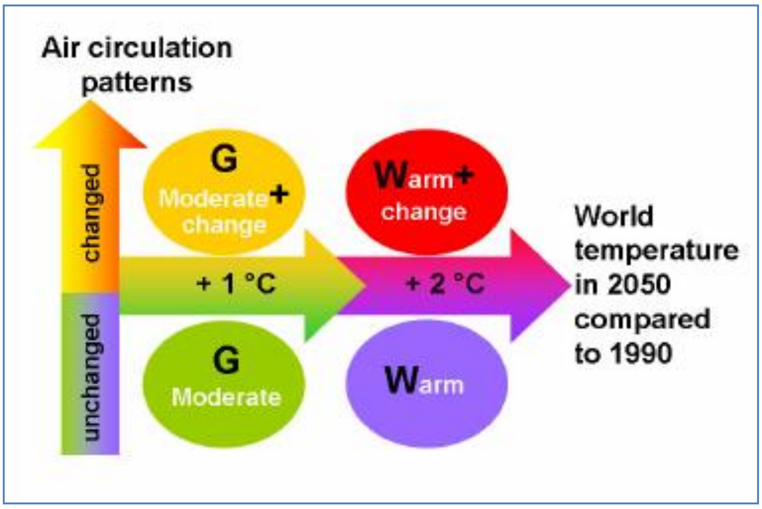

Figure 11. The Four KNMI'06 Climate Scenarios (Royal Netherlands Meteorological Institute, Climate Change Scenarios 2006 for the Netherlands, Scientific Report, WR 2006-01, De Bilt, The Netherlands 2006)

Selection of climate variables

The main variables that, *a priori*, could have an influence on extreme precipitation include:

- wind (speed, direction) or wind at higher altitudes
- air temperature
- humidity
- air pressure
- sea-surface temperature (The Netherlands)

Based on literature study and expert consultation, wind direction and maximum daily air temperature were chosen to be used for further analysis.

Some studies conducted in the Iberian Peninsula and the British Isles have led to the conclusion that a correlation exists between wind or atmospheric circulation and extreme precipitation (Phillips and McGregor 2001; Gallego et al. 2005; Mitchell and Phillips 2006). KNMI concluded that wind direction but not wind velocity was an indicator for precipitation (Overeem et al. 2008). Wind direction or, better, geostrophic circulation (wind at higher altitudes) could be an explanatory climate variable linked with differences between the KNMI'06 scenarios. The wind direction at higher altitudes determines from where air masses are transported to The Netherlands, for example from over the ocean (generally moist) or over land (in summer often dry and warm). Rain cloud formation is often caused by south-westerly circulation, corresponding to a limited range of G-West values. Under such circulation patterns, warmer air from the Mediterranean region is transferred to The Netherlands after absorbing moisture over the North Sea. At the surface the wind direction can be different, due to friction. G-west is a measure used at KNMI to quantify geostrophic wind from

westerly direction. G-West is the magnitude of the velocity of the wind coming from the west at 270°. A negative value of -2.6 m/s would correspond to a wind coming from the east at 90° with a speed of 2.6 m/s. G-west is thought to be an important explanatory variable for precipitation. A data series was compiled based on data from the ERA-40 database (Lenderink and van Meijgaard 2008) for The Netherlands and they are available from 1958. G-west is determined six times daily and is derived from surface pressure. For this study, average daily values are used.
Warm weather has been found to be key for short duration, high intensity rainstorms (Doswell et al. 1996; Chang 1998; Smith et al. 2002). Former analysis showed that the annual maxima for 24 h and 4 h mostly occurred during the months May-September. KNMI experts also indicated that maximum daily temperature could be an explanatory climate variable that can be linked with differences between the KNMI'06 climate scenarios. Warmer air can contain more moisture which is favorable for precipitation. Maximum daily temperature can be used instead of average daily temperature because it can easily be linked to KNMI'06 climate scenarios, which provide average daily temperature. Based on observations over the last 30 years, the difference between maximum, minimum, and average daily temperature did not really change. It is assumed that this relation between maximum, minimum, and average temperatures will not change in the future.

Selection and validation of historical data

KNMI has an automatic and manual rain gauge network to record precipitation. Until the 1970s, mechanical pluviographs were used as automatic rain gauges. Pluviographs have since then been replaced by electronic rain gauges. At the automatic stations, each hour recordings are made, at the manual stations only once per day. The 60-min precipitation data used in this paper were recorded with automatic rain gauges because the 60-min precipitation data recorded before 1980 have not yet been digitized. The quality of the 60-min automatic measurements was checked by comparing their daily sums with 24-h manual measurements.
At KNMI in The Netherlands, historical precipitation data is available for daily, 1-h and 10-min observational time segments. Many years of historical data are available for precipitation amounts on a daily basis. In comparison, fewer years of data are available on an hourly basis. Less than 25 years of data are available for shorter time intervals including 15-min or less. Five to 10 min data is the most interesting for urban drainage and urban water management. Urban water managers wish to have information about 10-min precipitation recordings as the characteristic time of urban runoff processes is of that order of magnitude (Graf 1977; Smith et al. 2002). However, 10-min recordings are not validated and/or the available number of years is too limited to cover most of the natural variability.
That is why it was decided to use validated 60-min precipitation data recorded at the station De Bilt in The Netherlands for this research. The station De Bilt was chosen for the long (>50 years) time series available for both daily and hourly precipitation. A minimum of 30 years of data is generally used to describe most of the natural variability, but for extreme values preferably even larger time series are used (Heijboer and Nellestijn 2002). In addition, De Bilt is a non-coastal location where there is hardly or no effect of seawater temperatures on extreme precipitation therefore making it easier to link extreme precipitation to air temperature and G-west. It is also recognized that urban areas may exacerbate formation of summer storms (Ntelekos et al. 2008) due to the urban heat island and that this effect is also not reflected in the time series of De Bilt.

STATISTICAL ANALYSIS AND GRAPHICAL PRESENTATION

The analysis consists of three parts. First, an exploratory analysis of the correlation between temperatures and precipitation extremes is put forward. Second, a similar analysis concerning the correlation between circulation patterns (G-west) and precipitation extremes is given. Finally, the ratio between daily and hourly precipitation as a function of maximum daily temperature and G-west is given, which allows for temporal downscaling on the basis of climate projections.

Temperature and precipitation extremes

A visual technique was used to obtain a first idea of how maximum daily temperature and G-west correlate with daily precipitation. Scatter plots were made using other climate variables to obtain a sense of when and under which circumstances extreme precipitation occurs. Raw data hardly show a relation between daily precipitation and maximum daily temperature.

Based on the data series 1958-2006, Fig. 2 presents a scatter plot of maximum daily temperature versus maximum hourly precipitation per day. It shows no clear relation between precipitation and temperature. However, the maximum values seem to have some relation with temperature. An interesting point is that extreme hourly precipitation amounts of more than 20 mm (shown in Fig. 2) do indeed occur during warmer temperature days of 20ºC and above. However, in a plot of the annual maximum precipitation against temperature, there is no clear relation. Annual maxima often occur during the summer half of the year with relatively high temperature (STOWA 2004). The main focus of this research is extreme precipitation and therefore these months will be analyzed further.

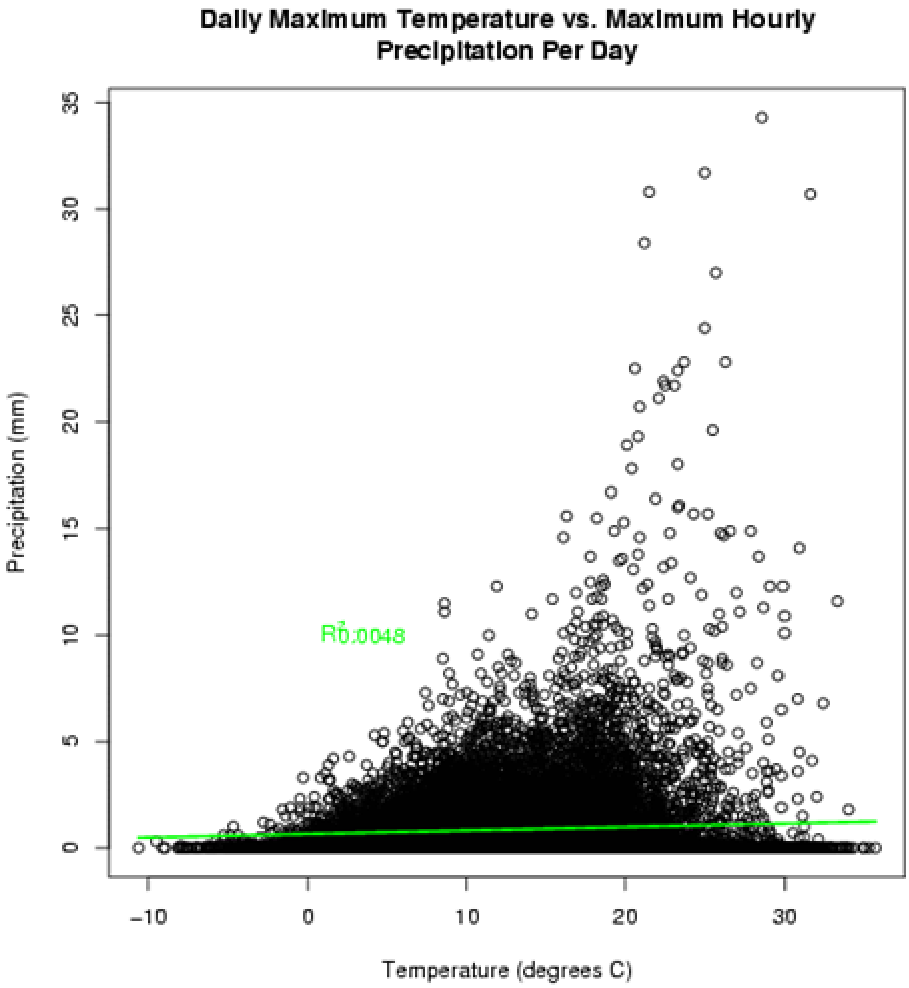

Figure 12. Maximum daily temperature vs. maximum hourly precipitation per day for De Bilt 1958-2006. *Green line* is the linear regression value of 0.0048

Circulation and precipitation

The second explanatory variable for climate change in The Netherlands is G-west. As mentioned earlier, G-west is derived from surface pressure. Figure 3 shows a scatter plot of G-west and daily precipitation for De Bilt during summer months June, July, and August. Figure 4 is a plot of G-west and maximum hourly precipitation per day.

Both Figure 3 and Figure 4 show that extreme daily precipitation and extreme maximum hourly precipitation per day occurred with a G-west value close to 0 m/s. This suggests that daily maxima and hourly maxima may occur during the same or similar meteorological conditions. Correlation between maximum daily temperature and G-west was not significant (>95% confidence). Therefore, we can assume for the remainder of this analysis that maximum daily temperature and G-west are independent of each other.

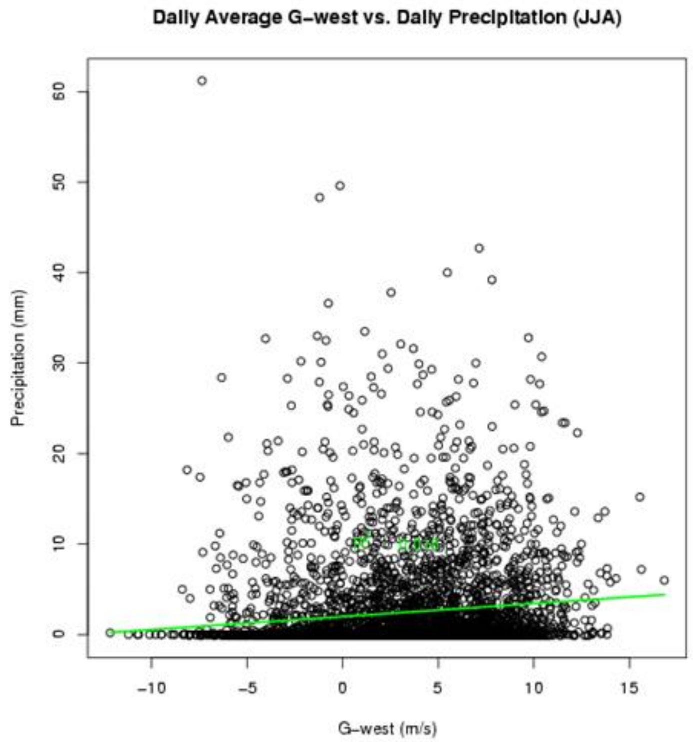

Figure 13. Daily average G-west vs. daily precipitation for summer months (De Bilt 1958-2006). *Green line* is the linear regression with a regression coefficient r^2=0.015

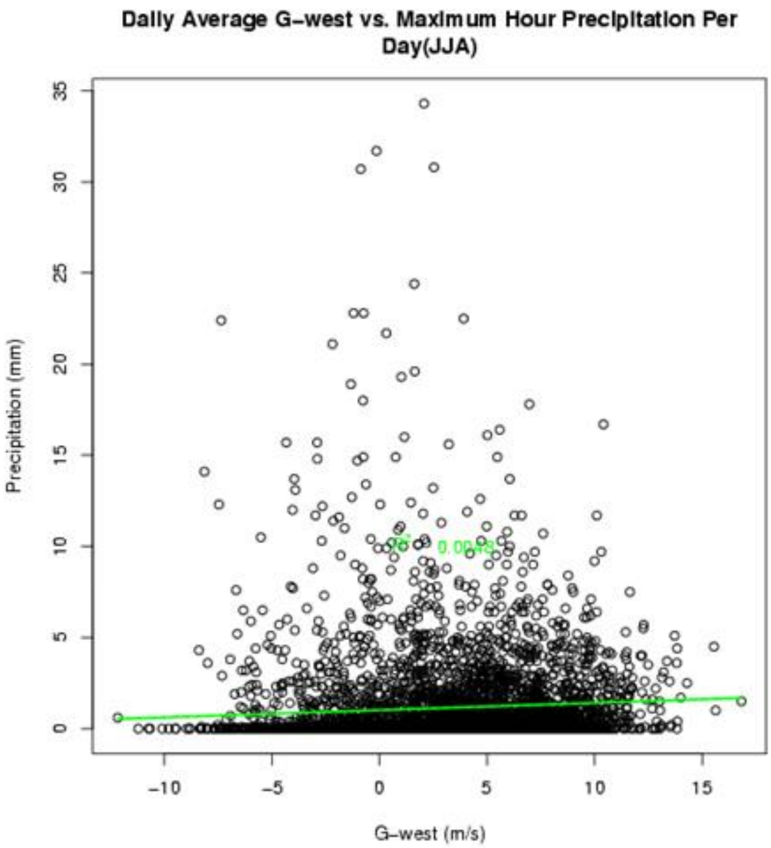

Figure 14. Daily average G-west vs. maximum hourly precipitation per day for summer months (De Bilt 1958-2006). *Green line* is the linear regression value with a regression coefficient r^2=0.0048

Correlations between daily and hourly precipitation and climate variables

Since we are interested in extreme hourly rainfall and we only have information about the change of extreme daily rainfall in case of climate change we decided to investigate the ratio between maximum hourly versus daily rainfall in relation to temperature and G-west. We also determined the quantiles. Primarily the upper quantiles: 90%, 95%, and 99% are of interest to us, as these indicate extremes of the recorded daily and hourly precipitation versus maximum daily temperature and versus G-west respectively.

Figure 5 shows a frequency representation (lower part of figure) of two climate parameters: maximum daily temperature and amount of precipitation (only wet days). The data represent the summer months May, June, July, August, and September for the years 1958-2006. In the upper half of Figure 5, lines indicate the percentage of data that are below the line (90% quantiles equals 90% below, 10% above).

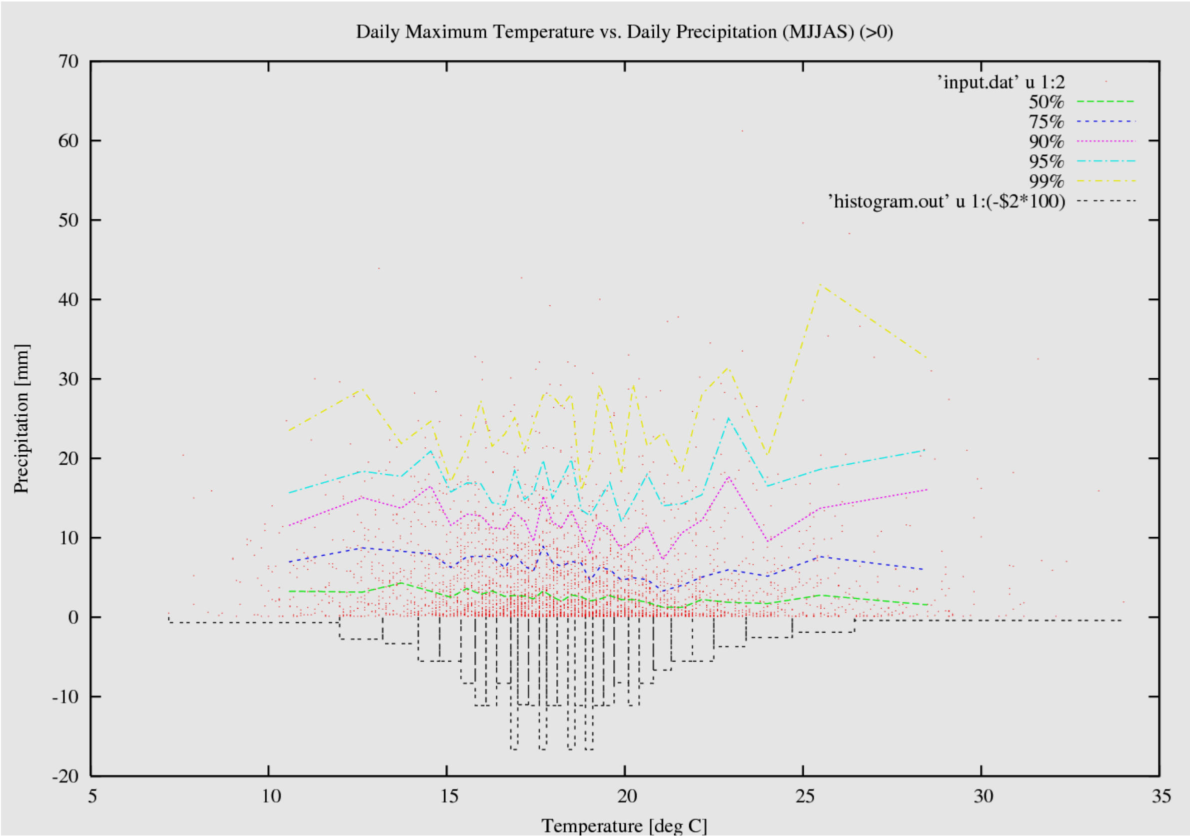

Figure 15. Maximum daily temperature vs. daily precipitation for summer months (May-September)

Figure 6 shows maximum daily temperature versus maximum hourly precipitation per day. Both figures allow for a comparison of maximum daily temperature with hourly and daily precipitation.

Below the horizontal axis, a histogram represents the frequency of the data. For both figures, more hours or days of precipitation occur with a maximum daily temperature value between 15ºC and 20ºC, at higher temperatures maximum hourly precipitation seems to increase with temperature. This is not clearly the case for daily precipitation. This is in line with our expectation that extreme precipitation is generally occurring during warmer days.

Figure 7 presents a frequency representation of daily G-west and precipitation (only wet days). Figure 8 shows G-west versus maximum hourly precipitation per day. Both plots show that more hours or days of precipitation occur with a G-west value of approximately 5 m/s.

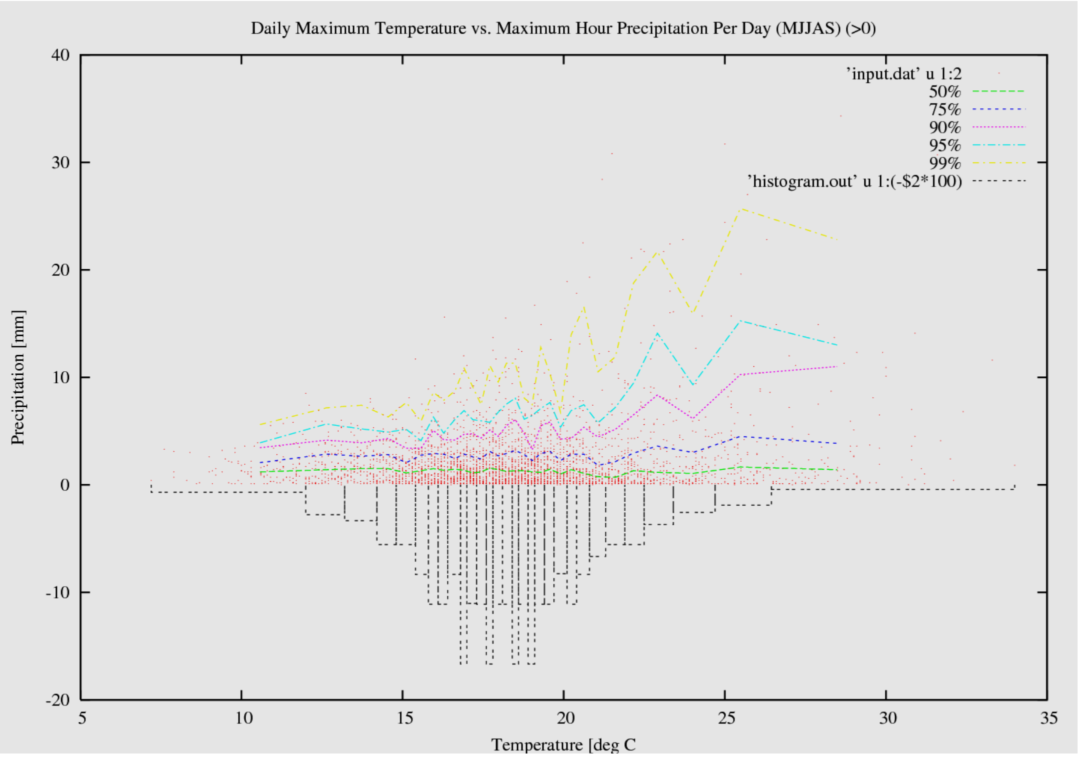

Figure 16. Maximum daily temperature vs. maximum hourly precipitation per day for summer months (May-September)

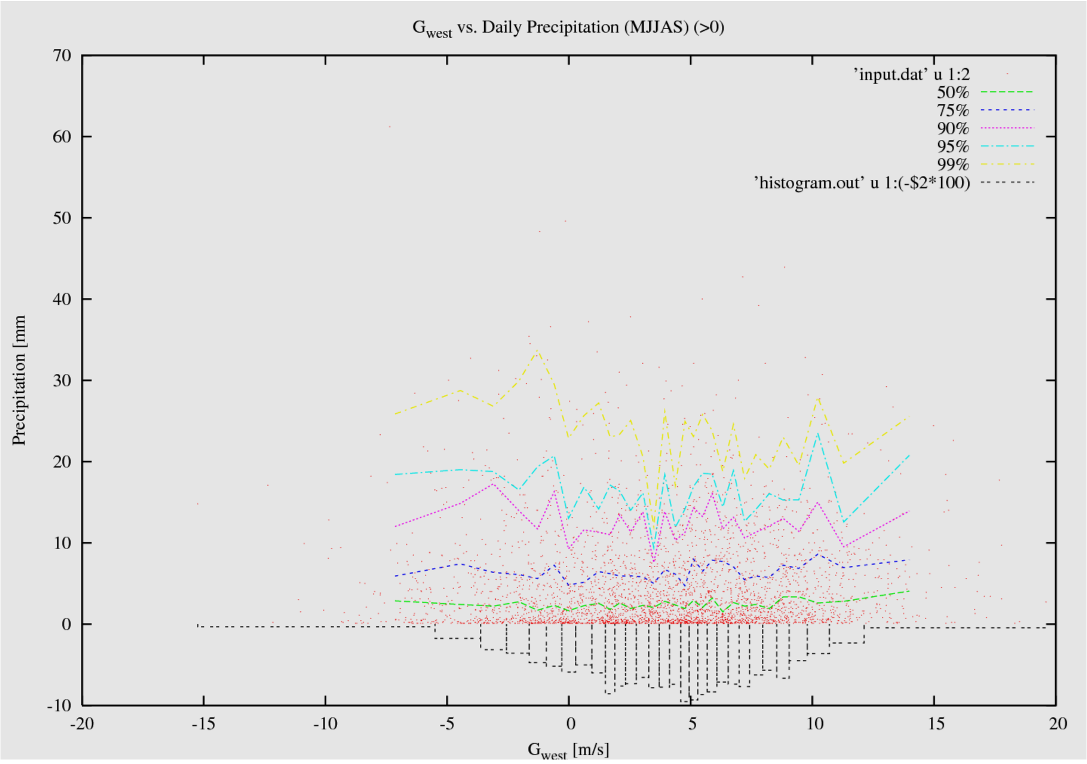

Figure 17. G-west vs. daily precipitation for summer months (May until and including September)

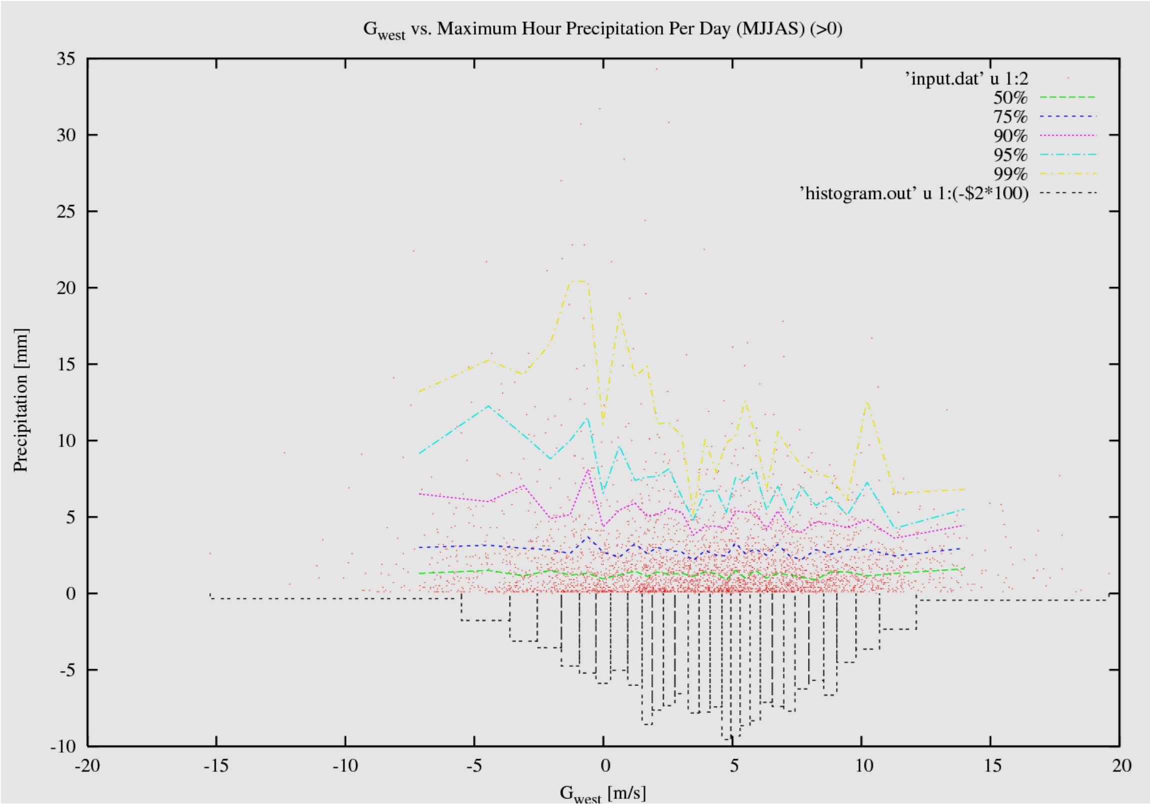

Figure 18. G-west vs. maximum hourly precipitation per day for summer months (May until and including September)

In the next step of our analysis, we started comparing points on the percentile lines for daily versus hourly precipitation. So we took the value of e.g. the 95% line of Figures 5 and 6 for the same temperature and determined the ratio of daily versus hourly rainfall. We did this for the whole range of temperatures from 10-29°C. And a similar analysis was made for G-west.

Figure 9 is a plot of the relation between daily and maximum hourly precipitation in relation to maximum daily temperature plotted in Figure 5 and Figure 6. The thin-dashed line is the 95% ratio. This was constructed by dividing the 95% percentile line for daily precipitation (Figure 5) by the 95% percentile line for hourly precipitation (Figure 6). If we assume a linear relation between these data points, the result is the bold-dashed line which gives the ratio of daily to maximum hourly precipitation versus maximum daily temperature.

A change in ratio indicates a different relation with maximum daily temperature and therefore a different relation between daily and hourly precipitation. The linear equation for the bold-dashed line in Figure 9 is,

$$y_{95} = -0.16x_{95} + 5.59$$

x = maximum temperature in °C

y= ratio of daily to hourly precipitation

A similar calculation was made for the 99% percentile line ratio, which is represented by the solid line. The linear equation for the solid line is,

$$y_{99} = -0.18x_{99} + 5.78$$

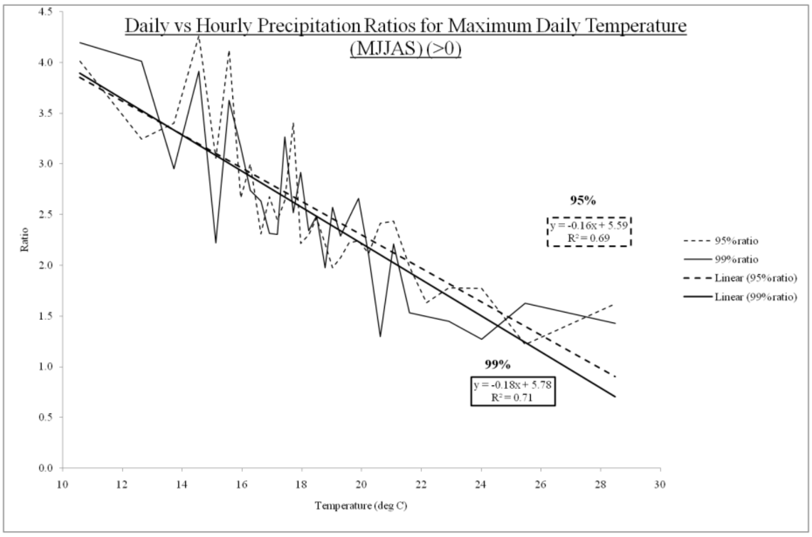

Figure 19. Daily/maximum hourly precipitation ratio in relation to maximum daily temperature for summer months (May-September). The *bold-dashed line* is the regression value of 0.69. The *solid line* is the regression value of 0.71

Figure 10 is a similar representation as shown in Figure 9, but now in relation to G-west. The bold-dashed line gives the ratio of daily to hourly precipitation for 95% percentile line versus G-west;

$$y_{95} = 0.09x_{95} + 1.99$$
$$x = \text{G-west in m/s}$$
$$y = \text{ratio of daily to hourly precipitation}$$

The same was done for the 99% percentile line ratio (solid line);

$$y_{99} = 0.08x_{99} + 1.92$$

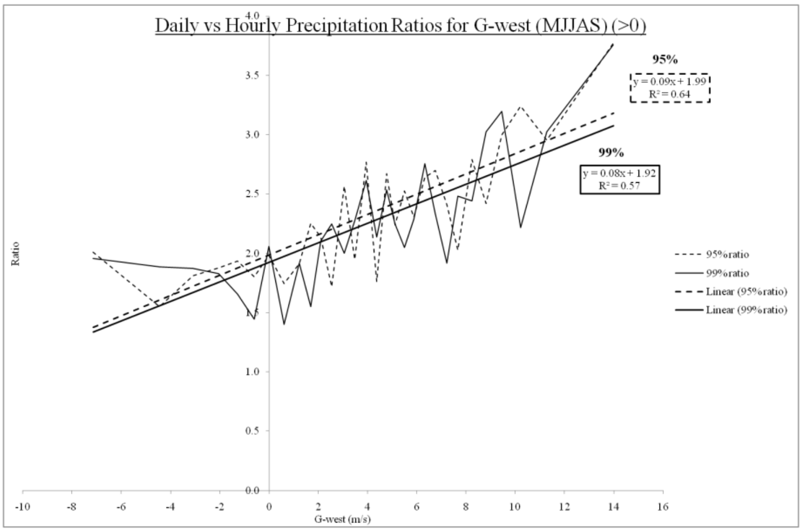

Figure 20. Daily/maximum hourly precipitation ratios in relation to G-west for summer months (May-September). The *bold-dashed line* is the regression value of 0.64. The *solid line* is the regression value of 0.57

Figure 9 and Figure 10 show that the ratios of extreme daily to hourly precipitation for temperature and G-west are certainly not constant. The higher the temperature the closer this ratio between daily and maximum hourly rainfall approaches the value 1 (which means that all daily rainfall occurs within 1 h). With strong westerly winds, daily rainfall is much higher than the maximum hourly rainfall.

Now, a relation has been established for extreme daily and hourly precipitation with the explanatory climate variables average daily temperature and G-west. These relations allow us to transform design storms and existing time series of hourly rainfall to new, synthetic series of rainfall under the assumption of a certain climate change scenario. Synthetic series or design storms can now be produced with the aid of the four KNMI'06 climate scenarios using projected daily precipitation, G-West, and maximum daily temperature.

CONCLUSIONS AND RECOMMENDATIONS

Based on the KNMI'06 climate scenarios, projections have been made for daily precipitation events for the time horizons 2050 and 2100. The methodology described above enables us to project these daily precipitation events into maximum hourly precipitation events. By examining historical data and analyzing the relationships between precipitation, at both daily and maximum hourly time scales, and explanatory climate variables, it was possible to determine a ratio to apply to daily precipitation projections that result in maximum hourly precipitation projections. Interestingly, although correlations between explanatory variables and precipitation were relatively weak, the correlation between explanatory variable and the daily/hourly precipitation ratio is strong. This strong correlation is the main finding of this paper. A useful extension of this research would be construction of synthetic maximum hourly precipitation. This extension would allow us to transform design storms and existing time series of hourly rainfall into new synthetic series taking into account climate change scenarios. Eventually, as a second extension, these synthetic data can be used as input for an urban drainage model. With such a drainage model and synthetic data for design storms or design series the effects of climate change on the systems' performance can be assessed and the efficiency of adaptive measures can be investigated.

ACKNOWLEDGEMENT

This article was originally published in Climatic Change.

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Article submitted to the Proceedings Book of the VI[th]. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

SUPERFICIAL POLLUTION OF QUATERNARY SOILS OF THE CITY OF ALI MENDJELI, CONSTANTINE, NORTHEAST OF ALGERIA

Smaine CHELLAT[1*], L. BOUDRAA[1], R. ZATOUT[1], A. BOUREFIS[1], M. HACINI[2]

[1]*Geology and Environment Laboratory, University of Constantine 1, Road Ain El Bey Zouaghi Slimane Constantine 25 000, Algeria*
[2]*Geology of Saharan laboratory, Department of earth sciences, Faculty of Hydrocarbon. University Kasdi Merbah Ouargla, Algeria,* *Corresponding author: smaine.chellat@gmail.com

The superficial soils of the city of Ali Mendjeli, located in the department of Constantine North-East Algeria, are characterized by decalcification clays, resulting from the alteration of limestone rocks and plio-quaternary marls. The set of analyzes carried out on these soils, calcimetry, particle size, DRX, show a dominant calcium component, clay aggregates packed by carbonate cement. X-ray diffractometric spectra show a dominance of $CaCO_3$, as an essential mineral. They also show the presence of pollution by the elements: Pb, Zn, and Cu, caused by anthropogenic factors such as washing and maintenance of vehicles and machinery during the installations of the various building and road sites that have marked this new city. Their presence is confirmed, but the values as a function of time vary from one point to another. These indications of surface pollution require further analysis of groundwater in lower areas, exploited by farmers and local residents.

***Keywords**: Clays, decalcification, Soil, Ali Mendjeli, Pollution*

INTRODUCTION

The new city Ali Mendjeli is considered a solution to raise the problem of housing in the city of Constantine, it occupies a vast rocky plot ideal for building, these plio-quaternary rocks are covered by a thin layer of marl and clay of up to 2 meters. The installation of the construction sites during the works left traces of pollution due to parks of the various machines.
Our goal is to show that these small temporary installations leave behind polluting elements in the superficial soil.
The new city Ali Mendjeli is located in the southwest of the wilaya of Constantine (Figure 1). It is between 36°13'38" and 36°17'04" North latitude and between 6°32'38" and 6°35'53" East longitude, with a total area of 1711.39 ha and a warm and temperate climate. [1].

Geological context

The region of Constantine is part of the external zones of the Maghreb, external domain, they are characterized by the slip thrust fault essentially in southern vergence, set up during the alpine tectonic phases [3]. It is the product of several tectonic phases [4], the early-tertiary phase [5], [6] and tertiary phases (late Lutetian, Miocene, recent and post-Miocene phase) [7], [8], [9] et [10].
The city of Ali Mendjeli rests on a tray named Ain El Bey, known by lake Plio-Quaternary formations, which is beige to reddish limestone interspersed with marly levels, in the majority of cases these limestones are covered with thin layers of brown to blackish clays of Quaternary age.
The result of a quaternary alteration phase in the presence of a vegetation cover (formation of complexolysis) gave decalcification clays.

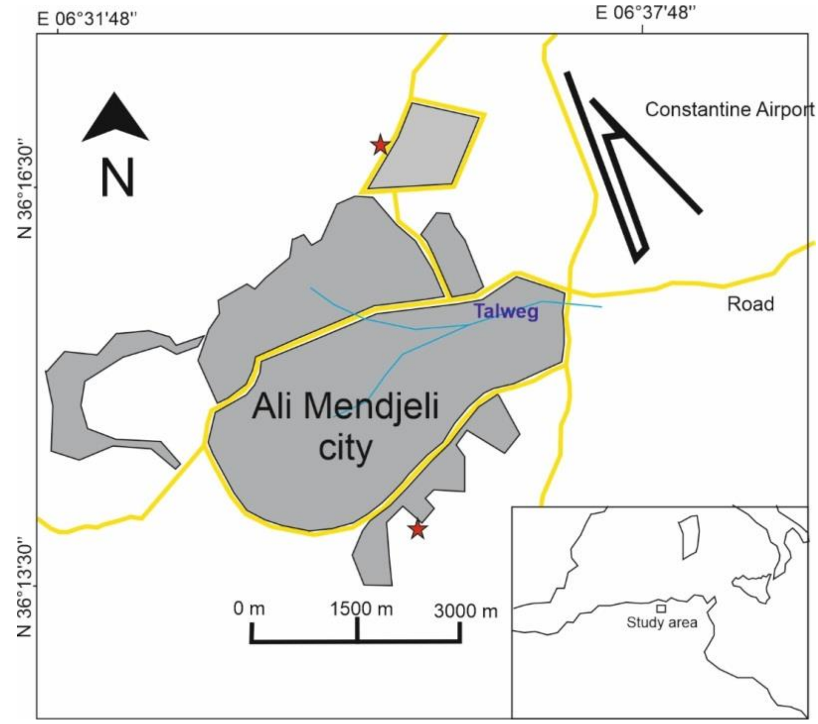

Figure 1. Localisation of the study area, the red stars shows the sampling area [2].

METHODOLOGY

Two sampling zones were chosen on the extremity of the city listed upstream of the watershed to the southwest and northeast. Sampling was carried out systematically from the soil surface to a depth of 1 metre. The loose samples, recovered, underwent particle size, geochemical sedimentometric and mineralogical analyses. The equipment used a series of sieves, a sedimentometer, a Bernard calcimeter and an X-ray aux diffractometer (Philips Xpert pro) equipped with a copper anticathode.
The clay samples analyzed by diffractometer were subdivided into three parts (raw and the other two underwent treatment with ethylene glycol and heated it to 550 degrees). The spectrum processing was done by PANalytical X'Pert HighScore 2 version 2014. An X-ray fluorescence spectrometer (Epsilon) for the estimation of heavy metals.

RESULTS AND DISCUSSION

The in-situ description shows a clear passage of sedimentary levels, the black surface layer followed brownish to beige layers, limestone slabs surmount in some places which suggests a lateral passage of facies. (Figure 2)
The results of particle size and sedimentometry show the following classes 50% clays 20% silts and 30% sands. The observation under the binocular magnifying glass shows the grains mostly fine, the silts and sands present debris of limestone rocks, carbonate nodules and iron oxides.
The carbonate content of these sediments varies from 40 to 80%, which indicates the link between the source rock and the surface soil. Limestone nodules, granules, whit spots are present. Clay aggregates are weakly cemented by carbonates.

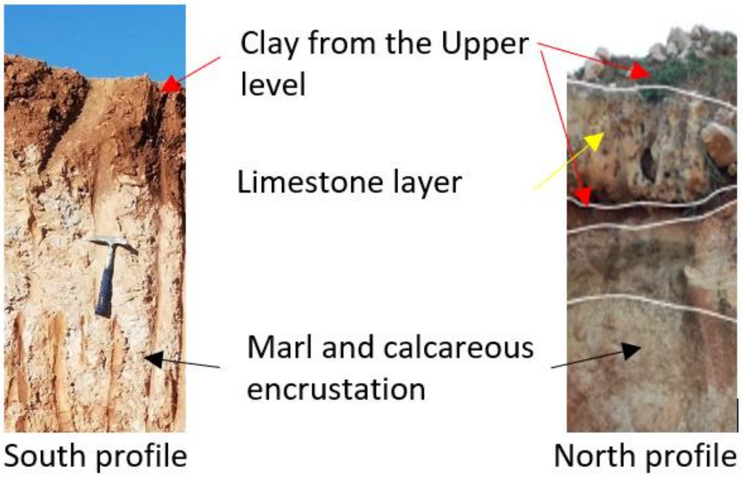

Figure 2. Upper clayey level above the calcareous encrustation (marl)

Analysis of diffractometric spectra by Xpert hight score (Figure 3) shows the dominant minerals Calcite, $CaCO_3$; Dolomite, $Ca(Fe,Mg)CO_3$, followed by secondary minerals such as Quartz SiO_2 of detrital origin, transported by wind. Iron oxides Hematite Fe_2O_3, Siderite $FeCO_3$, iron hydroxides goethite FeO(OH). The clay minerals present are Chlorite, Kaolinite, Illite

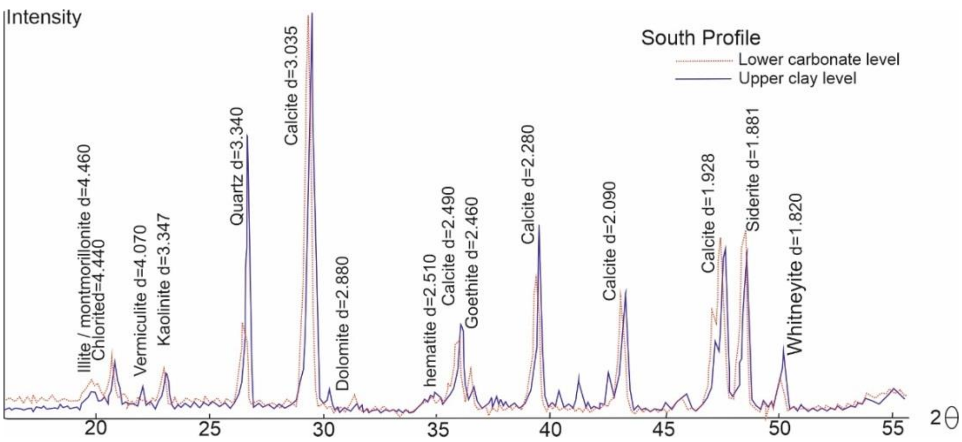

Figure 3. South profile diffractometric spectra

These mineral elements are either inherited from the source rock (marl or limestone) derived from pedogenesis in the presence of complexolysis (vegetation) exchange between soil-plants [11], [12], [13]. Clay minerals testify to the temperate climate (precipitation and snow in winter and dry season in summer [14], [15], [16]. The essential polluting metals observed on the XRD spectra and on the XRF analyses are Plomb Pb with a rate of 0.011-0.012 in two profiles, Zinc Zn is 0.122 in the south to 0.143 in the north, Chromium Cr has low values, Copper Cu the most abundant metal with values of 0.198 in the south and 0.188 in the north, the presence is certain with variable rates from one sample to another, their values increase in surface and decrease in depth. It is noted here that the presence of copper is probably also due to the containment of the sedimentation medium and not only to pollution. [17]. While the other elements, Pb and Zn have had to wash machines and vehicles in maintenance parks, exhausts of Combustion Gas, these elements move on the surface of the ground by the effect of leaching and runoff of rainwater. Recently washing stations have been set up in this city and discharge their partially polluted water directly to the surface of the ground and which will be driven by the tires of vehicles and redeposited in other points. (Table 1)

Table 1. Essential heavy metals in surface soils of the South and North profile

Samples Conc unit %	Cr	Cu	Zn	Pb
South profile	0.001	0.198	0.122	0.012
North profile	0.001	0.188	0.143	0.011
WHO standards %	**0.005**	**0.200**	**0.300**	**0.001**

CONCLUSIONS AND RECOMMENDATIONS

The study conducted on the superficial clays of the city of Ali Mendjeli, Constantine in the North-East of Algeria aimed to determine the physical and geochemical characteristics, the thing that led us to make an overview of the pollution of these clays is the presence of certain metallic elements in the surface sediments, such as Pb and Zn, Cu...

This pollution is only the beginning, because this city is very young, and small industries are starting to develop. Our findings on pollution and on upstream points to see the minimum of pollutants in the sediments, and despite that it is present. Further in-depth studies with extensive analysis are needed to identify the risk of pollution in the downstream parts of the watershed that use the groundwater table for agriculture.

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CHIRAL SEPARATIONS OF PHYRETROIC ACIDS USING CYCLODEXTRIN SELECTORS

Zoltán JUVANCZ*, Rita BODÁNÉ-KENDROVICS, Zita LACZKÓ

Institute of Environmental Engineering and Natural Science, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, H-1034, Doberdó út 6, Budapest, Hungary, ******e-mail: juvancz. zoltan@uni-obuda.hu*

The pyrethroid insecticides are broadly used insecticides. They are used also near food insecticides in households because they have low toxicity for warm blooded living creatures. On the other hand, they show high toxicity not only for insecticides but for fishes too. Therefore, it is important to decrease the environmental burden of the pyrethroids. One of the effective ways to decrease the pollution using chiral pure insecticide products instead of their racemic mixtures. For example, the chiral pure deltamethrin has same insecticide effect than the eight times more amount racemic mixture of deltamethrin. The enantiomer pure products require enantiomer selective synthesis and analysis. The pyrethroic acids are chiral compounds. Their chiral selective syntheses are necessary therefore their chiral selective analyses are crucial. The chiral selective analyses of pyrethroic acids are also important from the point of view of their degradation metabolism in the environment. This study shows various enantiomeric selective chromatographic methods: gas chromatography, supercritical fluid chromatography and capillary electrophoresis for separation of various pyrethroic acids. The used chiral selective agents were based on cyclodextrin derivatives. To find the appropriate chiral selective selector is the result of a trial-and-error method development. This systematic study explores the correlation of chiral selectivity-analyte structure using different pyrethroic acids in various derivatives forms.

Key words: *pyrethroic acids, chiral separations, gas chromatography, capillary electrophoresis, chiral selectivity-structure relationships*

INTRODUCTION

Phenomenon of the chirality

The chiral molecules are asymmetric molecules [1]. They are not same with their mirror images. A chiral molecule and its mirror image molecule are called enantiomers, or an enantiomeric pair (Figure 1).

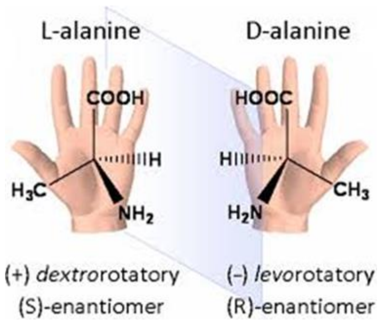

Figure 1. The structure of enantiomeric pair. They are asymmetric molecules. they are mirror images of each other, and they have not superimposable structures.

The properties of the member of an enantiomer pair are same in homogeneous (achiral) environment. However, they show different properties in inhomogeneous, chiral environment (e.g., magnetic field, receptor sites and interactions with other asymmetric molecules). The molecules of living organisms (e.g., amino acids, sugars, receptors etc.) of nature are dominantly asymmetric and several inorganic molecules are also chiral (e.g., quartz). The members of an enantiomeric pairs show different biological effects frequently. Every essential amino acid has only one member (L) of their enantiomeric pairs in the proteins. The proteins consist of enantiomerically pure amino acids.
The importance of chiral pure pharmaceutical is evident since the Contergan scandal [2]. Contergan (Thalidomide) pharmaceutical medicine was a mixture of enantiomer molecules, in which one enantiomer produced a desirable antiemetic effect. The other isomer of enantiomeric pair was toxic and produced teratogenicity side-effects. More than 10,000 children were born with serious deformations (phocomelia) if their mothers had taken Contergan during their pregnancy. Recently, the authorities allow only enantiomer pure medication products [3]. Chiral drug can contain less than 0.1% of its optical isomer. The use of enantiomer pure agrochemicals is increasingly making its way [4].

Pyrethroids

Pyrethroids are broadly used synthetic insecticides [5]. They have more intensive effects than their natural analogues: pyrethrum, produced by chrysanthemum flowers. The pyrethroids have low toxicity to mammalians, but high to bees and fishes [6, 7]. They have neurotoxic effects through the sodium channel [7]. Commercially available pyrethroids are esters. The acidic parts usually have two chiral centres in their cyclopropane rings (Figure 2).

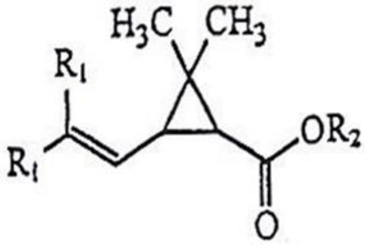

Figure 2. The general structure of tested pyrethroic acids. The R_1 can be methyl (chrysantemic acid), chlorine (permethrinic acid) or bromine (delthametrinic acid). The R_2 can hydrogen (free acid) or any alkyl substituents (ester).

The diastereomers are called cis/trans isomers according to the relative configuration of the carboxyl and substituted alkene (e.g., dimethyl-, dichloro-, dibromo-vinyl) groups on the cyclopropane ring. These acids are frequently esterified with optically active alcohols (cypermethrin, cyfluthrin and delthametrin) creating additional stereoisomers of the insecticidal products. The structural isomers have different biological effects [6-10].
The 1R-cis isomers of acids show much more effective insecticidal activity than the other isomers. For example, the deltamethrin pesticide has 3 chiral centres, but only one of the eight isomers (αS,1R,3R′-) has a really good and effective pesticide effect. On the other hand, every isomer has toxic side effects toward fishes [11].
In this way, a certain amount of the enantiomeric pure deltamethrin cause the same useful effect than the eight time more amount stereoisomeric mixture of deltamethrin. The same insecticidal effects cause eight times less environmental load with enantiomer pure products, than the mixture of all stereoisomers.
The large difference in their biological activity of these enantiomers require their chiral selective syntheses [4, 12,], and highly efficient chiral analyses with HPLC [6, 8- 13], SFC [14, 15] and GC [16]. The enantiomer selective analyses of pyrethroic acids are also important from the point of view of production processes and metabolism control in the environment. The GC [17], SFC [18] or CE [19-21] are also important in the chiral separation of pyrethroic acids.

Separation of enantiomers

There is no general chiral selector for every enantiomeric pair [22]. Chiral chromatographic separations request exact fits among the interaction groups of the selector and interaction groups of analytes [23, 24]. Namely, the three-point interaction recognition mechanism requires fair geometrical arrangements and chemical appropriateness among the interacting groups of the selectors and selectands.

A good chiral separation is the result of trial-and-error process on several occasions. However, certain rules can be established for the chiral recognition conditions with systematic studies using model compounds. These rules can be employed for other chiral separations, to gain a good chiral separation in a faster way than the trial-and-error method.

In this study, we present a systematic study to show the chiral selectivity structure relationships using pyrethroic acids.

Cyclodextrins

The cyclodextrins (CDs) are the most frequently used chiral selectors in the capillary column separations [25-27], therefore cyclodextrin were used for the chiral separation of pyrethroic acids in this study.

The CDs are cyclic oligosaccharide molecules [28]. The glucose units join together with α-1,4-glycosidic linkages. The most important members of CDs consist of six, seven or eight D (+)-glucopyranose units, to which the letters Greek, α, β and γ were assigned respectively. The structures of the β-CD are in Figure 3. The CDs have twisted truncated cone shape. They can include as host guest molecules insides in their cavities.

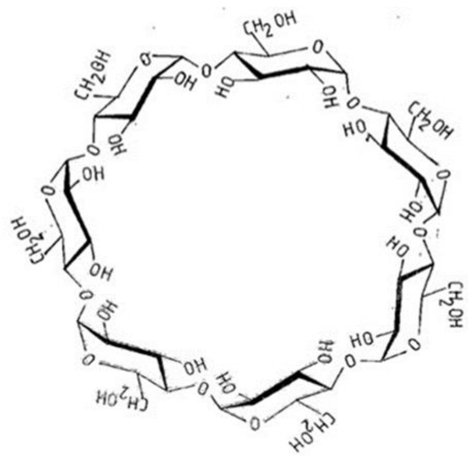

Figure 3. The structure of β-cyclodextrin

The most important features of the CDs are their excellent chiral recognition characters toward to extreme broad spectra of the enantiomers in the analytical chemistry. CD molecules are the most popular chiral selectors using capillary columns in gas chromatography (GC) and capillary electrophoresis (CE).

Enantiomers, having any functional groups or structures, can be separated with CD based selectors [17 24-30]. The reason of the broad chiral selectivity spectra of CDs are the following:

- The CDs have numerous, non-uniform chiral centres, (35 in β-CD), because the CDs have twisted truncated cone structures [25].
- The hydroxyl groups of CDs can substitute with different functional groups (e.g., methyl, phosphate, sulphate, amino, naphthyl, acetate) add extra interaction ability to the interaction potentials of underivatized CDs [28]. Some substitutions groups (such as hydroxypropyl and naphthyl-ethyl carbamoyl) add extra chiral centres to CDs, further broadening their recognition spectra [25].
- The most CD derivatives are randomly substituted molecules. They are mixtures of large number of isomers [28]. They differ from each other in the numbers and the positions of the

substituents, and almost every isomer has different chiral recognition features. Moreover, the substituents can be different in their chemical structures and arrangements in a derivatized CD [28].

- The derivatized CDs have rather flexible structure. CDs can change their shape to interact with analytes with the "induced fit" mechanism [28]. A CD can change its shape to produce stronger interactions resulting in further enlarged chiral selectivity spectra.
- The ionizable CDs can change their selectivity spectra according to their ionization states according to the pH value of their solutions [31].
- The types of the background buffer or mobile phases (normal, revers and polar-organic) influence also the selectivity features of CDs [25].

The CDs can also separate enantiomers, not only with carbon atom centre, but they can also separate enantiomers with phosphorus, nitrogen or sulphur atom centres. Chiral molecules can be also separated with planar or axial chirality with CDs [29].

We used cyclodextrin chiral selectors in our study. Our generalizable conclusions (structure-chiral selectivity correlations) can be used for solutions of several other chiral separations.

EXPERIMENTAL METHOD

The tested pyrethroic acids: chrysantemic acids, ($C_{10}H_{16}O_2$), permethrinic acids ($C_9H_{12}Cl_2O_2$) and deltamethrinic acids ($C_9H_{12}Cl_2O_2$) were products of Ciba-Geigy.

The used solvents and reagents: hexane, ethyl acetate, diethyl ether, and BF_3 methanol, ethanol, n-propanol, i-propanol, n-butanol, s-butanol and t-butanol were purchased from Merck, which were used for GC measurements. The syntheses of ester derivatives of pyrethroic acids were made using reaction of BF_3 with various alcohols.

The chemicals of background electrolyte of CE measurements were boric, acetic and phosphoric acids and sodium hydroxide from Sigma-Aldrich. The used deionized water was made by MilliQ instrument.

The permethyl monoamino β-cyclodextrin (PMMA βCD), monoamino β-cyclodextrin (MA βCD), permethyl β-cyclodextrin (TRIMEB), dimethyl β-cyclodextrin (DIMEB), hydroxypropyl β-cyclodextrin (HP βCD) were products of Cyclolab.

The gas chromatographic experiments were done on Chirasil-Dex, a polysiloxane anchored permethylated β-cyclodextrin coated. Column (10 m x 0.1 mm I.D.) and 25 m x 0.22 mm; stationary phase, Cydex-B (0.25 μm). Carlo Erba Mega was the GC instrument [17, 18]. Every tested molecule was separated at least 3 temperatures to calculate the selectivity values at 100° C.

The capillary electrophoresis measurements were carried out on a Hewlett Packard 3DCE system with diode array UV detector (202 and 220 nm) at 25 °C. Uncoated fused-silica capillary (58.5 cm x 50 μm I.D.) was applied [19, 20]. The background electrolyte (BGE) consisted of 40 mM boric, acetic and phosphoric acid buffers in ratio of 1:2:2 (Britton-Robinson). The exact pH values of BGEs were adjusted with 0.1 m NaOH solution.

RESULT AND DISCUSSIONS

Results of gas chromatographic measurements

Every enantiomer of pyrethroic acids were separated somehow (Table 1) under GC conditions. The measurements were done at different temperatures. For the sake of comparison, the measurements were done at 100° C, or calculated for this temperature.

The calculations were based on the linearity of $\ln\alpha$-1/T correlations where α is the chiral selectivity and T is the absolute temperature [29]. The linearity values are checked with regression calculations. The linearity of these regression calculations proved that the separation processes belong to only one chiral recognition mechanism for a given enantiomeric pair.

Probably, the rigid cyclopropane ring structure of the pyrethroic acids fit well to the cavity of the permethylated β-cyclodextrin. This inclusion process offers a good chiral recognition toward to pyrethroic acids.

Table 1. The chiral selectivity of pyrethroic acids at 100° C

Structures of the racemates			Selectivity (α)
cis/trans	R_1	R_2	
cis	Me	H	1.275
trans	Me	H	1.153
cis	Me	Me	1.013
trans	Me	Me	< 1.01
cis	Me	Et	< 1.01
trans	Me	Et	< 1.01
cis	Br	Me	1.046[b]
trans	Br	Me	1.040[b]
cis	Cl	H	1.284[b]
trans	Cl	H	1.194[b]
cis	Cl	Me	1.043
trans	Cl	Me	1.010
cis	Cl	Et	1.023
cis	Cl	Pr	1.019
cis	Cl	iPr	< 1.01
cis	Cl	Bu	1.014
cis	Cl	sBu	1.034
cis	Cl	tBu	< 1.01

[a] 10 m x 100 μm i.d. column, coated with Chirasil-Dex (d_f = 0.25 μm), at 100°C.
[b] Extrapolated values.

R_1, substitution in vinyl group; R_2, substituent in acid function

The free acids were excellent forms for chiral separations, because the free acid forms showed higher chiral selectivity than the ester forms (Table 1). Probably the H-bond donor ability of analytes play an important role in the chiral recognition. Even the chrysanthemic acid isomers showed excellent separations (Figure 4). It is interesting to note the trans isomers elutes among the cis isomers on Figure 4.

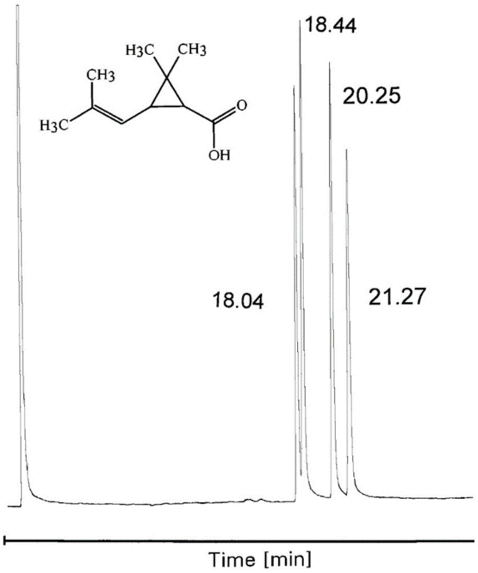

Figure 4. Chiral and cis-trans separation of Chrysanthemic acid isomers as free acids. The peaks of trans isomers elute between the peaks of cis isomers. Conditions: instument, Carlo Erba Mega; column, 25 m x 0.22 mm; stationary phase, Cydex-B; carrier, H_2 (50 cm/sec); temperature, 120° C.

The cis isomers showed higher selectivity values than trans isomers. The ester forms of pyrethroic acids, where R2are alkyl groups, show smaller chiral selectivity values than their free acid forms except for s-butyl derivative of c-permethrinic acid. Generally, the chiral selectivity values decrease with the increasing alcohol part of the esters (Me>Et>Pr>Bu) in the case of normal alcohol substitution. On the other hand, the chiral selectivity of different pyrethroic acids increase with the volumes of substituents of vinyl groups (R_1). Highest selectivity was measured for deltamethrinic acid (R_1 = Br), which was followed the permethrinic acids (R_1 = Cl) and the chrysantemic acid (R_1 = Me) showed the lowest selectivity. Probably, not only the volume of the R_1 groups can play role int the chiral recognitions, but the electron donor abilities of substituents too. The (+) isomers eluted before (-) isomers on every occasion.

Results of capillary electrophoretic measurements

The pyrethroic acids enantiomers can be effectively separated using various cyclodextrins in capillary electrophoresis [19-21]. The best resolution values are summarized in Table 2. The numbers of the Table 2 show the permethyl monoamino β-cyclodextrin (PMMAβCD) is the best chiral selective agents from the tested CDs. The permethyl β-cyclodextrin (TRIMEB) is also good for these purposes. The monoamino β-cyclodextrin (MA βCD), permethyl β-cyclodextrin (TRIMEB), dimethyl β-cyclodextrin (DIMEB), hydroxypropyl β-cyclodextrin (HP βCD are less effective separation agents toward to pyrethroic acids.

Table 2. The resolution values of pyrethroic acid using various cyclodextrin derivatives at pH 6.5 buffer

Resolution (pH 6.5)	15 mM PMMAβCD	15 mM TRIMEB	15 mM MAβCD	15 mM DIMEB	15 mM HPβCD
trans-deltamethinic acid	11.56	3.24	<0.5	<0.5	<0.5
cis-deltamethrinic acid	20	5.64	<0.5	<0.5	<0.5
trans-permethrinic acid	6.62	1.69	<0.5	<0.5	<0.5
cis-permethrinic acid	17.23	2.37	<0.5	<0.5	0.55
trans-chrysanthemic acid	1.08	<0.5	<0.5	<0.5	<0.5
cis-chrysanthemic acid	8.5	1.56	2.57	1.93	1.67

The PMMAβCD can separate every tested chiral pyrethroic acids (Figure 5). The trans-chrysanthemic acid enantiomers can also be baseline separated using 17.5 mMol PMMAβCD, but the increased concentration of the selector results in more than one over migration times.

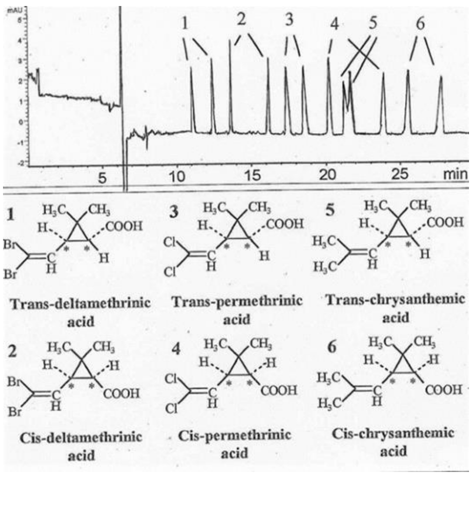

Figure 5. Simultaneous enantioseparation of 6 pyrethroic acids. Conditions: column 50 cm effective length x 0.050 mm i. d. uncoated fused-silica capillary; 15 mM PMMAβCD concentration;

background buffer, 40 mM boric, acetic and phosphoric acid buffers (1:2:2); potential, 30 kV; detection, 220 nm.

The resolution values highly depend on the pH of the background electrolyte [20]. The best resolutions were gained at pH 6.5 (Figure 6).

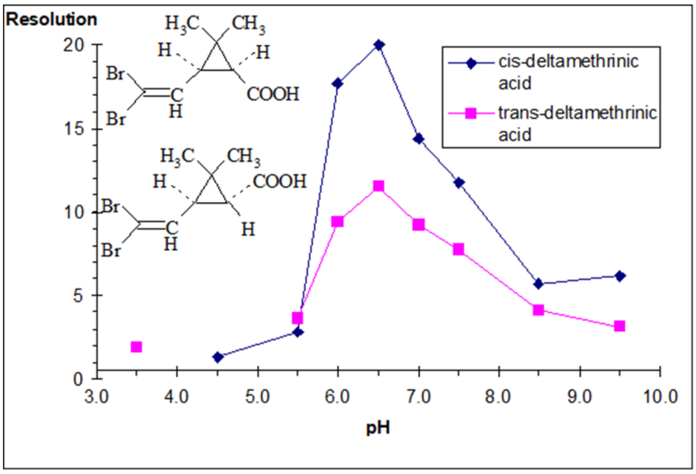

Figure 6. Resolution of enantiomers of cis- and trans-deltamethrinic acids depending on pH at Conditions: column 50 cm effective length x 0.050 mm i. d. uncoated fused-silica capillary; 15 mM PMMAβCD concentration; background buffer, 40 mM boric, acetic and phosphoric acid buffers (1:2:2); potential, 30 kV; detection, 220 nm.

The highest resolution can be achieved in a pH range, where the analytes and selector both are in ionized states. Namely the oppositely charged selector and analytes gained pseudo elongation of their separation length [30], because the analytes have opposite migration directions in complexed and uncomplexed states. The selectivity values of other tested pyrethroic acids showed similar pH dependency trend.

The TRIMEB is also a very good chiral separation agent toward to pyrethroic acids. The resolution values of cis-permethrinic acid enantiomers show maximum in the function of concentration of TRIMEB according to the theory of Wrenn [32]. The 12.5 mMol concentration of the TRIMEB showed the maximum value. The TRIMEB was also excellent to analyse the result of salt resolvation process [21.]. Using this selector, the simultaneous determination of anionic, cationic compounds and the enantiomeric ratio of the anionic compound were determined during one analysis run.

CONCLUSION

The enantiomeric separations of pyrethroic acids were solved with various gas chromatographic and electrophoresis methods. The highly methylated cyclodextrins TRIMEB and PMMAβCD selectors were the most effective for this task. The cis isomers showed higher selectivity than their trans isomers. The selectivity values gained the following tendency: deltamethrinic acids> permethrinic acids> chrysantemic acids. The selectivity of the permethrinic acids were influenced with the derivatization of these compounds in GC mode. The CE experiments show maximum resolution values in the function of pH and concentration selectors. The high chiral recognition properties of the pyrethroic acid partly come from their rigid cyclopropane structure. The chiral recognition improved by the H-bond donor and acceptor properties of the analytes. Our finding and conclusions concerning the chiral recognition mechanisms are also useful to find appropriate selectors for other chiral separations.

ACKNOWLEDGEMENT

The valuable advice of dr. Róbert Iványi and correcting activity of Ms. Beata are acknowledged.

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Article submitted to the Proceedings Book of the VI[th]. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

MOLLUSKAN TISSUES AS AN ACCUMULATION SITES FOR HEAVY METALS FROM LIBYAN COAST IN NORTH-EAST LIBYA

Eman R. B. OJALEY[1*], Hussein B. B. JENJEN[1], Osama R. SHALTAMI[2], Ahmed M. MUFTAH[2*]

[1]*Department of Zoology, Faculty of Science, University of Benghazi, P.O. Box 9480, Benghazi-Libya*
[2]*Department of Earth Sciences, Faculty of Science, University of Benghazi, P.O.Box 9480, Benghazi-Libya*

A number of living marine gastropods (Phorcus turbinata and Patella caerulea) which are commonly inhabited the rocky beach of meso-infra littoral zones in the entire Circum-Mediterranean coast are collected from nine coastal localities (Benghazi "Ashbilia and Sabri)", Tocra, Tolmeita, Al Haniyah, Al Hamamah, Susa, Hawa Eftaih and Ras Al Hilal) in April, 2018. The inductively coupled plasma mass spectrometer (ICPMS) was performed on the soft body for measuring the environment-sensitive elements such as Fe, Sn, Sb, Cu, Zn, Pb, Ni, As, Hg and Se. All analyzed metals are mainly of anthropogenic origin (excluding Fe). The statistical treatment indicates that most heavy metals are mutually correlated, but there is an absence of strong correlations among some metals, which suggests that these metals are possibly of different sources. The concentrations of all metals are below the recommended guideline in seafood, except for As in Phorcus turbinata and Pb in Patella caerulea. Moreover, the Phorcus turbinata is a good accumulator for Fe, Ni, As and Hg, whereas Patella caerulea is a collector for Cu, Zn and Pb. Additionally, the contamination indices suggest that Susa (distillation station) and Sabri are the most polluted areas.

***Keywords**: Mollusks, Heavy metals, Pollution, Phorcus turbinata, Patella caerulea, Libya*

INTRODUCTION

In the last few decades, increasing attention has been paid to the relationship between the conformation of heavy metals and their impact on aquatic organisms. The anthropogenic activity usually deteriorates the marine water with toxic metals where arise from agricultural, industrial, and urban effluents that reach the coast through the waterways, surface runoff, and precipitation. Both benthic and pelagic species may thus become contaminated by direct uptake and / or through biomagnifications. Therefore, an eternal assessment of water quality is necessary. To reveal the presence of pollutants and to measure their toxic effect, some biological indicators can be used, which are suitable for prediction of the expectable toxic influence of known or unknown substances such mollusks, foraminifers and fishes. Metals such as Arsenic (As), Mercury (Hg), Cadmium (Cd), Copper (Cu), Chromium (Cr), lead (Pb), Iron (Fe), Manganese (Mn), Zinc (Zn) do not degrade in general; therefore, they accumulate throughout the trophic chain (Mustafa *et al.*, 2015). Heavy metal toxicity in aquatic organisms, in association with the long residence time within food chains and the potential risk of human exposure, makes it necessary to monitor the levels of these contaminants in marine organisms (Giarratano and Amin, 2010). Accumulation in living organisms leads to concentrations several orders of magnitude higher than those of the surrounding water (Casas *et al.*, 2008). Despite this the relationship between the concentration of a metal in the aqueous phase and in an organism is far from straight forward as the accumulation ratio depends on many factors; some of them have an environmental origin (temperature, pH, salinity, etc.), whereas others are related to biological factors like age, sex, sexual maturity stage, etc. (Mubiana *et al*., 2006). To achieve a better estimate of bioavailable metal exposure, it is recommended that the tissues of the organisms should be analyzed using the accumulation of trace metals, because many benthic organisms accumulate trace metals to the levels reflecting those in the environment. Tissue metal concentrations can reflect contamination, and mollusks in particular may therefore be sensitive biomonitors of anthropogenic metal inputs (Hendozko *et al.,* 2010). Marine animals accumulate considerable concentrations of heavy metal in their tissues. Although numerous metals are essential, all metals are toxic at higher concentrations, because they cause oxidative stress by structure of free radicals. Consequently, metals disappear the marine ecosystem unsuitable for reproductive, growth and obliterate the biodiversity (Ghosh and Singh, 2005).

MATERIAL AND METHODS

One hundred and fifty living marine snails (gastropods) shells have been collected, 75 of living *Phorcus turbinate* and 75 of *Patella caerulea* from nine localities during spring season of April, 2018. Only soft body, the samples were put in closed container and were stored in freeze for two days. The whole mollusk were then put in 4% formalin and transported to the Laboratory at the Nuclear Materials Authority of Egypt, where the living tissues are chemically analyzed using Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) instrument. The samples were washed and the soft tissues were removed from the hard shells using a Teflon knife and then sorted into pools of similar size (3.5 – 5 cm) and homogenized by an Ultra-Turrax T25 homogenizer. Ten heavy metals (Iron (Fe), Tin (Sn), Antimony (Sb), Copper (Cu), Zinc (Zn), Lead (Pb), Nickel (Ni), Arsenic (As), Mercury (Hg) and Selenium (Se)) were analyzed using ICP-MS technique (Figure 20). The soft tissues were transferred to 4 ml HNO_3, 3 ml $HClO_4$ and 5 ml HF and evaporated to dryness under $200^{\circ}C$. The residue was dissolved with 5 ml (1:1) HNO_3 by heating. Five ml of 4 ppm indium solution was added as an internal standard. The reference and solutions were introduced by peristaltic pump with 0.18 rpm. Before each measurement, nebulizer and spray chamber were washed by introducing the solution for 3min with 0.5 rpm and 30 seconds with 0.18 rpm.

Location:
Nine localities (Figure 1) distributed along the northeastern coast of Libya extended from Ashbilia beach, Benghazi in the west to the beach facing the Madar Tower site, Ras al Hilal in the east are visited for molluskan collection.

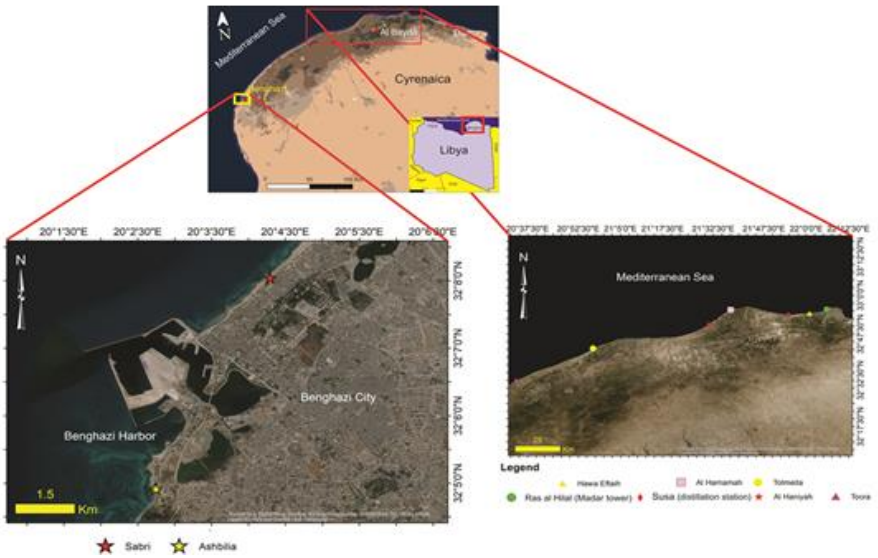

Figure 1. Location maps of the shell collection sites in the northeastern Libya. western area "Ashbilia and Sabri" and eastern area "Tocra, Tolmeta, Al Haniah, Al Hamamah, Susa, Hawa Aftaih, and Madar Tower

The stations are briefly described as follows:

Station 1 (Ashbilia):
It is located at coordinates (Latitude 32° 04´ 55.2" N and Longitudes 020° 02´ 44.8" E) (Figure 1). This station is situated in Benghazi City. The collected shells at this station were commonly attached to the beach rocks (Figures 1a and 1b). Some shells in particular "patellids" were heavily encrusted by marine algae.

Station 2 (Sabri):
It is located at coordinates (Latitude 32° 08´ 02.7" N and Longitudes 020° 04´ 17.4" E) (Figure 1). This station is situated in Benghazi City at a point named (Corniche). It is generally similar to the Ashbilia sandy to rocky beach. The collected shells at this station were commonly attached to the beach rocks and commonly represented by *P. turbinata* shells (Figure 2a).

Station 3 (Tocra):
It is located at coordinates (Latitude 32° 32´ 33.5" N and Longitudes 020° 34´ 04.3" E) (Figure 1). This station is at the ancient Tocra city 50km east of Benghazi city. This beach is predominantly a rocky beach with red color and rich in washed out *Posidonia oceanica* from the sea and partly covered with tar. The collected shells at this station were commonly attached to the beach rocks and represented by both *Patella* and *Phorcus* shells.

Station 4 (Tolmeita):
It is located at coordinate (Latitude 32 °42´ 53.1" N and Longitudes 020 °56´ 53.1" E) (Figure 1). It is generally described as largely sandy beach with some rocky patches, which was used only to build up the abounded harbor, on which some shells were attached with few washed out *Posidonia oceanica.* The collected shells at this station were commonly attached to the beach rocks and commonly represented by *P. turbinata* shells

Station 5 (Al Haniyah):
It is located at coordinate (Latitude 32° 50´ 43.3" N and Longitudes 0.21° 31´ 12.9" E) (Figure 1). This station represents a coastal village located at Al Jabal al Akhdar of northeast Libya and is 25 km north-west of Al-Bayda city. It is generally described as a calcarenitic rocky beach. The collected shells at this station were commonly attached to the exposed beach rocks. This locality is slightly polluted with Tar, Asphalt, and the domestic water. The *Phorcus* shells are presented in huge numbers (Figure 2b), while *Patella* were few

Station 6 (Al Hamamah):
This station represents a coastal village located at Al Jabal al Akhdar of northeast Libya and is 20 km north-west of Al-Bayda city (Figure 1). It is generally described as a calcarenitic rocky beach. The collected shells at this station were commonly attached to the exposed beach rocks. The presence of tar patches is also being observed (Figure 2c).

Station 7 (Susah):
It is located at coordinate (Latitude 32° 53´ 44.4" N and Longitudes 021° 54´ 44.9" E) (Figure 1). This station is a town and seaside resort in the District of Jabal al Akhdar in northeastern Libya .It is generally described as sandy beach intermittent with rocky beach. The collected shells at this station were commonly attached to the beach rocks. Some shells in particular "patellids" were heavily encrusted by marine algae

Station 8 (Hawa Ftaih):
It is located at coordinate (Latitude 32 ° 54´ 12.4" N and Longitudes 022 ° 00´ 55.6" E) (Figure 1). This cave is located in Cyrenaica, Eastern Libya, about 8 kilometers east of Susah (the Port of Sousa)

.It is generally described as sandy beach intermittent with fractured rocky beach. The collected shells at this station were commonly attached to the beach rocks. Some shells in particular “patellids” were heavily encrusted by marine algae.

Station 9 (Ras al Hilal):

It is located at coordinate (Latitude 32° 55´ 30.6" N and Longitudes 022° 06´ 04.6" E) (Figure 1). This station described as sandy beach intermittent with flat rocky beach. The collected shells at this station were commonly attached to the beach rocks, where few sporadic tar covering was observed (Figure 2d).

Objectives

The objectives of this paper are to assess the environmental status using living mollusks from the chemical point of view; to measure and compare the ratios of heavy metals in each species *(Patella caerulea and Phorcus turbinata*); and to use of Mollusca as an indicator of pollution using heavy metals.

The Gastropods *Phorcus turbinata* and *Patella caerulea*:

The Mollusks collect chemical pollutants at concentrations an amount of orders of scale above those observed in the water environment. Due to the widespread purpose of Mollusks as bio-monitoring marine animals in the aquatic environment, they have been the subject of numerous studies on the communication of heavy metals.

Mollusks are a large group of living organisms with more or less similar anatomies belonging to five classes, only two species (*Phorcus turbinata* and *Patella caerulea*) are used herein (Figure 3).

Figure 1. a) Rocky beach with molluskan taxa used in this study, a) A view of Sabri "station no. 2" in Benghazi city; b) Assortment of *Phorcus turbinata* at Al Haniyah "station no. 5"; c) Close view shows sporadic tar cover on calcarenite at Al Hamamah "Station no. 6"; d) A view of rocky beach of Ras al Hilal "station no. 9" with tar covering.

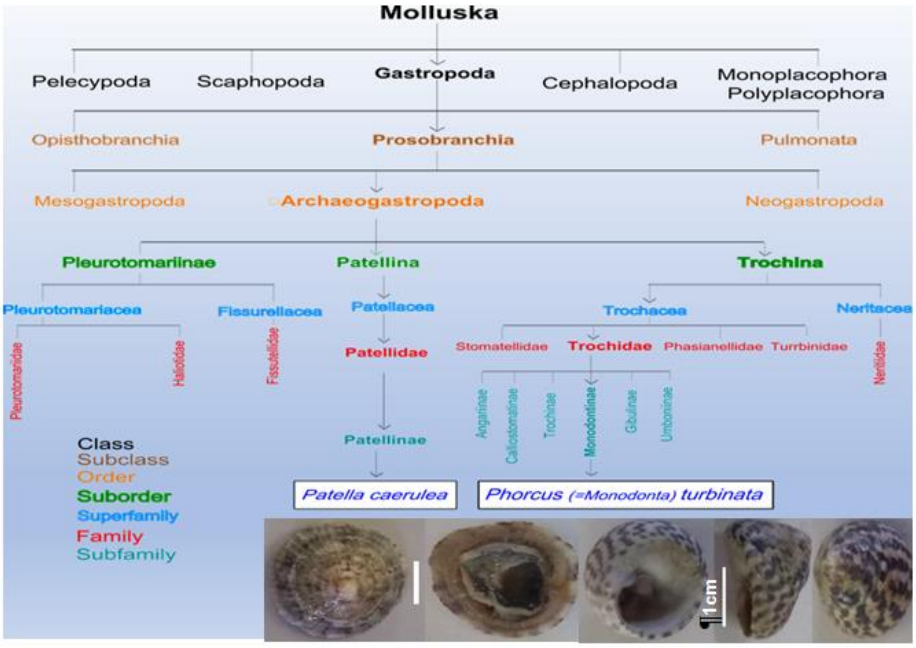

Figure 2. The taxonomical position of the studied *P. caerulea* and *P. turbinate*.

The geographical distribution of the *P. caerulea* and *P. turbinata* along the Mediterranean beach are documented from Spain to Cyprus (Figure 3). The *P. caerulea* is inhabiting the rocky shore from the infralittoral - mesolittoral depths (Sousa *et al*., 2018) (Figure 4A), Whereas, *P. turbinate* is inhabiting mesolittoral depths (Sousa *et al*., 2018) (Figure 4B).

Figure 3. The general geographical distribution of *Patella caerulea* and *Phorcus turbinata* (after Macdonald, 1982)

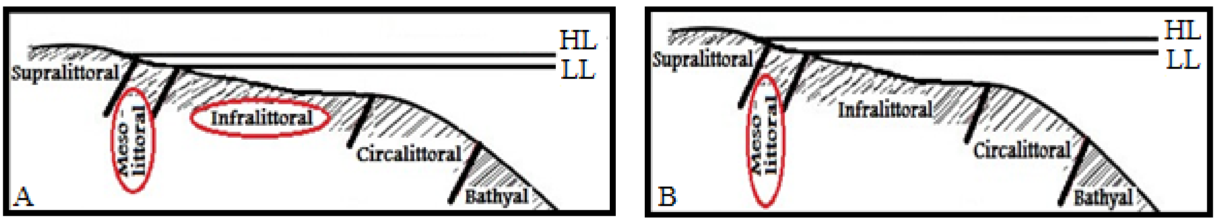

Figure 4. The environmental habitat distribution of A) *Patella caerulea* (infra-mesolittoral habitat zones) and B) *Phorcus turbinata* (mesolittoral habitat zone) (Modified after Macdonald, 1982).

RESULTS AND DISCUSSION

Environmental Geochemistry

Phorcus turbinata and *Patella caerulea* are dominant species of mollusks in the Cyrenaica coast, which is situated on the NE Libya. In this paper, we have focused on the identification of possible bioindicators for trace metal pollution in the soft bodies of these species. This is because it is necessary to identify a wider range of bioindicators and thus expand current understanding of different bioaccumulation strategies for trace metals. The influx of soil from wadis to the coast is the most important natural source of pollution in the study area, while the most important industrial sources are sewage, petroleum pollution, marine paint and desalination. A group of environment-sensitive elements such as Fe, Sn, Sb, Cu, Zn, Pb, Ni, As, Hg and Se were analyzed (Tables 1 and 2).

Table 1. Chemical analysis data (Fe in wt. % and trace elements in ppm) of the soft body of *Phorcus turbinata*

Locality	Fe	Sn	Sb	Cu	Zn	Pb	Ni	As	Hg	Se
Ashbilia	0.58	0.46	0.07	0.58	0.61	0.76	4.23	2.78	0.71	0.21
Sabri	0.88	0.57	0.29	1.68	1.81	2.97	7.00	5.11	2.07	0.39
Tocra	1.67	0.44	0.18	0.56	0.69	0.88	4.11	2.88	0.82	0.23
Tolmeita	1.12	0.17	0.22	0.48	0.65	0.79	2.25	2.33	0.31	0.10
Al Haniyah	0.59	0.11	0.02	0.16	0.21	0.45	1.00	2.00	0.55	0.04
Al Hamamah	0.62	0.06	0.19	0.19	0.21	0.39	1.00	1.87	0.50	0.12
Susa	0.91	0.34	0.41	1.55	1.89	2.86	5.53	5.00	2.28	0.28
Hawa Eftaih	0.62	0.24	0.18	0.16	0.18	0.51	1.33	1.93	0.48	0.16
Ras Al Hilal	0.38	0.40	0.33	0.31	0.46	0.56	1.94	3.13	1.00	0.17

Table 2. Chemical analysis data (Fe in wt. % and trace elements in ppm) of the soft body of *Patella caerulea*

Locality	Fe	Sn	Sb	Cu	Zn	Pb	Ni	As	Hg	Se
Ashbilia	0.05	0.33	0.12	3.49	3.51	18.18	0.66	0.97	0.18	0.17
Sabri	0.17	0.60	0.20	6.66	8.12	29.39	1.67	1.21	0.16	0.42
Tocra	0.10	0.39	0.16	3.58	3.60	18.73	1.05	1.10	0.11	0.29
Tolmeita	0.08	0.21	0.15	3.46	3.49	18.33	0.56	1.13	0.16	0.08
Al Haniyah	0.10	0.05	0.09	2.22	2.07	5.54	0.13	0.88	0.14	0.08
Al Hamamah	0.18	0.05	0.05	2.00	2.00	5.11	0.11	0.60	0.09	0.10
Susa	0.09	0.26	0.29	6.84	8.00	30.09	1.67	1.21	0.16	0.42
Hawa Eftaih	0.12	0.16	0.20	2.31	2.47	6.00	0.07	0.63	0.15	0.21
Ras Al Hilal	0.08	0.51	0.42	3.45	5.57	11.00	0.10	0.92	0.11	0.20

STATISTICAL TREATMENT

The chemical data were processed statistically using the SPSS© program. The statistical analysis includes descriptive statistics (Tables 3 and 4), Pearson's correlation coefficient (Tables 5 and 6) and factor analysis (Tables 7 and 8). The descriptive statistics show that *Phorcus turbinata* and *Patella caerulea* contain high concentrations of As (3ppm) and Pb (15.82ppm), respectively.

The correlation analysis indicates that Fe does not demonstrate any confident coherence to any of the analyzed trace elements, which indicates that natural sources (terra rossa) have a great influence on iron abundance in the study area. Moreover, most heavy metals are mutually correlated, but there is an absence of strong correlations among some metals, which suggests that these metals are possibly of different sources.

Three factors were extracted to explain approximately 93.91 and 89.52% of the total variables in *Phorcus turbinata* and *Patella caerulea*, respectively. The following is a brief discussion of these factors:

Factor one (F1):
It accounts for about 75.63 and 61.68% of the total variables in *Phorcus turbinata* and *Patella caerulea*, respectively. It shows positive loading for Sn, Sb, Cu, Zn, Pb, Ni, As, Hg and Se. It can be nominated as the factor of the environment-sensitive elements.

Factor two (F2):
It accounts for about 10.73 and 14.92% of the total variables in *Phorcus turbinata* and *Patella caerulea*, respectively. It loads positively for Fe. This factor is important in the interpretation of the influx of the wadis to the Mediterranean coast.

Factor three (F3):
It accounts for about 7.55 and 12.92% of the total variables in *Phorcus turbinata* and *Patella caerulea*, respectively. This factor is practically insignificant.

Table 3. Descriptive statistics of metals in *Phorcus turbinata* (Fe in wt. % and trace elements in ppm)

Elements	N	Minimum	Maximum	Mean	Std. Deviation
Fe	9	0.38	1.67	0.82	0.39
Sn	9	0.06	0.57	0.31	0.17
Sb	9	0.02	0.41	0.21	0.12
Cu	9	0.16	1.68	0.63	0.58
Zn	9	0.18	1.89	0.75	0.66
Pb	9	0.39	2.97	1.13	1.03
Ni	9	1.00	7.00	3.15	2.16
As	9	1.87	5.11	3.00	1.25
Hg	9	0.31	2.28	0.97	0.72
Se	9	0.04	0.39	0.19	0.10

Table 4. Descriptive statistics of metals in *Patella caerulea* (Fe in wt. % and trace elements in ppm)

Elements	N	Minimum	Maximum	Mean	Std. Deviatio
Fe	9	0.05	0.18	0.11	0.04
Sn	9	0.05	0.60	0.28	0.19
Sb	9	0.05	0.42	0.19	0.11
Cu	9	2.00	6.84	3.78	1.79
Zn	9	2.00	8.12	4.31	2.38
Pb	9	5.11	30.09	15.82	9.67
Ni	9	0.07	1.67	0.67	0.66
As	9	0.60	1.21	0.96	0.23
Hg	9	0.09	0.18	0.14	0.03
Se	9	0.08	0.42	0.22	0.13

Table 5. Correlation matrix of metals in *Phorcus turbinate*

Elements	Fe	Sn	Sb	Cu	Zn	Pb	Ni	As	Hg	Se
Fe	1.00									
Sn	0.22	1.00								
Sb	0.09	0.33	1.00							
Cu	0.27	0.63	0.62	1.00						
Zn	0.29	0.60	0.67	0.99	1.00					
Pb	0.23	0.56	0.64	0.99	0.99	1.00				
Ni	0.38	0.82	0.45	0.94	0.91	0.89	1.00			
As	0.17	0.70	0.71	0.97	0.97	0.96	0.91	1.00		
Hg	0.09	0.60	0.71	0.93	0.94	0.95	0.83	0.97	1.00	
Se	0.26	0.85	0.57	0.87	0.84	0.84	0.93	0.88	0.83	1.00

Table 6. Correlation matrix of metals in *Patella caerulea*

Elements	Fe	Sn	Sb	Cu	Zn	Pb	Ni	As	Hg	Se
Fe	1.00									
Sn	-0.06	1.00								
Sb	-0.30	0.61	1.00							
Cu	0.04	0.62	0.43	1.00						
Zn	0.05	0.72	0.63	0.96	1.00					
Pb	-0.10	0.62	0.29	0.95	0.86	1.00				
Ni	0.08	0.54	0.17	0.94	0.82	0.96	1.00			
As	-0.30	0.60	0.30	0.81	0.73	0.90	0.83	1.00		
Hg	-0.43	0.15	-0.01	0.44	0.32	0.52	0.41	0.46	1.00	
Se	0.18	0.64	0.46	0.88	0.86	0.80	0.86	0.59	0.24	1.00

Iron (Fe)
Fe is negatively correlated with the analyzed trace elements (Tables 5 and 6). The authors believe that the distribution of Fe in the study area is controlled by the influx of the wadis to the coast. Figure 5 shows that *Phorcus turbinata* is good accumulator for Fe.
The Fe contents in this species are lower than the maximum allowable level in seafood (2%, Food Standards Australia New Zealand (FSANZ, 2008). Moreover, these Fe values are higher than those in the Iskenderun Bay, North-Eastern Mediterranean Sea (0.21%, after Duysak and Ersoy, 2014).

Nickel (Ni)
Ni was measured to be in relatively low concentrations in the studied samples. The lowest concentration (0.07ppm) was measured in *Patella caerulea*, while the highest concentration (7ppm) was measured in *Phorcus turbinata* (Figure 6). The estimated maximum guideline in seafood for Ni is 70 ppm (FSANZ, 2008). Thus, the concentrations of Ni in all the samples are far below the stipulated limit.

Table 7. Factor analysis of the metals in *Phorcus turbinata*

Eigenvalue	7.56	1.07	0.76
% of Variance	75.63	10.73	7.55
Cumulative %	75.63	86.36	93.91
Factor	1	2	3
Fe	0.28	0.84	0.46
Sn	0.74	0.28	-0.52
Sb	0.68	-0.38	0.40
Cu	0.98	-0.02	0.06
Zn	0.98	-0.04	0.14
Pb	0.96	-0.10	0.12
Ni	0.95	0.23	-0.16
As	0.99	-0.13	0.00
Hg	0.95	-0.24	0.04
Se	0.93	0.11	-0.22

Table 8. Factor analysis of the metals in *Patella caerulea*

Eigenvalue	6.17	1.49	1.29
% of Variance	61.68	14.92	12.92
Cumulative %	61.68	76.59	89.52
Factor	1	2	3
Fe	-0.08	0.89	0.36
Sn	0.74	0.13	-0.41
Sb	0.50	0.03	-0.82
Cu	0.98	0.08	0.12
Zn	0.95	0.17	-0.13
Pb	0.96	-0.08	0.21
Ni	0.92	0.08	0.34
As	0.86	-0.27	0.09
Hg	0.46	-0.68	0.33
Se	0.88	0.31	0.01

Copper (Cu) and Zinc (Zn)
The correlation matrix indicates that Cu and Zn are mutual (Tables 5 and 6). Furthermore, in the study area the distributions of these elements are similar (Figs. 7 and 8), indicating their derivation from a common source. Clearly, *Patella caerulea* is fine collector for Cu and Zn. The concentrations of Cu and Zn in the studied samples are below the recommended guideline in seafood (30 and 100 ppm, respectively, FSANZ, 2008).

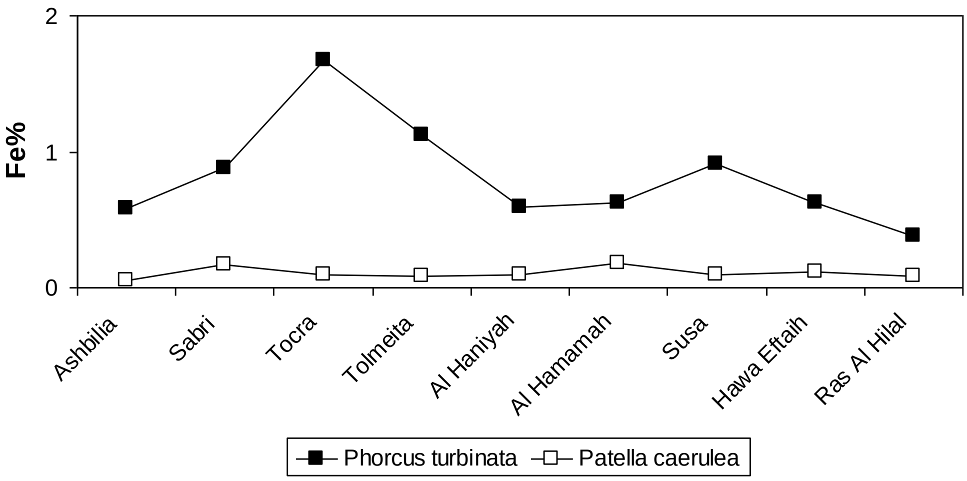

Figure 5. Distribution of Fe in the study area.

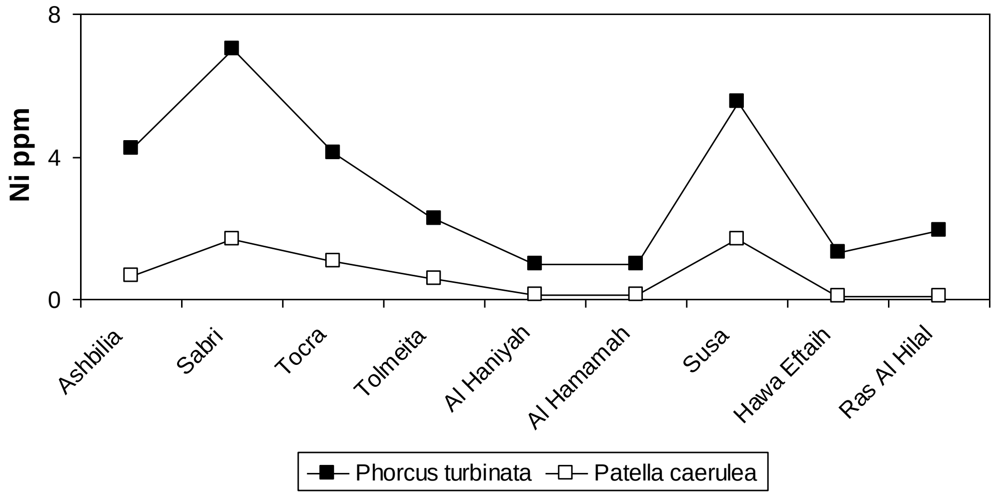

Figure 6. Distribution of Ni in the study area.

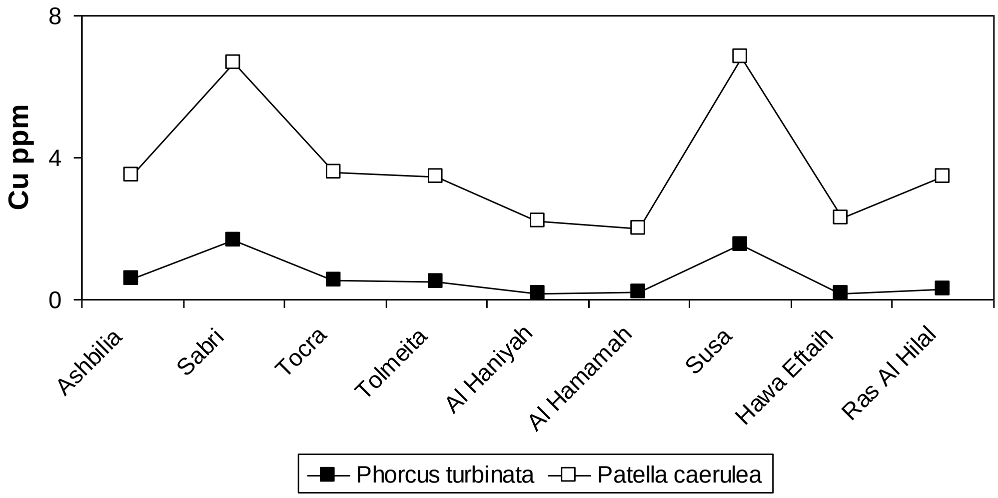

Figure 7. Distribution of Cu in the study area.

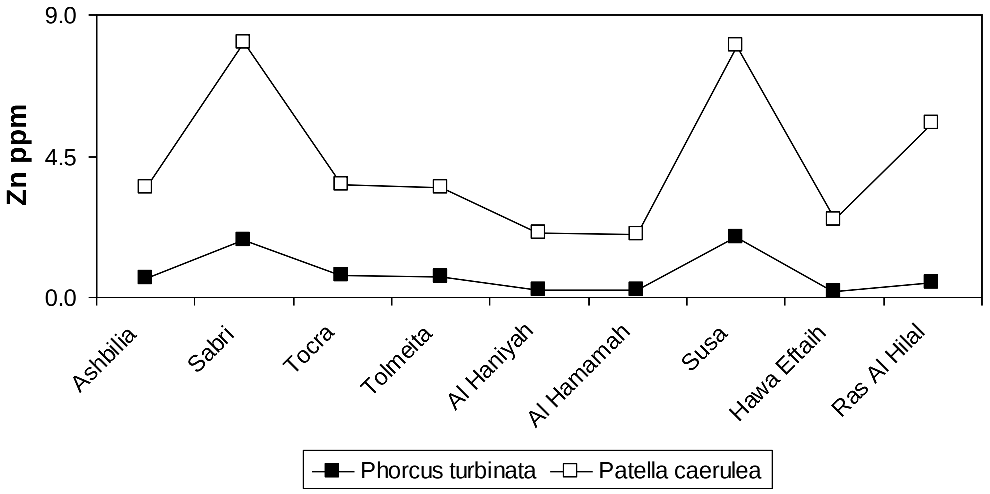

Figure 8. Distribution of Zn in the study area.

Antimony (Sb), Tin (Sn) and Selenium (Se)

The studied species have almost the same sensitivity for Sb, Se and Sn (Figs. 9-11). The Sb, Se and Sn concentrations in the study area are below the maximum recommended limits in seafood (1, 0.5 and 1 ppm, respectively, FSANZ, 2008).

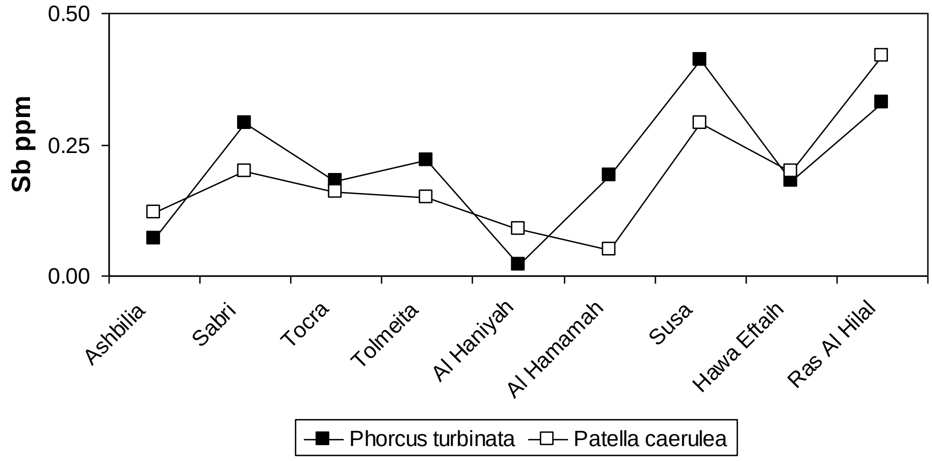

Figure 9. Distribution of Sb in the study area.

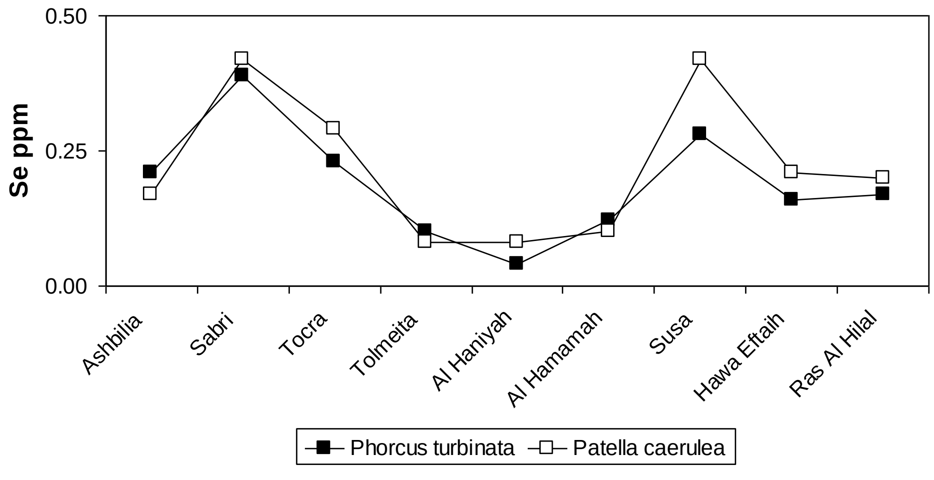

Figure 10. Distribution of Se in the study area.

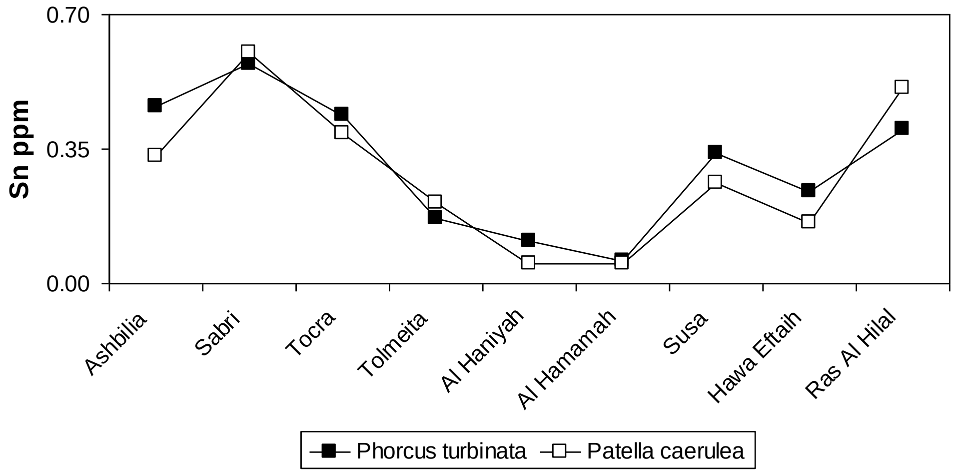

Figure 11. Distribution of Sn in the study area.

Arsenic (As)
The result shows that *Phorcus turbinata* is better accumulator for As than *Patella caerulea* (Fig. 12). Moreover, most *Phorcus turbinata* contain As concentrations above the maximum recommended limits in seafood (2 ppm, FSANZ, 2008). The possible source of the high concentration in both sites of arsenic in Sabri is the sewage of the old slaughterhouse as well as the sewage of the Benghazi Port and distillation station in Susa.

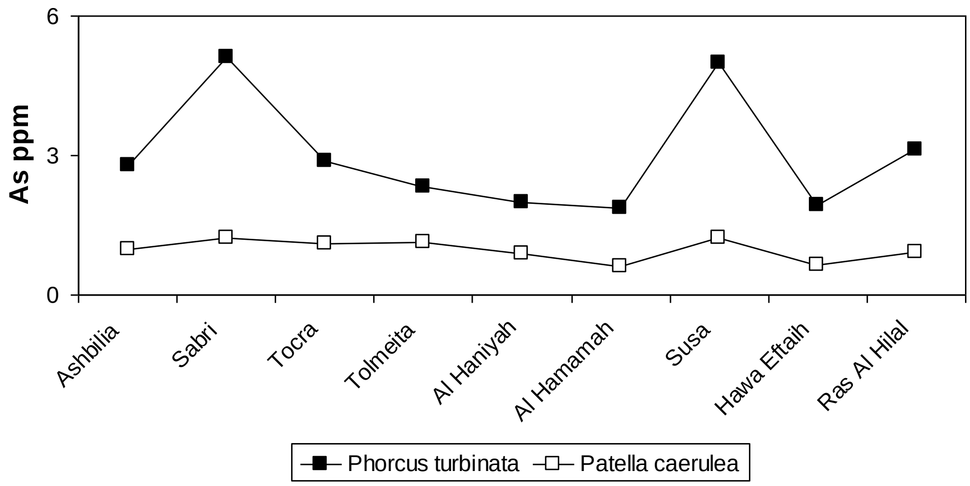

Figure 12. Distribution of As in the study area.

Mercury (Hg)
Like the arsenic, *Phorcus turbinata* is better accumulator for Hg than *Patella caerulea* (Fig. 13). The Hg level in the *Phorcus turbinata* in all localities is within the safe limits in seafood (1 ppm, FSANZ, 2008), except for the distillation station in Susa (2.28 ppm).

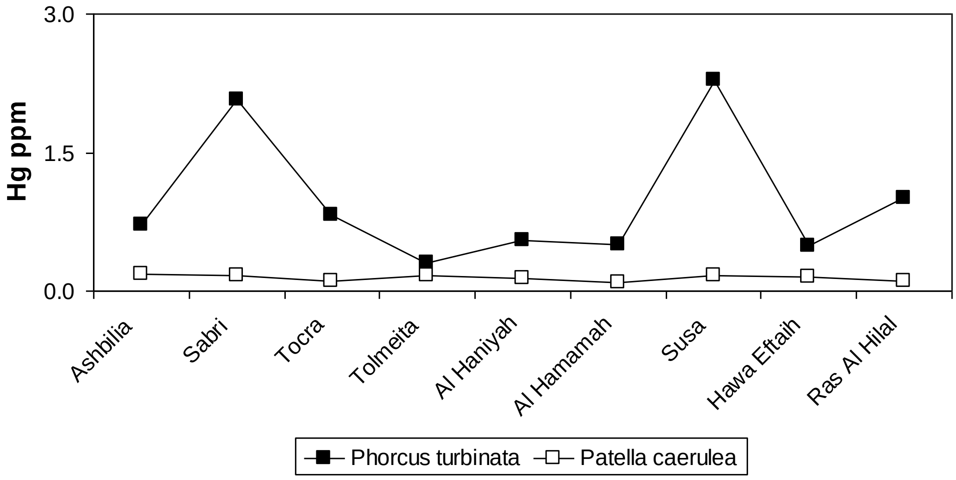

Figure 13. Distribution of Hg in the study area.

Lead (Pb)

Patella caerulea is finer collector for Pb than *Phorcus turbinata* (Fig. 14). It should be noted that the Pb values in the *Patella caerulea* are much higher than the acceptable limit in seafood (2 ppm, FSANZ, 2008). Pb pollution in the study area should be treated especially at Susa (distillation station) and Sabri.

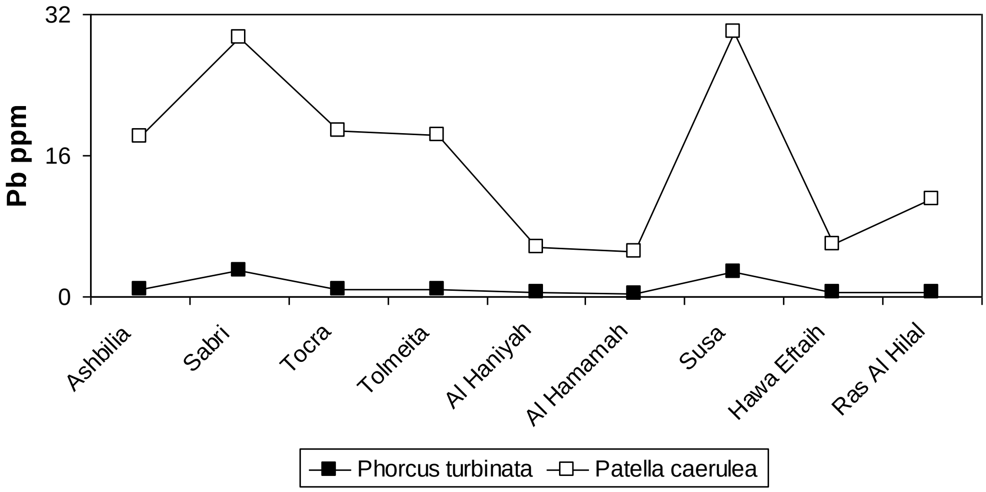

Figure 14. Distribution of Pb in the study area.

CONTAMINATION INDICES

Index of Pollution (IP)

According to Chester *et al.*, (1985) the index of pollution (IP) can be calculated according to the equation: IP = E/threshold. Where, E is the concentration of any element. Acceptable limit in seafood (FSANZ, 2008) are used as the background concentrations for metals. Whenever IP>1 this indicates that additional pollutant input has been introduced to the sample.

The IP of As, Hg and Pb for *Phorcus turbinata* is high (>1) in Susa and Sabri (Figure 15), while in the other metals the factor is low (<1). The IP of the analyzed metals for *Patella caerulea* is low (<1), except for Pb (Table 3.14 and Figure 16).

Metal Pollution Index (MPI)

Regardless the type of species, the overall metal content of mollusks at the investigated locations in the current study, was compared using the metal pollution index (MPI). According to Usero *et al.*, (1996) the MPI can be calculated with the following formula: MPI = (Fe x Sn x Sb x Cu x Zn x Pb x Ni x As x Hg x Se)$^{1/8}$. When the MPI value is high (>1), the area is considered polluted (Usero *et al.*, 1997). The studied species display high MPI values in two localities (i.e. Susa and Sabri, Figure 17). Pollution in the Sabri sea is due to two reasons: (1) Sewage water; and (2) In this area there was a war lasted for four years and therefore there are the remains of decomposed corpses and weapons.

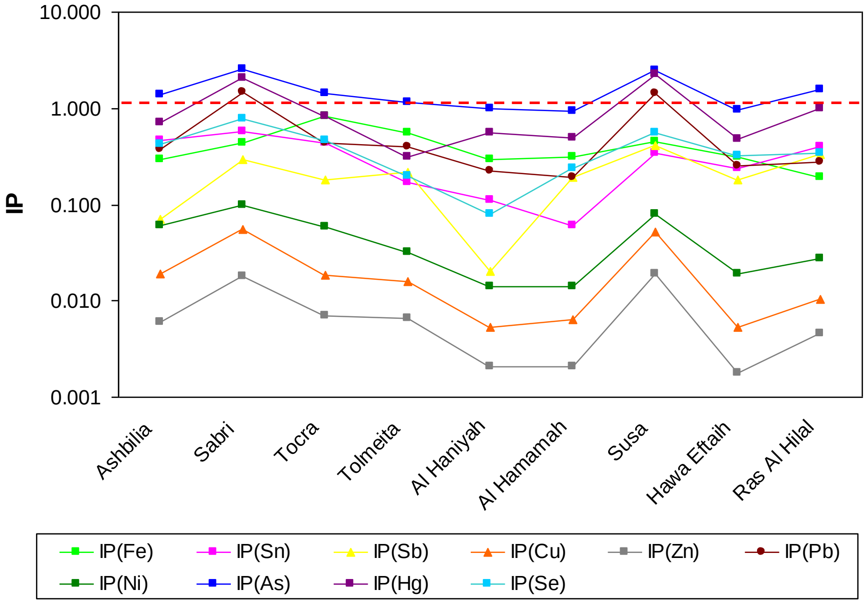

Figure 15. Index of pollution for *Phorcus turbinata*.

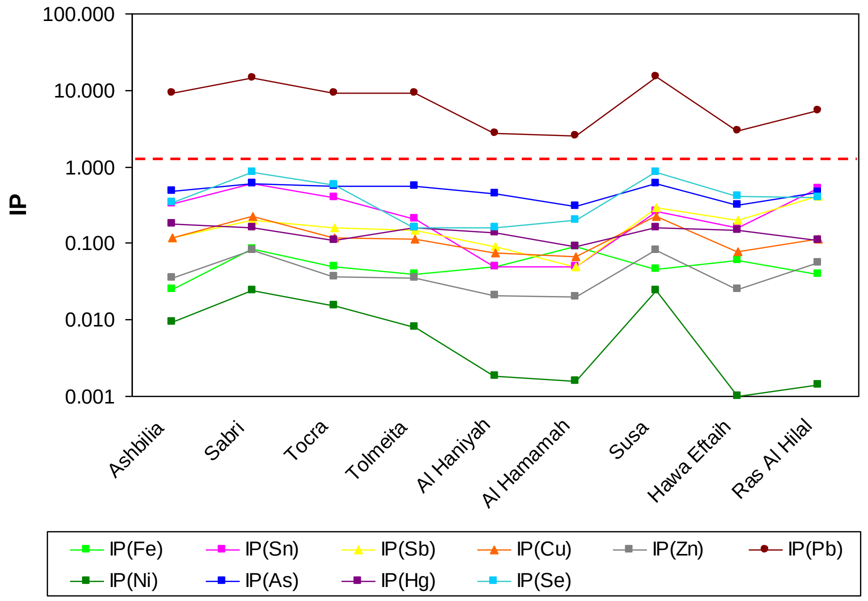

Figure 16. Index of pollution for *Patella caerulea*

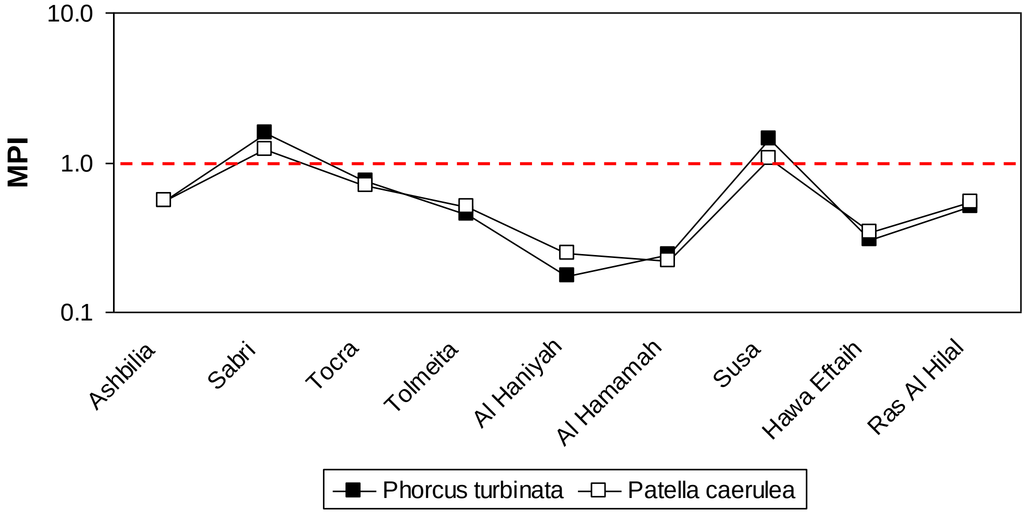

Figure 17. Metal pollution index for the studied species

CONCLUSION

The attached mollusca *Phorcus turbinata* and *Patella caerulea* proved to be a good bioindicator for heavy metals in Libyan rocky beaches. All the analyzed elements (Sn, Sb, Cu, Zn, Pb, Ni, As, Hg and Se) are mainly of anthropogenic origin (excluding Fe). The concentrations of all elements in soft tissue are below the recommended guideline in seafood (FSANZ, 2008). Exceptionally, As in *Phorcus turbinata* and Pb in *Patella caerulea* are above the recommended limit of sea food (2ppm, FSANZ, 2008). The *Phorcus turbinata* is good accumulator for Fe, Ni, As and Hg, while *Patella caerulea* is fine collector for Cu, Zn and Pb. The contamination indices show that the most polluted stations in the study area are Sabri and Susa (distillation station), the former is due to sewage water; and the remains of decomposed corpses and weapons, whereas in Suas is attributed to distillation station and the nearby sewage.

ACKNOWLEDGEMENTS

The staff members of Zoology Department are thanked for their invaluable help in many stages of this study. The authors would like to appreciate the laboratory of Nuclear Materials Authority of Egypt for performing the samples analysis using ICP-MC instrument.

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THE RELATIONSHIP BETWEEN ECONOMIC GROWTH, FOSSIL FUELS ABUNDANCE AND ENVIRONMENTAL SUSTAINABILITY IN COUNTRIES OF CIS: THE CASE OF OIL AND GAS EXPORTING COUNTRIES

Dina MALGAZHDAROVA

Hungarian University of Agriculture and Life Sciences (MATE), Kaposvar campus, Guba Sandor Str. 40, Kaposvar, 7400, Hungary, dina.malgazhdarova@gmail.com

The article investigates the relationship between indicators of the country's economic sustainability, the fuel, and energy potential of the state, and the country's environmental sustainability, as well as the major problems of the development of the fuel and energy complex. The major issues of the fuel and energy complex development and the necessity of the national production greening are analyzed, as well as its nexus with the economic growth within CIS countries exporting energy resources.

Keywords: *Sustainable development, economic growth, resource safety, environmental sustainability, environment and economy*

INTRODUCTION

Modern economic realities convincingly indicate that the dynamic development of the national economy is impossible without a balance in the complex triad "resources - economy (production) - ecology". Global economic crises and the globalization of the world economy make the task of maintaining this balance more urgent. For the third year, the world community has been operating under special conditions caused by the pandemic. On the one hand, the harsh conditions for restricting economic activity have shown the "vulnerability" of the global economy, but on the other hand, they have activated the "internal" reserves of many countries.

Most countries do not demonstrate high rates of development, the energy sector of the world economy is experiencing certain difficulties, and environmental disasters are becoming sustainable. Quite a lot of works have been devoted to the issues of studying the mutual influence of providing resources to business entities (resources in general and fuel and energy, in particular), stable economic growth, and environmental sustainability.

A significant increase in the attention of theorists and practitioners to the issues of the relationship between the provision of fuel and energy resources (FER) and sustainable development is noted in the 70s of the last century when the energy crisis forced entrepreneurs from leading countries to develop and implement resource-saving technologies [30]. Then, such a term as "energy security of the country" appeared. The International Energy Association (IEA) defines energy security as the uninterrupted availability of energy sources at an affordable price. The IEA recommends that its main elements be considered: the availability and access of energy, access to electricity for the population, and energy intensity [25]. Unfortunately, the issues of energy security today have acquired a military context. The Iranian-American conflict, recent events in Afghanistan, the conflict in Ukraine confirm this thesis. In addition, since 2008, energy security issues have become a separate area of research for the senior leadership of NATO countries.

For a long time, the issue of sustainable development, reliability of energy supply, and energy security was considered from the standpoint of resource-saving in general and energy saving in particular [35,

37]. Quite significant results in the implementation of this policy have been achieved by such countries as Germany, Sweden, Denmark, etc. [1,4].
A little later, the “lens” of researchers shifted to powerful industrial clusters, the core of which are oil and gas producing, oil and gas processing, petrochemical enterprises, infrastructure facilities, and marketing complexes for the sale of products of the cluster industries.
A significant number of works is devoted to the so-called "resource curse", i.e., the problem of ensuring the dynamic development of countries with significant FER. This term was introduced by the English economist R. Authy to explain a phenomenon: a significant drop in living standards in oil-exporting countries in 1970s and 1980s. Since 1974, GDP per capita in the OPEC countries has been declining by an average of 1.3% per year, while in other developing countries it has grown by an average of more than 2% per year [32].
It is noted in [29] that despite a sharp increase in prices commodities still can provide the country with additional economic growth, however, in the long term, such dependence of the economy on commodities clearly correlates with slow economic growth. In this context, we note that maintaining a leading position in the world trade of energy resources, as well as exporting almost half of the primary energy produced has a negative effect for countries of CIS. This negativity is expressed in the high dependence of the domestic economy on the fuel and energy sector (FES) and the export of energy resources [4, 13].
Undoubtedly, FER plays an important role in ensuring the sustainable development of national economies. However, there are other resources that can destabilize the economic situation. Some researchers believe that the next war may take place not for land, but for water, this is what is being increasingly discussed in Arab countries today. Such a serious prediction has an equally serious reason. Water supply in the Middle East is the most important problem today.
Indeed, the Arab countries occupy 9% of the land and the fifth largest population in the world. Meanwhile, its water resources account for only 0.7% of the total world reserves and the volume of water per capita is 1.5 thousand cubic meters per year with an average global supply of 13 thousand cubic meters.
The situation is such that the growing shortage of water will soon become an important constraint for economic growth here. No coincidence that the problem of water in the Middle East is increasingly becoming an object of disagreement in the relations of the Arabs with neighboring countries and among themselves. The shortage of water resources has long been initiating contradictions between Turkey, Syria and Iraq, between Israel, Syria and Jordan, between Egypt and Sudan. Thus, the problem of water becomes a life-support issue and becomes of paramount importance within the framework of national security. Based on the current situation, since the mid-1980s, the question of the growing threat of conflict over water has been increasingly raised in the Arab world [21].
After studying the researches of russian speaking CIS scientists as Belov S.V., Domracheva V.A., Fedorets A.G. and others devoted their scientific works to the study of the general strategy of greening national production. It is their studies that allow us to use a rich range of definitions of environmentally friendly use of resources, technosphere safety and environment. The issues of the relationship between sustainable development and environmental safety of production are the object of research by such scientists as Muratova T., Kiushkina V. Kokorina A. and others.
Environmental restrictions, according to scientists, should be the basis for the formation of the main proportions of the economy. This will help to achieve coherence between the economic and environmental components of sustainable development.
Economic growth should be accompanied by adequate social transformations and contribute to solving the problem of improving the quality of the natural environment. Otherwise, the growth of the economy will be deprived of any sense from the point of view of mankind development. Most scientists argue the need to find new approaches to reduce the environmental burden on the environment and ways to develop environmentally-oriented activities of enterprises and industries. In modern society, environmental campaigns and programs find their supporters and lobbyists at the highest levels of government.
In the context of the relationship between the use of resources and environmental sustainability, one can recall the environmental catastrophe that was the result of the conflict between Iraq and Kuwait. During this war, 700 powerful oil wells were set on fire, which had burned for eight months.

As the review of the main areas of scientific research has shown, most of them focus on one of the problems of the scientific triad that we have chosen as the object of research: either "resources or sustainable development", or "resources and ecology", or "sustainable development and ecology". In our opinion, it would be legitimate to combine all of these areas.
The purpose of the current article is to develop a model that demonstrates the relationship between such elements of the country's economic development as fuel and energy resources, economic growth, and environmental sustainability. The depth of the study is determined by the regional aspect, i.e. the object of the study was the indicators of socio-economic development of the CIS countries.

UNDERSTANDING THE TERMS

Based on the fact that the object of the current study are three concepts - FER (FEC), economic growth and environmental sustainability, it is necessary to conduct a brief study of these concepts, i.e. consider the tools used from the standpoint of the synthesis of these concepts. The result of the research is presented in Table 1.

Table 1. Semantic analysis of the main concepts of the study

Author (source)	Meaning (interpretation)
Fuel and Energy Resources	
Bolotov G. [1]	a set of different types of fuel and energy (products of the extraction of fuel and energy minerals, the production of petroleum products, electricity and heat), which are necessary to ensure the production process of industrial organizations.
Russian Financial dictionnary [10]	Reserves of fuel and energy in nature, which, with the current level of technology, can be practically used by man for the production of material goods
Fuel and Energy Complex	
Bolotov [1]	A complex system that includes a set of industries and processes for the extraction of fuel and energy resources, their transformation, transportation and consumption
Economic growth / sustainable development	
Galuzina S., Turovskaya M. [12]	the possibility and ability of the region's economy to gradually improve the quality of life of the population at the level of generally accepted standards, to withstand the influence of internal and external threats at the optimal cost of all types of resources and the rational use of natural factors, to ensure socio-economic and general political stability
Environmental sustainability	
Philosophic dictionnary [6].	The ability of an ecological system to maintain its structure and functions under the influence of internal and external factors

Assessing the development of the fuel and energy complex (FEC) from the perspective of the world economy, it should be noted that the global demand for energy in the modern world economy retains its leading position. Despite a certain decrease in the growth rate of this demand, the energy sector as a branch of the world economy is among the leaders. Over the last 150 years of history, energy sector as an industry has shown a 35-times increase [31, 34]. The group of distinctive features of modern world energy can include: significant changes in regional proportions, high shares and growing volumes of consumption of fossil fuels, problems of ensuring investments in the development of the energy sector, increasing quality requirements for energy supply and other equally important trends. FER influence the formation and development of the national economies of many countries. Currently, there are several "growth points" in the global petrochemical complex. These are areas where there are large reserves of oil and gas raw materials, the necessary infrastructure has been created, qualified personnel has grown, a noticeable innovation potential has been created, the largest petrochemical companies and serious investors have been attracted. Now, oil and gas chemical clusters in Saudi Arabia, South Korea, Brazil, China, and India have been added to the "old" petrochemical centers in the USA, Canada, Western European countries, and Japan [2]. Over the past 20-30 years, significant regional and structural shifts have taken place in the global petrochemical industry. Regional shifts have manifested themselves in the rapid development of the industry in the Asia-Pacific regions, the countries of the Middle East and a number of countries in South America. The role of China has especially increased [13]. The sustainable development of national economies in the context of the petrochemical business in world practice occurs in the following main areas:

- expansion and improvement of the resource base through the involvement of new types of raw materials (shale gas ethane, directly natural gas, gas condensate, bio-raw materials);
- improvement of equipment for the preparation and processing of raw materials;
- search for new technologies, primarily methane processing technologies, biotechnologies, nanotechnologies;
- expansion of the range of manufactured products through the production of polymers with predetermined properties, special plastics, bioplastics, membranes, etc.;
- improvement of methods for substantiating the directions of technological and organizational and economic development of petrochemicals, development and implementation of investment projects [11].

However, the disproportionate development of the country's fuel and energy complex may lead to the dependence of the national economy on imports of fuel and energy resources, as well as to the emergence of a structural monopoly of producers in some sectors of the economy. As a result, certain industries may lose competitive advantage in a competitive market due to the price factor and lower profits. On the other hand, the consequence of the structural monopoly of individual producers may be unreasonably high costs, low profits, and low development opportunities.

If the country's FER can be assessed by a simple summation of all their types, then such concepts as economic growth (stability) and environmental sustainability are synthetic and are determined by a set of indicators, in which an indicator is understood as the most general indicator on the basis of which changes in the state of the economic system can be established [7].

Indicators can have both absolute and relative values; in some cases they can have an interval expression. To assess the country's economic growth, existing domestic and foreign practices provide a significant range of approaches, concepts, techniques and methods. In the most aggregated form, economic growth (in the current study, a synonym for economic sustainability) is assessed by five main indicators:

- GDP per capita (EU countries - 38.9 thousand international dollars (2020));
- inflation rate;
- volume of external debt;
- the share of imports in domestic consumption;
- human development index.

A significant place in the system of ensuring economic growth is occupied by environmental sustainability, since, according to Jacque Fresco, "science and education, devoid of social consciousness and concern for environmental and human problems, do not make sense."

The problem of effective nature management does not lose its relevance. On the contrary, every sector of the national economy is looking for ways to “softer” use of natural resources, including fuel and energy. Issues of environmental sustainability are relevant for all countries, including the CIS. This thesis is confirmed by the relevant regulatory and legislative framework (Table 2).

Table 2. Legal and regulatory framework of the CIS countries regulating environmental issues

Country	**Law and regulations**
Azerbaijan + Russia	Law "On Ecological Expertise" Law "On Environmental Education"
Azerbaijan + Kazakhstan + Russia	Law "On Specially Protected Natural Territories" Law "On the Protection of Atmospheric Air" Law "On drinking water and drinking water supply"
CIS	Forest, Land, Water, Ecological model codes. "Code on Subsoil and Subsoil Use for the CIS Member States" Law "On Environmental Audit" Law "On Environmental Safety" Law "On ecological agricultural production" Law “On Conservation and Restoration of Biological Diversity” Law "On elimination of accumulated environmental damage"

	Law "On state information systems in the field of environmental protection, nature management and environmental safety", Law "On the development and protection of mountain territories", Law "On the legal regime of territories subjected to radioactive contamination" Law "On the Fundamentals of Ecological Entrepreneurship"

The environmental burden on the environment is manifested even in the conditions of conventional production through the consumption of natural resources. Thus, obtaining each ton of grain of wheat requires 2,500 tons of water, rice - 4,560 tons, cotton - 10,000 tons, beef - 30,000 tons. For the smelting of one ton of steel, 30 tons of water are required, for alcohol this value is 300, for cellulose - 500, for synthetic fibers - 5000, etc. [2]. As follows from the report of the United Nations Commission on Environmental Problems (UNEP), the forecast for the development of mankind until 2032 is disappointing. Under the influence of human activity, irreversible changes will occur on the planet. More than 70% of the earth's surface will be deformed in one way or another, more than 1/4 of all species of the animal and plant world will be irretrievably lost, safe air, clean drinking water, undisturbed landscapes will become an irreplaceable deficit, and the ability of nature to recover after anthropogenic impact will decrease [27]. Noteworthy are the works of such scientists as Kokorina A., Muratova T., Egorova M., Levchenko L., who investigate the main causes of environmental problems in the fuel and energy complex. In the scientific developments of scientists, it is noted that the main cause of environmental problems is the global problem of the raw material orientation of the economies of some countries (Table 3).

Table 3. The share of raw materials in the exports of some countries, %
(compiled according to [19])*

Country/group of countries	2005	2010	2020
EU (mineral fuels, mineral oils, and products of their distillation)	4,8	4,3	5,9
Latin America (oil and oil products)	18	17	14
USA (oil, gas)	16	10,5	8,3
Canada	33	62	59

*Source: World Bank database

Under current conditions of globalization, ignoring environmental requirements can be costly for the manufacturer. Today in the world practice there are uniform environmental standards and in case of violation of these standards, manufacturers cannot participate in international contracts. In modern society, the greening of production performs various functions: reproductive, spatial, socio-ecological. The reproductive function of production greening is based on the possibility of creating optimal conditions for the conservation and reproduction of natural potential. The substantiation of the system of ecological zoning, the formation of territorial schemes for nature management, the identification of disagreements within environmental and economic regions form the basis of the spatial function of the greening of production. The implementation of this function contributes not only to the optimization of the distribution of productive force, but also to the rational use of natural resources. No less important is the socio-ecological function associated with the environmental education of the population, the improvement of the general culture of production [9]. Currently, the issues of greening the fuel and energy complex are being actively discussed, taking into account the preservation of its financial stability. By 2050, the global energy sector will get rid of greenhouse gas emissions, the total amount of which today is 11 gigatonnes per year [4, 15]. The decarbonization policy aims to reduce greenhouse gas emissions in the global economy as part of the fight against climate change. Thus, at the UN climate conference COP-21, this was held in December 2015, out of 162 adopted national plans, 106 made a special emphasis on accelerating the development of renewable energy.

METHOD AND CALCULATIONS

The next stage of the study is to assess the state and dynamics of these categories in the CIS countries.

The fuel and energy complex occupies a special place in the development of the CIS countries that export the corresponding resources (Table 4).

Table 4. Share of FEC in GDP of CIS, %

Country	2000	2005	2010	2015	2020
Azerbaijan	19,6	20,3	22,1	26,2	32,5
Kazakhstan	21,1	25,2	22,5	26,9	29,7
Russia	30,5	29,3	28,6	25,9	23,6
Turkmenistan	9,2	15,4	16,2	21,1	22,0

*Source: World Bank database

All considered countries of the commonwealth are characterized by a high level of fuel and energy complex in the formation of GDP. Over the past years, despite the imposed sanctions, investments in fixed assets of enterprises for the extraction of crude oil and natural gas have been constantly increasing. Similar trends are typical for other CIS countries that export oil and gas. We calculate the general indicator of sustainable economic development (SD) using the multiplicative model (1):

$$K_{sd} = \prod_{i=1}^{5} K_i \quad (1)$$

where K_i is the coefficient of intermediate indicators of sustainable development (in Tables 5-9, these are indicators 1-5). The coefficient of intermediate indicators of sustainable development is calculated using the coefficient method (2.3):

$$K_i = I_f : I_{opt} \quad (2$$

or

$$K_i = I_{opt} : I_f \quad (3)$$

where I_f is the actual value of the indicator, I_{opt} is the optimal value of the indicator
Formula (2) is used for stimulating indicators, and formula (3) is used for destimulating indicators. General indicator of sustainable economic development of the CIS countries exporting fuel and energy resources is presented in Tables 5 - 9.

Table 5. Sustainable Development Index of the Republic of Azerbaijan (compiled according to [3] [20], [28], [33], [36])

Index	Optimal value	2000	2005	2010	2015	2020
1	2	3	4	5	6	7
1. GDP per capita, thousand int. dollars (countries with an average level of development)	1,1 < GDP < 10	3,6	6,8	10,0	7,8	14,5
- coefficient	x	0,36	0,68	1	0,78	1,45
2. Inflation rate, % per year	10	2,2	5,4	7,9	7,6	2.6
- coefficient	-	4,54	1,85	1,27	1,32	3,85
3. Volume of external debt, % of GDP	25	22,8	13,5	12,5	28,3	20,1
- coefficient	x	1,10	1,85	2,0	0,88	1,24
4. Share of imports in domestic consumption, %	30	31,6	39,8	25,8	34,8	36,5
- coefficient	x	0,95	0,75	1,16	0,86	0,82
5. Human Development Index	-	0,64	0,758	0,713	0,751	0,756
- Optimal value	x	0,917	0,968	0,938	0,944	0,957
- coefficient	-	0,698	0,783	0,760	0,796	0,790
Sustainability summarizing factor	x	1,19	1,37	2,23	0,62	4,48

The generalizing coefficient of sustainable development of the Republic of Azerbaijan is quite stable. Over the past 20 years, only in 2015 is its value below 1. Moreover, with an optimal value of 1, in 2020 it was almost 4.5. The stable value of this coefficient is achieved by curbing inflationary processes. A positive fact is also the growth of GDP per capita. For other indicators, the actual values are below the optimal values. The Republic of Kazakhstan over the past 20 years has been steadily improving the indicators of the sustainable development coefficient. Since 2005, the value of the generalizing indicator has exceeded 1, and in 2020 its value exceeded 3. This indicates the presence of a certain margin of "strength" in the economy. This stable position is achieved due to the growth of GDP per capita, relatively low inflation rates and reduced dependence on imports. However, the growth of external debt reduces the indicators of the general indicator of sustainable development. It should be noted that the average indicators for countries with an average level of development were chosen as the optimal base. It is quite logical to assume that Kazakhstan should be transferred to a higher category of countries.

Table 6. The coefficient of sustainable development of the Republic of Kazakhstan (compiled according to [3] [20], [28], [33], [36])

Index	Optimal value	2000	2005	2010	2015	2020
1	2	3	4	5	6	7
1. GDP per capita, thousand int. dollars (countries with an average level of development)	1,1 < GDP < 10	7,7	13,9	12,6	13,7	26,6
- coefficient	x	0,77	1,39	1,26	1,37	2,66
2. Inflation rate, % per year	10	9,8	7,5	7,8	13,6	7,5
- coefficient		1,02	1,33	1,28	0,73	1,33
3. Volume of external debt, % of GDP	25	17,7	7,5	11	22	27,4
- coefficient	x	1,41	3,33	2,27	1,14	0,91
4. Share of imports in domestic consumption, %	30	54,8	46,7	29,6	24,5	26,5
- coefficient	x	0,55	0,64	1,01	1,22	1,13
5. Human Development Index	x	0,685	0,807	0,714	0,788	0,825
- Optimal value	x	0,917	0,968	0,938	0,944	0,957
- coefficient	x	0,747	0,834	0,761	0,835	0,862
Sustainability summarizing factor		0,45	3,28	2,81	1,16	3,14

Table 7. The coefficient of sustainable development of the Russian Federation (compiled according to [3], [8], [20], [28], [33], [36])

Index	Optimal value	2000	2005	2010	2015	2020
1	2	3	4	5	6	7
1. GDP per capita, thousand int. dollars (countries with an average level of development)	1,1 < GDP < 10	9,5	16,2	20,5	24,1	28,2
- coefficient	1	0,95	1,6	2,05	2,4	2,82
2. Inflation rate, % per year	10	20,2	10,9	8,6	12,9	4,9
- coefficient		0,49	0,92	1,16	0,78	2,04
3. Volume of external debt, % of GDP	25	93,4	9,6	7,5	16,2	17,8
- coefficient	x	0,27	2,60	3,33	1,54	1,40
4. Share of imports in domestic consumption, %	30	34,7	15,2	44	35,4	28,2
- coefficient	x	0,86	1,97	0,68	0,85	1,06

5. Human Development Index	x	0,720	0,806	0,719	0,798	0,824
- Optimal value	x	0,917	0,968	0,938	0,944	0,957
- coefficient	x	0,785	0,833	0,766	0,845	0,861
Sustainability summarizing factor		0,08	6,28	4,12	2,07	7,35

The generalizing coefficient of sustainable development in the Russian Federation does not have stable values: its growth in 2005 was replaced by a reduction in 2010 and 2015. However, in 2020 the situation changed for the better. Growth of GDP per capita and relatively low inflation rates play a significant role in stabilizing this coefficient. Compared to Azerbaijan and Kazakhstan, Russia has a higher human development index.

Table 8. The coefficient of sustainable development of Turkmenistan (compiled according to [3] [20], [28], [33], [36])

Index	Optimal value	2000	2005	2010	2015	2020
1	2	3	4	5	6	7
1. GDP per capita, thousand int. dollars (countries with an average level of development)	1,1 < GDP < 10	2,6	5,8	6,8	8,0	14,3
- coefficient		0,26	0,58	0,68	0,8	1,43
2. Inflation rate, % per year	10	10,9	7,5	8,2	10,3	15,6
- coefficient		0,92	1,33	1,22	0,97	0,64
3. Volume of external debt, % of GDP	25	25,6	38,2	42,5	35,3	30,9
- coefficient	x	0,98	0,65	0,59	0,71	0,81
4. Share of imports in domestic consumption, %	30	42,8	51,5	42,5	46,8	54,3
- coefficient	x	0,70	0,58	0,71	0,64	0,55
5. Human Development Index	x	…	0,728	0,669	0,688	0,715
- Optimal value	x	0,917	0,968	0,938	0,944	0,957
- coefficient	x	…	0,752	0,713	0,723	0,747
Sustainability summarizing factor		0,16	0,22	0,25	0,25	0,30

Among the countries considered above, the Republic of Turkmenistan has the lowest indicators of the generalizing coefficient of sustainable development. Moreover, the best value is only 30% of the optimal (2020). For all indicators as basis of calculation for the summarizing coefficient the actual values are much lower than the optimal level.

Table 9. The coefficient of sustainable development of the Republic of Uzbekistan (compiled according to [3] [20], [28], [33], [36])

Index	Optimal value	2000	2005	2010	2015	2020
1	2	3	4	5	6	7
1. GDP per capita, thousand int. dollars (countries with an average level of development)	1,1 < GDP < 10	1,8	2,4	3,0	2,0	7,8
- coefficient	x	0,18	0,24	0,3	0,2	0,78
2. Inflation rate, % per year	10	28,2	7,8	7,3	5,6	11,1

- coefficient	x	0,35	1,28	1,37	1,78	0,90
3. Volume of external debt, % of GDP	25	30,5	49,3	38,4	25,4	30,8
- coefficient	x	0,82	0,51	0,65	0,98	0,81
4. Share of imports in domestic consumption, %	30	25,7	28,6	25,0	17,0	15,2
- coefficient	x	1,17	1,05	1,2	1,76	1,97
5. Human Development Index	x	0,595	0,701	0,617	0,675	0,720
- Optimal value	x	0,917	0,968	0,938	0,944	0,957
- coefficient	x	0,649	0,724	0,658	0,715	0,752
Sustainability summarizing factor		0,03	0,12	0,21	0,44	0,84

The low values of the generalizing coefficient of sustainable development of the Republic of Uzbekistan are "compensated" by its stable growth. For 20 years, this indicator has increased by 28 times and such dynamics is not typical for other analyzed countries.
To a greater extent, this is due to low starting values. More clearly, the change in the generalizing indicator of sustainable development of the analyzed countries is shown in Figure 2.
Analyzing the coefficient of sustainable development, it is necessary to take into account its generalizing nature. This means that its change does not always correlate with the dynamics of sustainable development of a separate community of people.

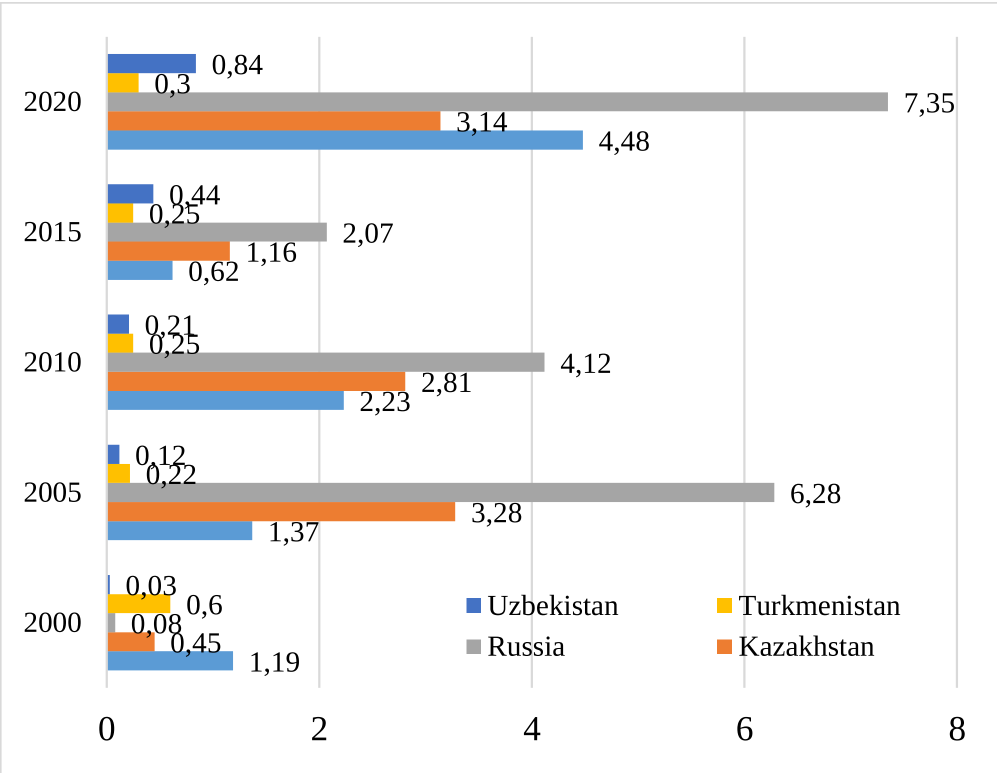


Figure 2. Sustainability summarizing factor (based on author's calculations)

The social orientation of the economy, written in the Constitutions of most of the countries under consideration, suggests that the interests of the individual should be the basis for ensuring the sustainable development of the country.
Unfortunately, under modern conditions, the most elementary requirements of sustainable human economic development are not always guaranteed (Table 10).

Table 10. Dynamics of availability of main food groups (g/person/day), 2005-2020 (compiled according to [5], [19], [24])

Group of products	Azerbaijan	Kazakhstan	Russia	Turkmenistan	Uzbekistan	EU-15
Fruits	156-258	69-191	99-105	177-162	123-268	146-215
Vegetables	368-494	421-542	303-354	385-400	394-793	388-533
Vegetable oils	34-55	39-58	42-62	18-20	30-30	26-31
Whole plant origin	1-1	2-1	1-2	0-3	0-0	2-4
Legumes	520-790	531-791	990-1005	580-585	547-1092	502-803
Fish	11-15	10-19	15-17	9-13	25-39	13-18
Milk	356-570	682-750	608-564	403-391	386-554	445-506
Poultry	42-52	29-49	70-85	3-5	28-43	17-24
Red meat	209-232	267-291	273-301	248-308	133-183	178-214
Whole animal origin	807-893	986-1110	990-1206	669-717	572-819	653-767

Table 10 is given to demonstrate the generalizing nature of the indicator considered above, the use of which is advisable at the macro level. To assess the environmental sustainability of countries under consideration, we use the index of environmental efficiency, the calculation method of which was proposed by Yale and Columbia Universities in cooperation with the Joint Research Center of the European Commission [18]. The list of countries according to the environmental performance index has been presented at the World Economic Forum for 15 years now. When calculating the environmental sustainability factor, the best value is taken into account, i.e. the value of the country that in the specified year occupied the 1st place in the ranking. Calculations of environmental sustainability of the countries under consideration are presented in Table 11.

Table 11. Calculation of environmental sustainability of the CIS countries (compiled according to [18], [38])

Indices	2005	2010	2015	2020
Optimal value	94,5	93,5	90,68	82,5
1. Azerbaijan	70,9	62,5	83,78	46,5
- coefficient	0,750	0,668	0,924	0,564
2. Kazakhstan	87,9	71,6	90,68	44,7
- coefficient	0,930	0,766	1	0,542
3. Russia	67,2	61,2	83,52	50,5
- coefficient	0,711	0,655	0,921	0,612
4. Turkmenistan	58,1	38,4	70,24	43,9
- coefficient	0,615	0,411	0,775	0,532
5. Uzbekistan	35,6	35,8	63,67	44,3
- coefficient	0,377	0,383	0,702	0,537

The index of environmental efficiency in general for 180 countries of the world has a clear downward trend, so if in 2005 the highest value of the index was 94.5, then in 2020 - 82.5, i.e. the reduction was almost 13%. This fact is a clear confirmation of the deterioration of the environmental situation in the global economy. A significant improvement in environmental performance was noted in 2015, but this environmental balance was not maintained over the next five years. More clearly, the change in the index of environmental efficiency for group of chosen CIS countries is shown in Figure 3.

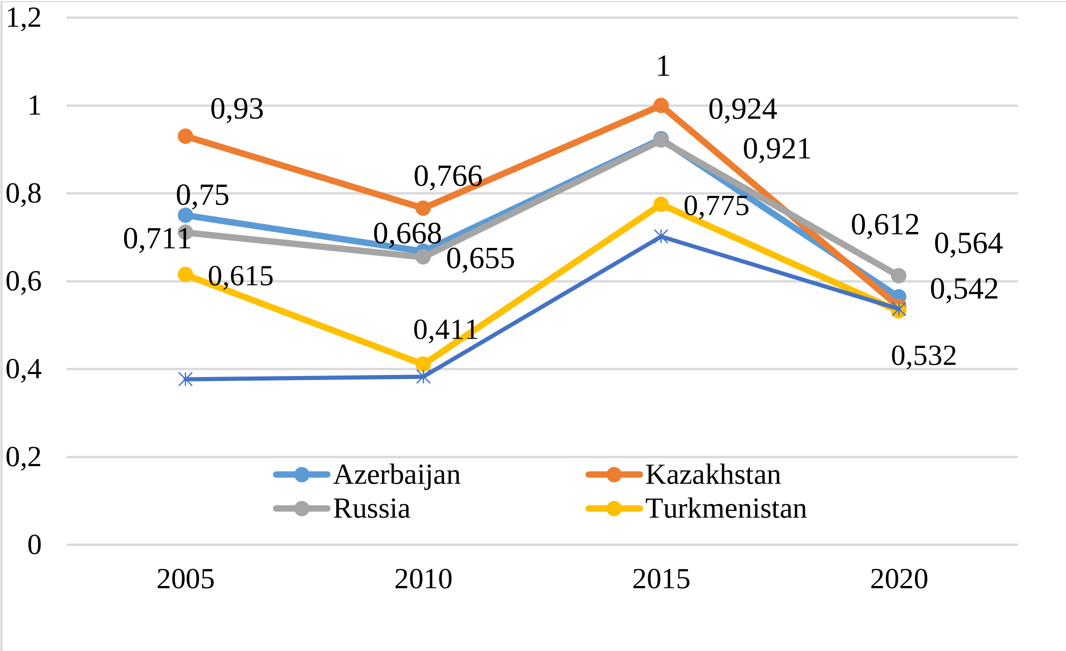


Figure 3. Indices of environmental performance of the CIS countries
Source: based on author's calculations

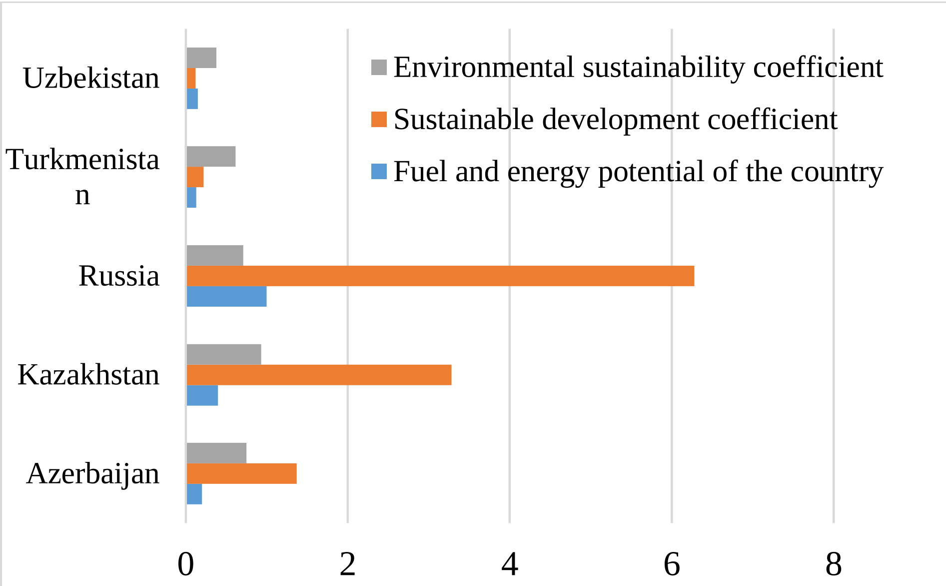
The decrease in the indicator of environmental efficiency is typical for all analyzed countries. There is no unequivocal leader among the five countries under consideration. The best indicators are kept by Azerbaijan and Kazakhstan. The position of an outsider is steadily occupied by Uzbekistan.
The conducted research allows compiling a generalizing Table 12. When presenting the values of the fuel and energy potential of countries, data on the ranking of countries in the world in terms of production, export and consumption of fuel and energy resources were used.

Table 12. Development indicators of the CIS countries exporting fuel and energy resources

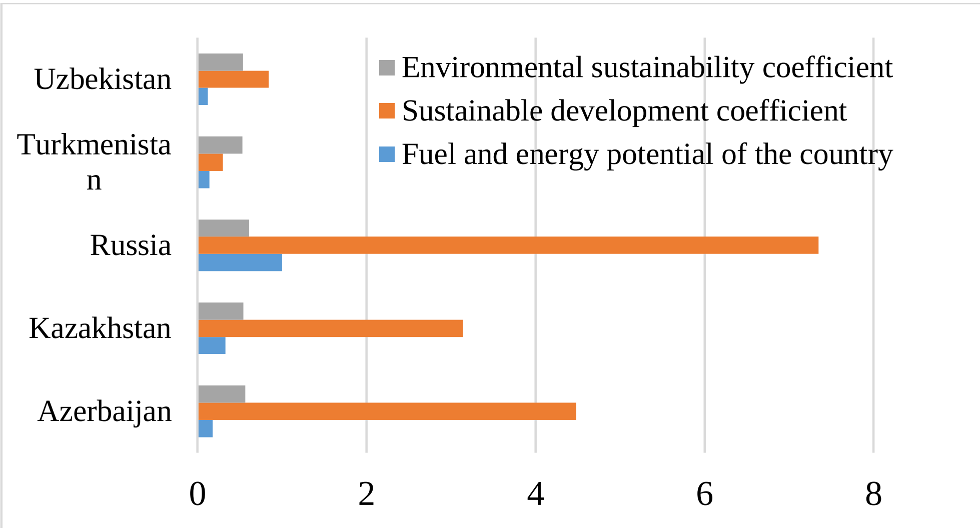
Indices	2000	2005	2010	2015	2020
Azerbaijan					
Fuel and energy potential of the country	22 (0,18)	20 (0,2)	20 (0,15)	18 (0,17)	17 (0,18)
Sustainable development coefficient	1,19	1,37	2,23	0,62	4,48
Environmental sustainability coefficient	x	0,750	0,668	0,924	0,564
Kazakhstan					
Fuel and energy potential of the country	12 (0,33)	10 (0,4)	10 (0,3)	9 (0,33)	9 (0,33)
Sustainable development coefficient	0,45	3,28	2,81	1,16	3,14
Environmental sustainability coefficient	x	0,930	0,766	1	0,542
Russia					
Fuel and energy potential of the country	4 (1)	4 (1)	3 (1)	3 (1)	3 (1)
Sustainable development coefficient	0,08	6,28	4,12	2,07	7,35
Environmental sustainability coefficient	x	0,711	0,654	0,921	0,612
Turkmenistan					

Fuel and energy potential of the country	33 (0,12)	30 (0,13)	27 (0,11)	25 (0,12)	22 (0,14)
Sustainable development coefficient	0,6	0,22 ()	0,25	0,25	0,3
Environmental sustainability coefficient	x	0,615	0,411	0,775	0,532
Uzbekistan					
Fuel and energy potential of the country	35 (0,11)	27 (0,15)	28 (0,11)	27 (0,11)	25 (0,12)
Sustainable development coefficient	0,03	0,12	0,21	0,44	0,84
Environmental sustainability coefficient	x	0,377	0,383	0,702	0,537

The conducted studies have demonstrated the relationship between economic growth, the provision of the country with fuel and energy resources and environmental sustainability. These components have mutual influence and are in constant development (Figure 4).



Year 2005



Year 2020

Figure 4. Development indices of CIS countries exporters of FER

CONCLUSION

It shall be noted that all countries analyzed in this paper have significant potential for the development of renewable energy. The conducted studies demonstrate a close relationship between such economic categories as fuel and energy resources, sustainable development and environmental sustainability. The assessment of the quality of development and functioning of modern industrial production technologies, which are based on the exhaustible resources of natural ecosystems, states the fact of their increased exploitation, and this poses a threat to the sustainable development of all mankind.

Today, the issues of greening national economies and sustainable environmental development among the global priorities of the world community are among the ten most important. The realization that the preservation and improvement of the environment is an essential condition for the sustainable development of each country has firmly established itself in the international agenda. In the end, it should be noted that the globalization of economic processes is manifested in all sectors of the world economy. Scientists and practitioners note that renewable energy is becoming the main direction in the development of global energy. Under the influence of changes in energy policy and the development of new technologies, the world economy is entering the stage of the 4th energy transition to the widespread use of renewable energy sources and the displacement of fossil fuels [26]. This naturally leads to corresponding changes in the formation of a strategy for economic growth and the greening of production.

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WIND ENERGY APPLICATION IN HUNGARY

Lóránt SZABÓ

Institute of Environmental Engineering and Natural Sciences, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, H-1034 Budapest, Doberdó u. 6, Hungary, szabo.lorant@rkk.uni-obuda.hu

This paper deals with green wind energy application (depends on solar energy). Nowadays global energy consumption was increased increasingly due to the growing the population and standards of living style. Moreover, with increasing the global warming and environmental pollution, the development of renewable energy sources was becoming more essential. Wind energy is one of the most promising clean and sustainable energy. Wind power plants produce electricity by having rotating three blades. It has three main in its energy chain: wind turbine, gear box and electric generator. A wind turbine turns wind energy into electricity using the aerodynamic force from the rotor blades, which work like an airplane wing. If wind flows across the blades, the air pressure on one side of the blade decreases. The difference in air pressure across the two sides of the blade creates both lift and drag forces. The force of the lift is bigger than the drag and this causes the rotor to spin. The rotor connects to the generator, either directly (if it's a direct drive turbine) or through a shaft and a series of gears (a gearbox) that speed up the rotation and allow for a physically smaller generator. This translation of aerodynamic force to rotation of a generator creates electricity. The total capacity of wind power capacity is 329 MW in Hungary. Number of operating wind farms are 39, with 172 wind towers. Most of wind farms are in the Kisalföld region in Hungary. Current legislation in Hungary does not allow the installation of new wind power station. My work shows that there is a justification for the use of wind energy in Hungary.

***Keywords**: wind power, wind turbine blades, lift force, generator, wind farms in Hungary, clean energy.*

INTRODUCTION

Within green energy, renewables are enjoying a renaissance. This is due to the climate change as well as the rapid decline of fossil energy carriers (coal, oil derivatives) and rising extraction costs. One of the largest problems of renewable wind energy that depends on many factors for example: meteorological conditions, geographical location, wind condition, etc. The storage of the green electricity generated by wind farms is currently not yet fully solved problem.

Renewable energy is a reliable energy source that includes solar, wind, geothermal, hydropower, biomass and tidal energy (Figure 1).

The utilization of renewable energies mean a sustainable solution to many urgent problems, there are energies environmentally friendly, since there is no emissions during use. There are two known options for the utilization of renewable energies:

- passive, and
- active utilization.

Aside from geothermal and tidal energies, renewable energy sources are replenished constantly by sunlight.

Previous wind energy studies have proven that Hungary does not have sustainable usable wind power potential due to its low annual average wind speed. Hopefully, in the near future the Hungarian government's intention to promote increasing energy consumption will change, and a research project to investigate Hungary's wind energy potential resources will be initiated. Measurement and analysis of air flow at the lower altitudes 90-180 m with a complex vertical profiling system.

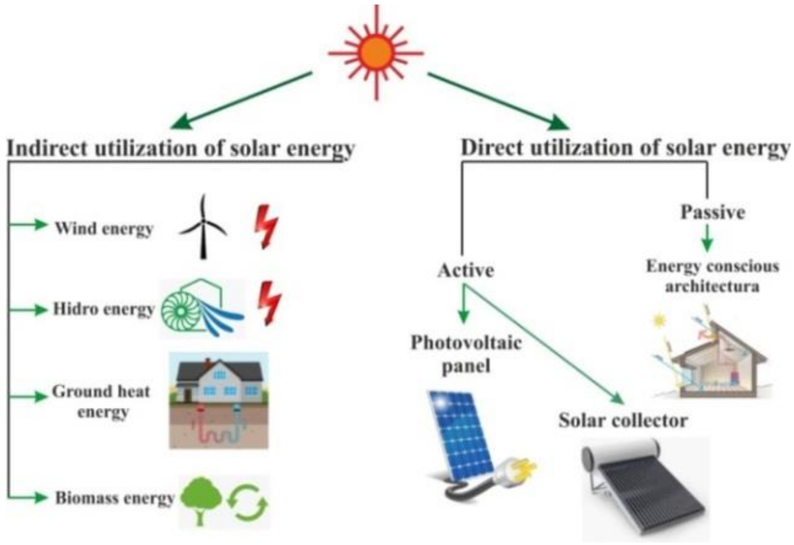

Figure 1 : Types of renewable energies

Because the installation of wind farms is prohibited by the Hungarian Government Decree 277/2016 (IX. 15.) [3]. Quote from the amendment to the law: "Within 12 000 m (12 km) of the built-up area and the boundary of the built-up area, with the exception of small wind farms of household size, no wind turbine or wind farm may be located." This situation is shown in Figure 2.

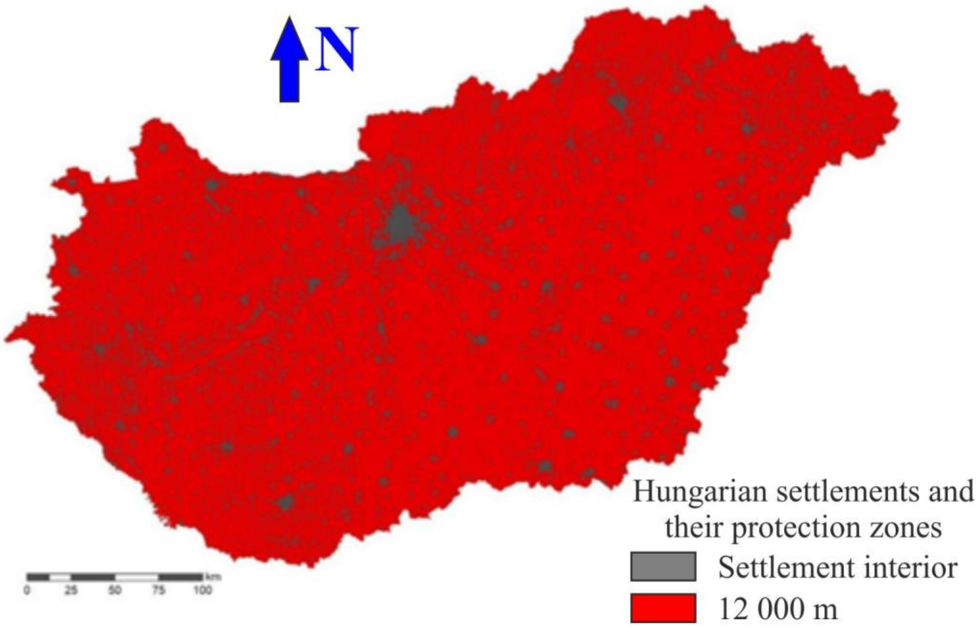

Figure 2. No possible installation site in Hungary [2]

The utilisation rate of wind power plants in Hungary exceeds that in Germany, but due to the unprecedented strict regulation in Hungary, no new wind power plants can be built today, even though the current capacity of 329 MW could be multiplied many times over with new turbines. The following research aims to demonstrate the timeliness of wind turbine expansion in Hungary.

BASICS OF WORKING METHOD OF WIND POWER PLANT

One of the most important energy generators is wind power, which uses wind turbines to generate electricity. Using wind energy is good for us and good for nature. There are many advantages - but there

are also disadvantages. Wind power is the most widely used renewable energy source in the world, ahead of hydropower and solar power. Wind is the result of solar radiation reaching the Earth's atmosphere, which reaches the surface in uneven proportions.
Because the intensity of the sun radiation varies from place to place, it is inevitable that the layers of air with strong solar radiation will be warmer, while the surrounding atmosphere will be much cooler. We know from thermodynamics that warm air travels upwards and cold air travels downwards. Therefore, cool air flows in instead of the warm layers: this is called wind.
Wind energy (like solar energy) therefore comes from the Sun. About 1-4% of the Sun's energy reaching the Earth is converted into wind energy. In terms of wind power among renewable resources, Hungary ranks 21st in the EU with a total wind power capacity of 329 MW. Table 1 shows the biggest total capacity wind farms in Hungary in MW.

Table 1. The biggest wind farms in Hungary [6]

WIND FARM by LOCALIY	POWER [MW]
Kisigmánd	50 MW
Ikervár	34 MW
Bőny	25 MW
Levél	24 MW
Bábolna	15 MW
Nagyigmánd	14 MW
Sopronkövesd	12 MW
Csém	12 MW
Ács	12 MW
Nagylózs	11 MW

Figure 3 shows the energy chain in the wind power station. Wind turbines operate on the basic principle that the kinetic energy of wind creates lift and turns its propeller-like blades. The blades of the turbine are connected to a drive shaft that spins a generator and in turn generates electricity. The use of wind energy means using the kinetic energy of the atmosphere directly or converting it into electrical energy.

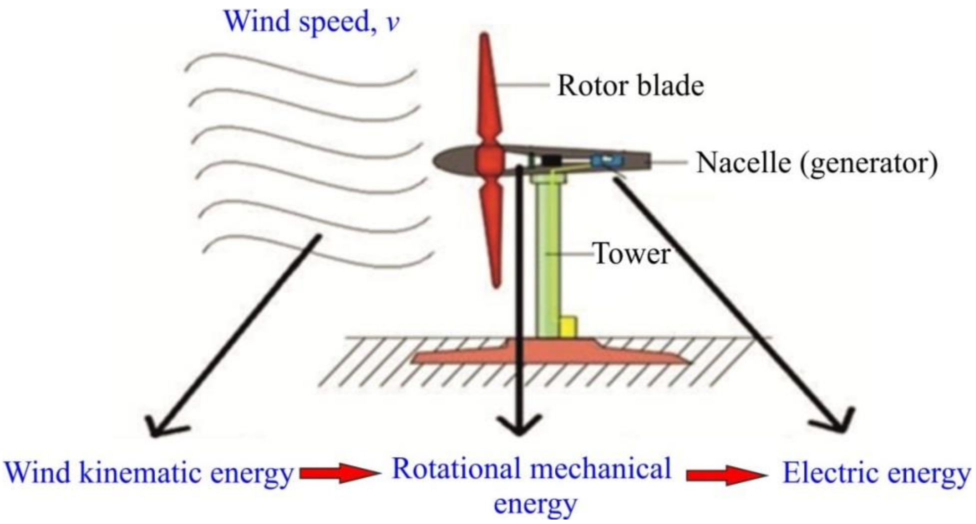

Figure 3. Wind energy becomes electric energy

The kinetic energy of an air mass moving at speed *v* can be written as follows

$$E = \frac{1}{2}mv^2 \qquad (1)$$

where

- E kinetic energy of wind flow [J],
- m mass of the air [kg],
- v wind speed [m/s].

Wind turbines are usually characterised energetically by their power output (at rated wind speed). The relationship between kinetic energy and mechanical power can be written as follows (using Eq. 1) [1]

$$P = \frac{E}{t} = \frac{\frac{1}{2}mv^2}{t} = \frac{1}{2}\underbrace{\frac{m}{t}}_{\dot{m}}v^2 = \frac{1}{2}\underbrace{\dot{m}}_{\rho\dot{V}}v^2 = \frac{1}{2}\rho\underbrace{\dot{V}}_{Av}v^2 = \frac{1}{2}\rho A v^3 \qquad (2)$$

where

- P total input wind power to rotor [W→MW],
- $\dot{m}$ mass flow [kg/s],
- ρ air density [kg/m^3],
- $\dot{V}$ volume flow [m^3/s],
- A swept area of wind turbine rotor blades [m^2].

RESEARCH OBJECTIVES AND IMPLEMENTATION

The main steps of the research were as follows:

- Wind speed map calculated for 90 m above ground level and other thematic maps to map wind energy potential.
- Delimit areas that are not suitable for wind farm development at all.
- Delineate areas proposed and potentially proposed for wind farm development. (For the county land use plan).
- Measure the wind speed at the set point.
- Conversion of near-surface data to 90 m altitude.
- Proposals for the installation of a wind farm.

Due to the location of Hungary the prevailing wind is the north-western. Based on the average wind speed, Hungary can be classified as a moderate windy region, the annual means of wind speed are varying between 2 and 4 m/s at 10 m altitude (Figure 4).

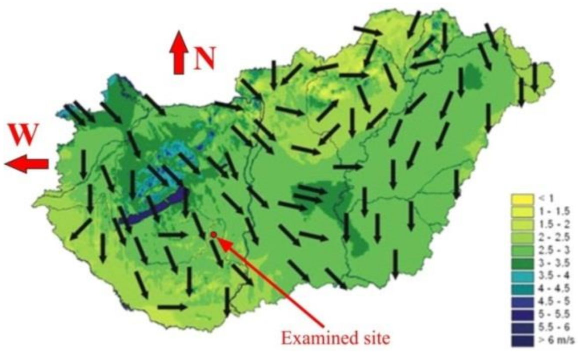

Figure 4. Wind direction and speed in Hungary at 10 m altitude [4]

The proposed wind farm (only one tower) is located in Tolna County (Fig. 4). The measurement location and GPS coordinates are shown in Figure 5.

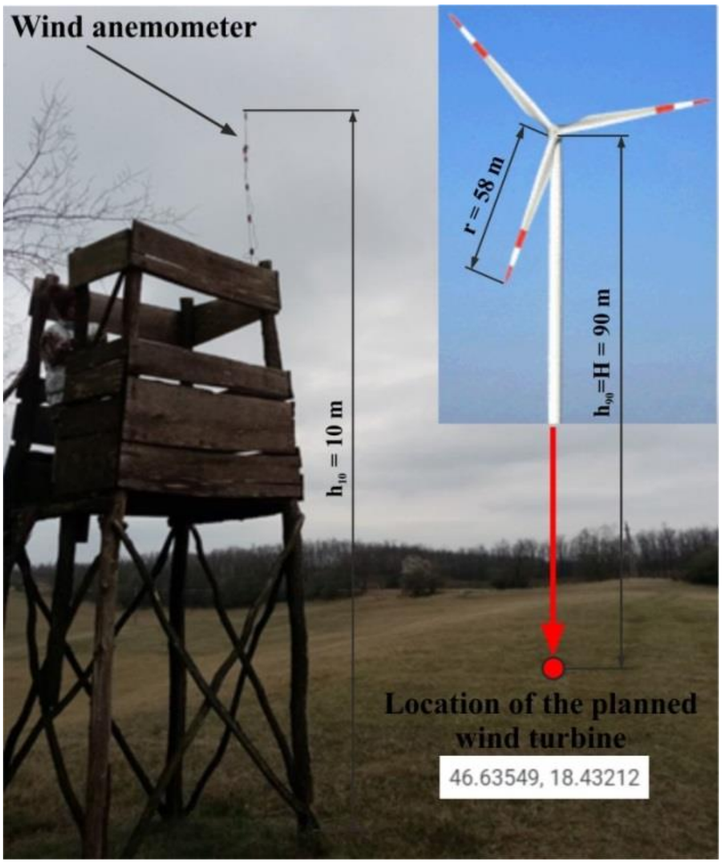

Figure 5. Planned location and measurement site

Comparative measurements were carried out at the planned site. This was compared with the measurements of the Hungarian National Meteorological Institute. Figure 6 shows the applied wind anemometer, and its position can be seen in Figure 7.

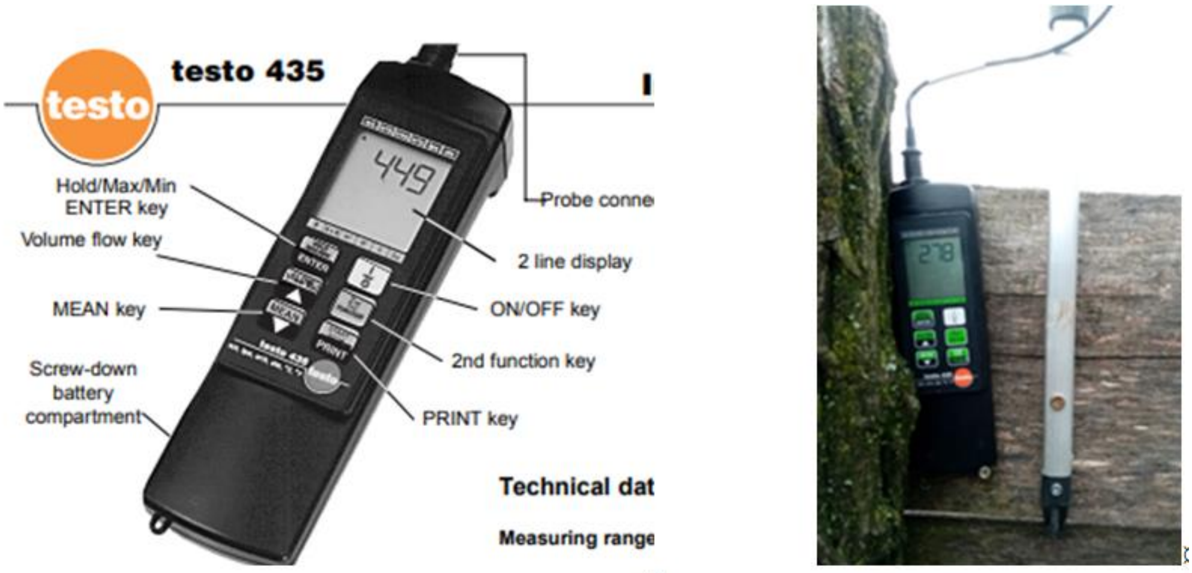

Figure 6. Used measuring instrument [3]

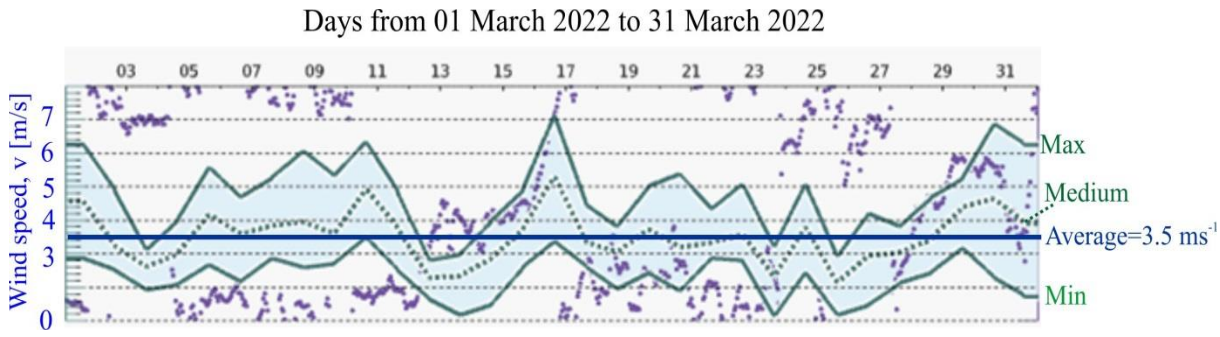

Figure 7. Minimum, average, medium and maximum wind speeds in March of 2022 in Hungary at 10 m altitude [5]

Comparative measurements were carried out in March at the planned location. The results were plotted and the average wind speeds were determined (Figure 8).

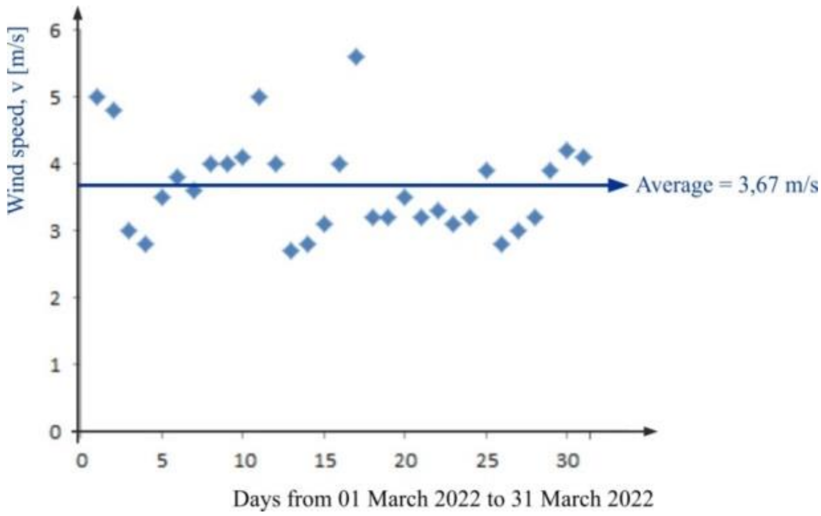

Figure 8. Results of the comparative measurement of wind speed at 10 m altitude

It can be seen from Figure 7 and Figure 8 that the average wind speeds are almost identical. We can therefore accept the meteorological service data for 2021.
The average wind speed is converted to the higher altitude of 90 metres [1], where the axis of the wind turbine's rotating rotor is located.

$$v_{90} = v_{10} \sqrt[5]{\frac{h_{90}}{h_{10}}} \tag{3}$$

where

- v_{90} calculated wind speed at 90 m altitude [m/s],
- v_{10} average wind speed at 10 m altitude [m/s],
- h_{90} 90 m altitude [m],
- h_{10} 10 m altitude [m].

Figure 9 shows maximum, medium, average and minimum wind speeds.

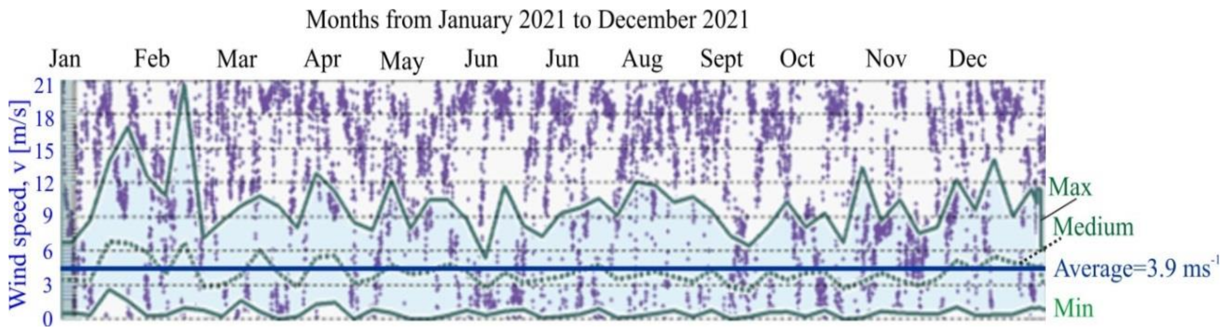

Figure 9. Wind speed for all 2021 year at 10 m altitude [5]

Average wind speed 3.9 m/s can be read from Figure 9. Applying (Eq. 3) and average wind speed

$$v_{90} = v = v_{10} \cdot \sqrt[5]{\frac{90}{10}} = 3.9 \cdot 1.55 \cong 6 \ m/s. \tag{4}$$

The real electrical output power of a wind turbine can be written according to Eq. 5

$$P_e = e_t C_F \frac{1}{2} \rho \underbrace{A}_{\frac{D^2\pi}{4}} v^3 = e_t C_F \frac{1}{2} \rho \frac{D^2 \pi}{4} v^3 \tag{5}$$

where

- P_e electric power [W→MW],
- e_t total efficiency of wind plant, about 30% [-],
- C_F capacity factor, about 0.45 [-],
- D diameter of rotor blades [m].

The designed diameter of the turbine rotor is D = 2·r = 116 m. Wind turbine type is “Alpha ventus D”. Taking Eq. 4 and Eq. 5 into account, we obtain the useful electrical power

(6)

Eq. 5 shows that the electrical output of a wind turbine depends on the 3rd power of the wind speed. Taking that the average wind speed increases to 10 m/s.

$$P_e(v = 10) = 0.3 \cdot 0.45 \frac{1}{2} 1.25 \frac{116^2 \pi}{4} 10^3 \cong 0.9 \ MW \tag{7}$$

From Eq. 6 and Eq. 7, we see that the power has increased by 4.5 times. Note that the capacity factor increases with increasing wind speed up to about 14 m/s.

RESULTS AND DISCUSSION

The average wind speed at the site of a potential wind farm can be used to determine the electric power output. The value of the useful electrical power (200 kW) determined from the average wind speed obtained for the measurement site is plotted in the Figure 10.

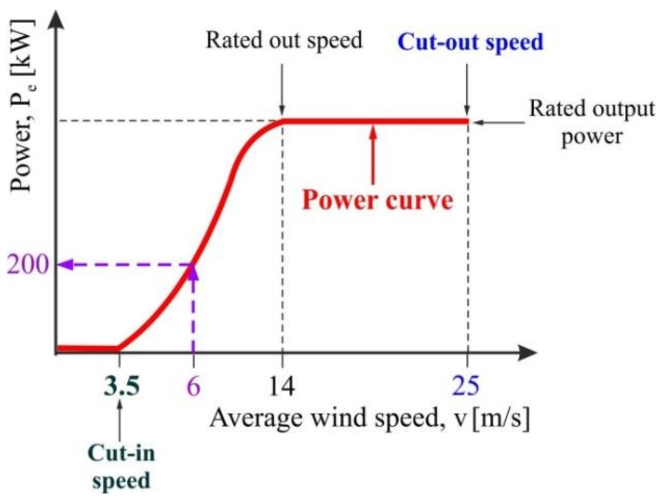

Figure 10. Typical wind turbine power output with average wind speed

Figure 10 shows that the wind turbines reach their rated power around 14 m/s. Hence, they should be installed where the average wind speed is close to 14 m/s. Assuming that the wind farm has a constant power output, the generated electricity during one year can be determined (applying Eq. 7).

$$E = P_e \cdot \underset{1\,year}{t} = 200 \cdot 10^3 \cdot 360 \cdot 24 = 1.73 \cdot 10^9 \; Wh = 1.73 \; GWh \tag{8}$$

The result of Eq. 8 indicates that the calculated electricity is significant. The resulting energy can replace large amounts of traditionally used fossil fuels.

CONCLUSIONS AND RECOMMENDATIONS

Most important local and global aspects are energy supply and environmental protection. The planed wind turbine is capable of producing up to 1.73 GWh every year, enough to power around 500 European homes, displacing more than 820 tons of CO_2. Based on the results, I would dare to suggest that the strict siting law for wind farms might be worth reconsidering. The engineering creations want to improve the people work and live. Of course, in addition to the many advantages, there are also many disadvantages for the living and built environment. The present study does not deal with this research field.

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Article submitted to the Proceedings Book of the VI[th]. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

ODOUR PROBLEM OF ANIMAL KEEPING IN HUNGARY

Csaba ÁGOSTON

Institute of Environmental Engineering and Natural Sciences, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, H-1034 Budapest, Doberdó u. 6, Hungary, e-mail: *agoston.csaba@rkk.uni-obuda.hu*

Among the harmful effects of human activity on the environmental elements, the pollution of ambient air with odors has a special place. The peculiarity of the odor load is due to the fact that its nature and extent are directly perceived by the population, so the population smells common.

Keywords *environmental odour, air pollution, animal keeping, legislation*

Investigation of the validity of public complaints, technical substantiation of official decisions on the reduction or eventual elimination of emissions (objective quantification of the odor problem) is a measurement task that requires significant equipment and high preparedness. [1]
A common undesirable side effect of animal keeping is an unpleasant odor. [2] From the point of view of the assessment of odor emissions, it is important to distinguish between livestock (backyard) livestock and recreational livestock farming carried out by the population as an economic activity with a larger volume and, as a result, significant emissions. [3]

In the case of small-scale recreational or self-sufficient livestock farming, small-scale activity rarely results in the development of significant, already disturbing odor concentrations.
In addition, the change in the lifestyle of the rural population in recent decades has resulted in a decline in backyard animal husbandry.

At the same time, the decline in backyard animal husbandry in several settlements also resulted in a more sensitive response of the non-livestock population living in the area to the otherwise insignificant odor effect of the remaining backyard stock,
Backyard animal husbandry and its odor effect are nowadays a common cause of neighborhood disputes and legal lawsuits. [1] In previous years, these disputes were often settled on the basis of local livestock regulations of municipalities. These regulations contained restrictions, albeit indirectly, in relation to odor emissions from livestock farming.

With the repeal of these regulations in 2012, this is not possible at present, so backyard animal husbandry is currently being approached as a neighborhood issue, and odor measurements are being carried out to assess the extent of the disturbance. [1] It is also an essential issue to assess the conditions of animal husbandry in order to assess the necessity or inevitability of the release and, in this context, of the disturbance.
In most cases, the volume of livestock farming in the framework of economic activity exceeds backyard livestock farming by orders of magnitude.
In addition, we need to base our assessment of the emissions of related activities, such as manure storage, composting, field application, operation of slaughterhouses and food establishments, destruction of slaughterhouse by-products and pests, on environmental protection, in particular air quality. [4], [5], [6], [7]

The odor ("environmental odor disturbing the population") and the related tasks have been incorporated into the legislation on air quality protection, for example, Government Decree 306/2010 (XII. 10.) contains a definition of odor and empowers the competent authority to prescribe operational requirements for odor-emitting technologies.
In the environmental permit of livestock farms, the issues of manure storage, handling and transport, as well as the application of manure in the field are regulated in all cases, the purpose of which is to reduce the odor effect to a significant extent.

The authority also has the option of requiring the installation of odor control equipment. [4] Among the passive and active methods of reducing the odor effect, in the case of livestock farms, the passive methods are dominated by the very frequent use of a protective forest strip or various cover films.
Other activities related to animal husbandry, such as the processing of slaughterhouse by-products or animal carcasses, use active odor reduction methods, in most cases biofilters.

No legal or technical regulation improves the condition of the environment if its observance or fulfillment cannot be objectively verified.
Therefore, it is necessary that the odor emission (emission) and the odor effect (immission) in the environment can be quantified and measured.
In addition, it is necessary to regularly determine the proper operation and odor reduction efficiency of odor control equipment [7], which requirements are also set out in the permit of the authority.

When approving the establishment or expansion of livestock farms, the protection zone to be designated for the purpose of air quality protection is of special importance.
The protection zone may not contain a residential building, a holiday building, an educational, health, social and administrative building or a residential area designated in the development plan [4], therefore the size of the protection zone around the site means the minimum required distance from the settlement.
The protection zone is designated on the basis of the impact area determined by propagation modeling based on the measured values of the site's odor emissions.
The result of the model calculation and the size of the impact area determined by the calculation are influenced by the type of the applied model, the input data of the model (mainly atmospheric data and the emission data of the plant), and the value of the permissible concentration in the ambient air.

Both the legislation and the technical standards in force contain restrictions on the models used and the input data, so if they are used (high-altitude meteorological data, annual hourly wind data, etc.), the model calculations can give comparable results. [4], [7], [8] In the case of modeling the spread of odor emissions from livestock farms, it is of paramount importance that the odor emission data used in the model calculation be real, measured data, as even a small change in housing conditions can significantly change the amount of odor emissions.

In the model calculation, the boundary of the impact area is given by the envelope along which the concentration of the tested air pollutant decreases to the expected value (fixed by law).
It is important to mention that in the case of odors, the limit values for ambient air have been laid down in legislation [6], the boundary of the impact area is set at 3 SZE / m3 (odor effect of intensive animal husbandry) and 1.5 SZE / m3 (processing of animal remains).

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Article submitted to the Proceedings Book of the VI^th^. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

NEW METHODS FOR APPLYING THE SYMMETRY THEORY OF STEREOREGULAR POLYMERS FOR QUANTUM-MECHANICAL MODELLING OF PHOTOVOLTAIC TYPE MATERIALS

Csaba MÉSZÁROS[1]*, István Róbert NIKOLÉNYI[1], Ágnes BÁLINT[2,3]

[1]Department of Mathematics and Basic Natural Sciences / Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary, e-mail: Meszaros.Csaba@uni-mate.hu, Nikolenyi.Istvan.Robert@uni-mate.hu
[2]Institute of Environmental and Natural Sciences, Óbuda University, Budapest, Hungary,
[3]Hydro-Bio-Mechanical Systems Research Center, Budapest Hungary e-mail: balint.agnes@uni-obuda.hu

It is well-known, that the detailed experimental and theoretical investigation of basic structural and physical properties of different types of carbon nano - tubes plays a role of continuously increasing importance in the whole condensed matter physics, because of the very promising experimental investigation results about solar energy applications, too. Among them, the very powerful symmetry analysis methods based on the representation theory of symmetry groups of the ideal, and infinitesimally long discrete chain-type subsystems accepted as the relevant ones. The adequate quantum mechanical analysis of the collective elementary excitations was developed by applications of the representation theory of line groups. In order to apply our own earlier theoretical results in this contemporary research area, we decided to extend them in more details, in order to give new, original significant contributions to the theoretical modeling of the basic optical properties of the stereoregular polymers and carbon nanotubes at the quantum-level.

Keywords*: Alternative energetics, nanotechnology, symmetry theory, solar energetics, stereo-regular polymers*

INTRODUCTION

The applications of the projective representations [1] of crystallographic point groups in solid state physics are known for decades but they are absent even from the most complete recent works about applications of line groups in various types of structural investigations of condensed matter systems [2]. These seemingly purely theoretical studies in the condensed matter physics may have very promising future applications in the field of solar energetics, too. Therefore, we decided to fill this gap, and have succesfully introduced the concept of the projective representations of line groups (= symmetry groups of discrete, chain-type molecular systems, usually called quasi-one-dimensional (*Q1D*) systems in the literature) together with some basic applications into theory of the incommensurately modulated crystal structures. In the present work, we will demonstrate explicitly the applicability of the same technique in the cases of optical scattering processes in incommensurate systems, including multiple-type Raman processes.
According to the definition, the complete set of symmetry transformations leaving invariant a *Q1D* system belongs to one of the (discrete) infinitely many line groups gathered into 13 families. The irreducible representation $D^{(\mu)}(L)$ of a full line group L can be obtained from the irreducible representation of symmetry groups (concretely: point groups) of the motifs: $D^{(\nu)}(P)$. The construction of the complete irreducible representation matrices is usually realized by use of the induction technique

elaborated in the group representation theory for decades, and widely applied in solid state physics (e.g. [2]), usually denoted by $D^{(\mu)}(L) = D^{(\nu)}(P) \uparrow L$). From the point of view of the applications in this study, we point out here the importance of the basic (helical) line group $Ln_p = (n/r) \otimes C_q^a$, on the base of which the irreducible representations of its can be directly obtained as a product of the irreducible representations of the constitutive subgroups, i.e. of the cyclic discrete rotational point group: $A_m\left(C_q^s\right) = e^{ims\alpha}$ (where "α" is the discrete-valued, elementary, smallest rotation around the main axis of the actual *Q1D* system) and of the subgroup of generalized translations n/r is given by: $D(R|v_R) \equiv {}_kA\left(\left(C_n^r|v\right)^t\right) = e^{ikt\zeta}$, where $k \in \left(-\frac{\pi}{\zeta}, +\frac{\pi}{\zeta}\right]$, and ζ is the distance between nearest-neighbour scattering centre motifs in the given actual helical system.

On the base of this formalism (according to which the irreducible representation matrix of the relevant general line group element can be given as ${}_kA_m\left(\left(C_n^r|v\right)^t C_q^s\right) = e^{ikt\zeta}e^{ims\alpha}$), the formulae necessary for quantum-mechanical selection rules between an initial (*i*) and a final (*f*) state in chain-type systems are (*k* denotes the absolute value of a wave vector, *j* is an integer number of the possible allowed integer translations along the main axis of a *Q1D* system being investigated) [2]:

$$\Delta k \equiv k_f - k_i = k + j\frac{2\pi}{\xi}, (j \in \mathbb{Z}) . \tag{1}$$

Furthermore, it is a unique feature of the representation theory of line groups, that analogous relations expressing conservation of quasi-angular momenta during propagation of collective excitations along the main axis of the actual chain-type system must also be respected [3], i.e.:

$$\Delta m \equiv m_f - m_i = m + zq, \tag{2}$$

where the symbol *m* denotes one of the possible discrete momentum values, *z* is an integer number again, while *q* is the order of a simple cyclic rotation group, also characterizing allowed integer translations along the main axis of the system. In the present study, all these selection rule relations will be generalized within frame of the projective representations of line groups relevant for incommensurately modulated structures and incorporated into correlation functions necessary for comparison of experimentally measured-, and theoretically derived light scattering intensity curves. From newest applications of the representation theory of line groups in the condensed matter physics, relevance of this powerful symmetry method in the rigid-layer dynamics with applications in the Raman-, and infrared activity [4] must be particularly pointed out, because it may induce further novel-type experimental methods in this rapidly developing experimental research area, according to the relevant recent review articles. Finally, it must also be emphasized here, that by applications of the contemporary theory of the irreducible representations of line groups, the modulation types characterized by both rational-, and irrational $\vec{k}$ -s in the first Brillouin zone, can be equally treated [3].

METHODS

The basic informations summarized in the previous sections will be applied in detail by a new formalism presented in this section. The most essential feature of the forthcoming calculations is the following: the very basic-type selection rules of type (1) and (2) will be directly incorporated into the matrix elements of types (4), relevant for the Raman-type optical scattering processes of emission-, or absorption characterized by the frequency change Ω . (At this point, relevance of the basic results published already in [1,2] must be particularly pointed out, because they also represent in detail the irreducible representations of polar vectors, which are necessary for systematization of the perturbation matrix

elements at optical absorption processes in dipole approximation.) Besides, as it has been mentioned in the introductory part of this paper, the useful applications of the projective representations will also be taken into account, wherever possible.
Then, as it is known (e.g. [2]), at the case of the inelastic light scattering processes from crystals, the basic relations relevant for the phonon impulse-, and energy changes, are the following ones:

$$\begin{aligned} &\vec{k}_0 \pm \vec{k} = \vec{q}, \\ &\omega_0 - \omega = \mp\Delta\omega, \end{aligned} \tag{3}$$

where $\vec{k}_0$ and $\vec{k}$ are the wave vectors of the incident-, and scattered polarized monochromatic light beam, and $\pm\vec{q}$ is the wave-vector change in the given scattering process. Similarly, the symbols $\omega_0, \omega, \mp\Delta\omega$ denote relevant frequency (and the: adequate energy-) changes in the same light beam. It must be emphasized, that the wave-vector change expression in (8) is a relation of basic importance, and for an adequate, accurate descriptions of the light-scattering processes, the orthogonal-type transformations of the wave vectors must also be applied, for obtaining correct selection formulae relevant for them. Then, the dipole moment component in the ground state is [2,4]:

$$p_i(t) = \langle 0|p_i|0\rangle + \sum_j \left\{ \alpha_{ij}(\Omega) E_{+j} \cdot e^{i\Omega t} + \alpha_{ij}(-\Omega) E_{-j} \cdot e^{-i\Omega t} \right\}, \tag{4}$$

where $\alpha_{ij}(\Omega)$ denotes the (-Hermitian – type-) polarizability tensor, and $E_{\pm}$ are the electric field components of the polarized light beam. Accordingly, we have:

$$\hat{\sigma}_{\pm} = (\beta)\vec{E} \cdot e^{\pm i\Omega t}, \tag{5}$$

where β is an electro-elastic tensor, equivalent to the polarization tensor in isotropic active optical media. Then, in order to realize this analysis in the case of the incommensurately modulated crystal structures, we will here firstly summarize all the expressions, which are accepted as the basic quantum-mechanical tools necessary for an accurate description of the Raman-scattering processes. Accordingly, at the optical transitions, related to the initial-, and scattered electromagnetic waves polarized along the relevant unit vectors $\vec{e}_i$ and $\vec{e}_j$ correspond to $p_i = \vec{e}_i \cdot \vec{p}, p_j = \vec{e}_j \cdot \vec{p}$. Then, the relevant total perturbation expression is given by $p_f R^{fi} p_i$, where R^{fi} denotes a component of the actual Raman-tensor. The basic selection rules in this type of scattering processes is related to examination of the direct product

$$D^P(L) \otimes D^P(L) \otimes D^{\left(k_i^{ph} m_i^{ph} \Pi_i^{ph}\right)}(L), \tag{6}$$

according to which [2], the decomposition of (6) must contain the identity representation too, in order to the given quantum transition to be possible. For an accurate, precise description of the new method of modelling calculations to be realized in this study, the results originally published in [3] and [6] are to be applied here, too. In general case, the quasi-impulse conservation law can be written as [2,6]:

$$\vec{w}_1' + \hat{\alpha}_0 \vec{w}_1 = \vec{K}, \tag{7}$$

where $\hat{\alpha}$ denotes a general orthogonal symmetry transformation operator, and the reciprocal space vectors $\vec{w}_i\,(i = \pm 1, \pm 2, \ldots)$ are related to the actual phonon modes of crystals and/or actual subsystems

of them containing finite atomic and molecular *Q1D* chains incorporated into (in-)finite two-dimensional (*2D*) nanolayers.
Finally, in agreement with the basic results about collective excitations in modulated crystals summarized e. g. in [5,6,7], we may accept the detailed classifications of the spectral terms, which emanated from the generalized versions of the selection rule types, as it has been demonstrated above.

CONCLUSIONS

In the present study, a detailed calculation method, necessary for elaborating of more advanced modelling applications of the light-matter interactions at quantum mechanical level has been proposed. The fundamental mathematical tools emanating from the representation theory of the symmetry groups of infinitesimally long discrete chain-type systems have been applied in a novel manner. On the base of this new – type mathematical concept, the quantum-mechanical selection rules relevant for incommensurately modulated 3-dimensional crystal systems have been successfully incorporated into the already developed formalisms in this research field. By this way, a new mathematical research tool has been introduced; whose applicability limits may be to be far beyond of the problem solution area indicated by this paper.

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SOIL QUALITY IN THE SEBKHAS ENVIRONMENT (SOUTH-EASTERN CONSTANTINE), ALGERIA.

Hadjer BOUSBA[1*], Ramdane MARMI[1], Kamel BOUFAA[2], Fouad BOUAICHA[1], Rima KIFOUCHE[1]

[1]*Geology and Environement Laboratory, University of Constantine 1, Route Ain El Bey Zouaghi Slimane Constantine 25 000, Algeria.*
[2]*Geological Engineering Laboratory, University of Jijel, Cité Ouled Aissa 18 000, Algeria*
*Corresponding author: hadjer.bousba@student.umc.edu.dz

The sebkhas (Sabkhet Djendli and Garaat Ank Djemel) considered in our study are part of the Boulehilet plain (ex. Lutaud) located on the southern edge of Constantine's high plains. The soils surrounding these sebkhas are dotted with very sparse vegetation consisting mainly of halophytic plants. These two lakes are drained, respectively, by Oued el Madher and Oued Chemora. Chemical analyses of the soils (about 150 samples) show relatively high concentrations of sodium and sulphates. The latter are more present in the vicinity of Sebkhet Djendli, the source of which would be the leaching of the Triassic formations that lie just to the north-east of the Sabkha. However, the CaCO3 content does not show a significant variation across the plain. As for sodium levels, they increase significantly with depth, especially on the eastern edge of Sebkhet Djendli. The soils of the Boulehilet plain are relatively salty and have a pastoral interest. Conductivity measurements carried out in 70 farmers' wells on the outskirts of Sebkhet Djendli indicate values that are sometimes quite high, exceeding 2000µs, thus corroborating the salinity of the water that is used for domestic supply. Trace elements analyses (Zn, Cu, Cr, Ni, Ba, etc.) of soil samples taken from auger-digged boreholes (12 samples) show relatively high levels. The presence of these metals is thought to be linked to mining waste from previous operations near these sebkhas.

***Keywords**: Salinity, Sebkhas, Sodium, Sulphates, Soils, Trace elements, Triassic formations.*

INTRODUCTION

"Stop soil salinisation, increase soil productivity", was declared in 2021 by the FAO in the World Soil Day. In Algeria, as in the rest of the world, soil salinisation and sodification is one of the most harmful scourges for agricultural production, food security and sustainability, especially in arid and semi-arid regions. More than 1,000,000 ha of agricultural land are affected by this problem in Algeria (INSID), part of which is located in the irrigated areas of the country's north-eastern region.

The alluvial plain of Boulhilet constitutes a vast irrigable area (more than 26,586 ha), located in the southern part of the high plains of Constantine; the country of the salt lakes or sebkhas. The soils surrounding these sebkhas, which are of pastoral and agricultural interest, are relatively salty, dotted with very sparse vegetation consisting essentially of halophytic plants.

The objective of the present study is therefore to assess the quality of the soils and to quantify the rate of their degradation with regard to salinisation, sodification and contamination of this plain.

MATERIALS AND METHODS

The physical originality of the study area

Located in one of the semi-arid regions of North-Eastern Algeria (Figure 1), the Boulhilet alluvial plain is part of the wetland complex of the Constantine High Plains. It extends over an area estimated at 26,586 ha from the town of El Madher (Batna) to Aïn Kercha (Aïn M'Lila) in the north, the towns of Chemora (Batna) and Khanchela in the south. From a paleogeographical point of view, it corresponds to a transition zone between the Tellian Atlas and the Saharan Atlas (pre-atlasic domain). It is situated at an altitude of between 840 and 850 meters (an important factor in agricultural development).

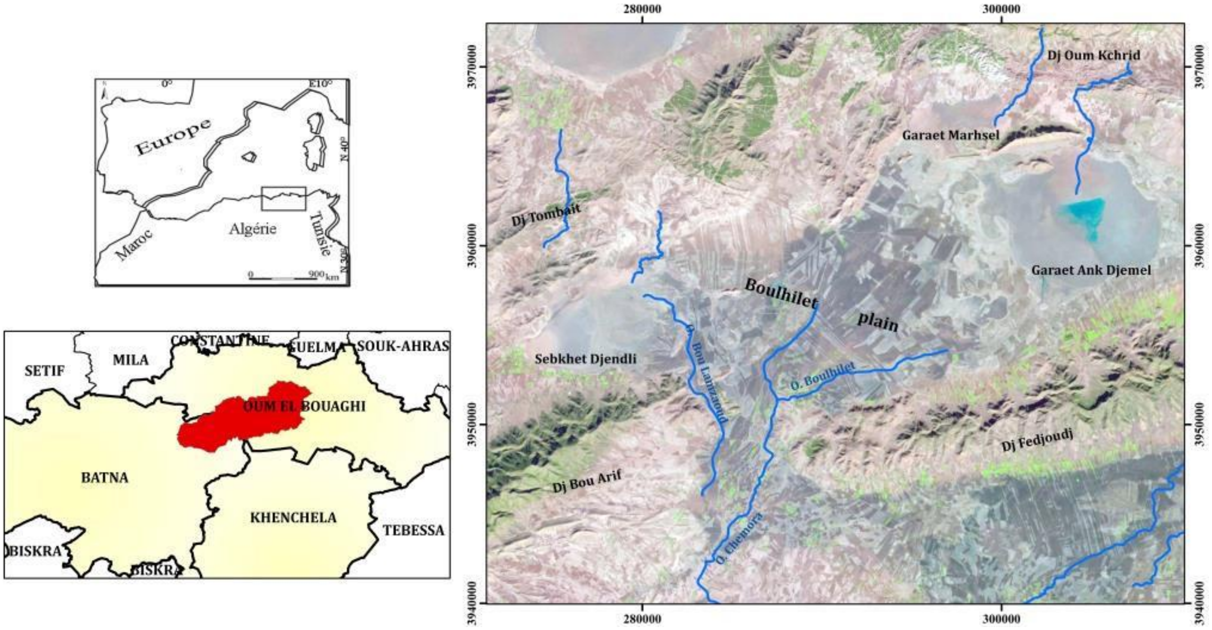

Figure. 1. Geographical location of the Boulhilet plain (South Constantinois)

Given its location, rainfall is deficient (350 to 400 mm maximum/year, 4 to 5 dry months), climatic constraints are strong (many days of frost, sirocco, etc.), the soils are not very developed and favourable, and it is necessary either to irrigate or to insert crops that are resistant to drought. The irrigation of the plain will be ensured by water from the Beni Haroun dam and the spreading of flood waters from Oued Chemora.

Geological setting

The area of the sebkhas, including the Boulhilet plain, belongs to the foreland of the Maghrebid belt of north-eastern Algeria. Limestone Mountains whose geological formations are essentially carbonate with a dominant Cretaceous age. These basins are filled with detrital sediments whose thickness can exceed 150 metres. They are generally covered by a thin layer of salt water during wet periods and dry during dry seasons. These Sabkhas occupy a gullied area, generally oriented in a SE-NW direction (Fig.ure 2).

Lithologically, it is important to note that:

- *-All the massifs surrounding the plain are made up of Mesozoic limestone; thus providing important limestone stocks for runoff. Calcimorphy will therefore play an important role in the areas lower than these limestone foothills (glacis) and the flat areas beyond.*
- *-If these large reserves of limestone can be made available to glacis and terrace soils, the movement of this element (due to its low solubility and the low rainfall of the region) will remain limited.*
- *The alluvium of Oued Chemora in the plain has a fine texture (the coarser elements are deposited upstream between Timgad and Chemora). So we will have heavy soils in the flat parts of this region.*
- *These alluviums come essentially from the purple mio-pliocene marls of the Timgad basin and the southern slope of the Dj. Bou Arif: they will be quite loaded with salt and gypsum.*

On the geomorphological level, the plain includes 4 closed basins (endoreic) (Figure 2)

- To the west, sebkhet Djendli, which is fed mainly by oued Bou Lamzaoud, is supported by a faulted anticline, very rectified (Dj. Tombaït). At the base of the latter appear limestones and dolomites of the Jurassic, surmounted in places by Triassic points,
- To the north, Garâet el Marshel, bordered to the west by Dj Marhsel, to the south by the limestone table of guelâat Ouz, to the south by Dj Ank Djemel and to the north by Dj. Oum Kchrid (predominantly Triassic formations);
- To the north-east, Garaet Ank Djemel, fed by oued Boulhilet and Rhezal, this Garâa is only separated from Garâet Guellif by a threshold of a few metres,
- To the east garâet Guellif.

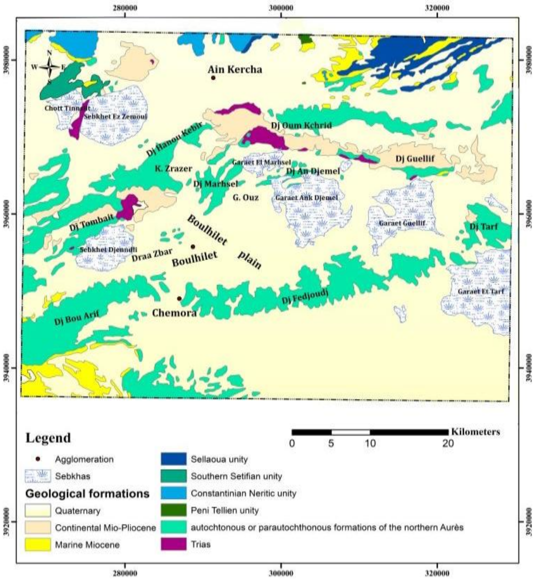

Figure 2. Simplified geological map of the study area (after Vila, 1980)

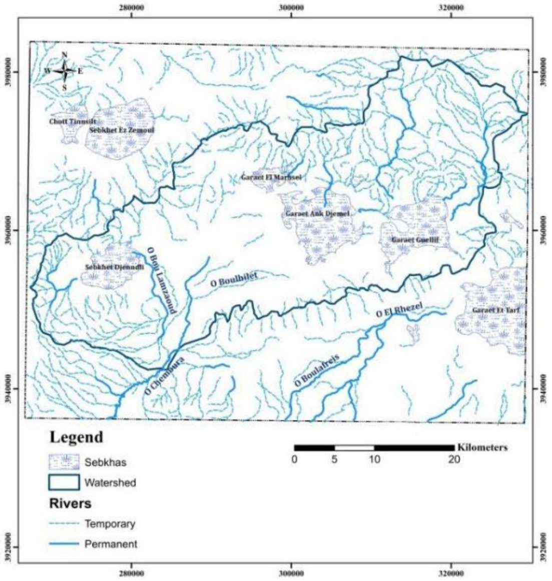

Figure 3. The hyrography of the study area

HYDROGRAPHIC NETWORK

The hydrographic network characterising the Sebkhas area is of the endoreic type: the rivers do not reach the sea, but flow towards the Sebkhas (Figure 3). It is relatively dense but rare wadis are perennial (Oued Chemora). It is a region with low rainfall (350-400 mm/year).

The Chemora wadi take its source in the northern heights of the Aurès and is then lost, after a journey of about 50 km, in the sebkhas of the southern part of the high plains of Constantine (sebkhet Djendli and Gareat Ank Djemel). This situation explains the dissymmetry of its watershed (Figure 2 and Figure 3), characterised by its upstream, mountainous part, culminating at more than 2000 m, with ve ry steep longitudinal and transverse slopes, whereas, downstream of Timgad, these reliefs give way to a vast spreading plain where the Chemora wadi meanders as far as the town of Chemora. The configuration of the basin and its lithological components facilitate the supply of an important material to the wadis, heterometric material, ranging from limestone blocks and pebbles to sands and silts. The former are stopped by the various channels corresponding to the synclines and the exit into the plain, the latter go much further (Boulhilet plain and surrounding sebkhas) [1].

The boundaries of the sebkhas on the topographic map are irregular because their extent depends on the climate and the load of the wadis that feed them.

SAMPLING

In the case of Sebkhet Djendli, the methodology adopted to achieve the objective is based on field work and laboratory analysis. The investigations were mainly based on in situ measurements and sampling in trenches reaching a depth of between 2 and 2.5 m (58 samples, to estimate the $CaCO_3$ content) and 4 hand augering holes with an average depth of 250 cm in the flooded areas, (12 samples, chemical analyses on trace elements).
Soil sampling across the Boulhilet plain was carried out according to soil profiles, with an irregular mesh, to an average depth of 140-150 cm, exceptionally reaching 190 cm by drilling. Samples were collected from different horizons for each profile at more or less regular intervals (Figure 4).

Physico-chemical analyses
The physico-chemical analyses (pH, electrical conductivity at 25°C, total limestone, active limestone, soluble salts, sulphates, gypsum) were carried out by the laboratory of the scientific studies department of Constantine.
From the analysis data, we established thematic maps using the IDW (Inverse Distance Weighting) method to study the evolution of certain parameters vertically (on the profiles) and spatially across the Boulhilet plain.

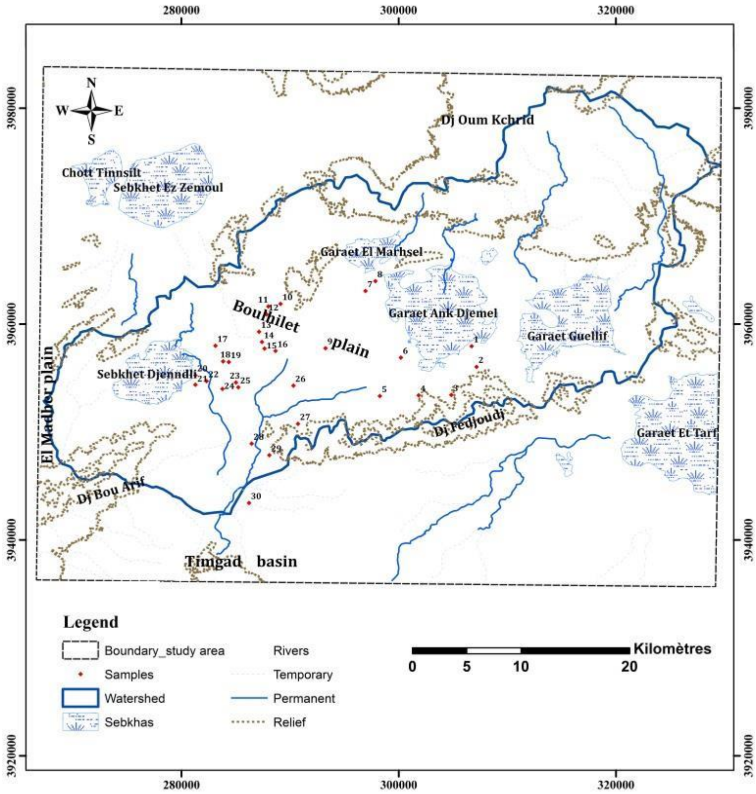

Figure.4. Spatial distribution of soil profiles

DATA PROCESSING

Analysis of pedogenetic factors
Climate is an important factor in pedogenesis and agricultural development; it intervenes through all its components

- In the plain, rainfalls are low, they are concentrated in autumn, winter and early spring: the phenomena of entrainment of certain elements will be limited, these rainfalls are also characterized by a significant variability from one year to another: this will have a considerable influence in the development, the success of the cultures in dry will be aleatory

- During the summer period (which actually starts in mid-spring), rainfalls are almost non-existent and the temperature is high; their combination with the wind action will have the effect of increasing evaporation and evapotranspiration (Figure 5), creating a water deficit that will have repercussions on the evolution of the soil, the soil reserves and the cultivation methods that allow to reduce these losses somewhat.

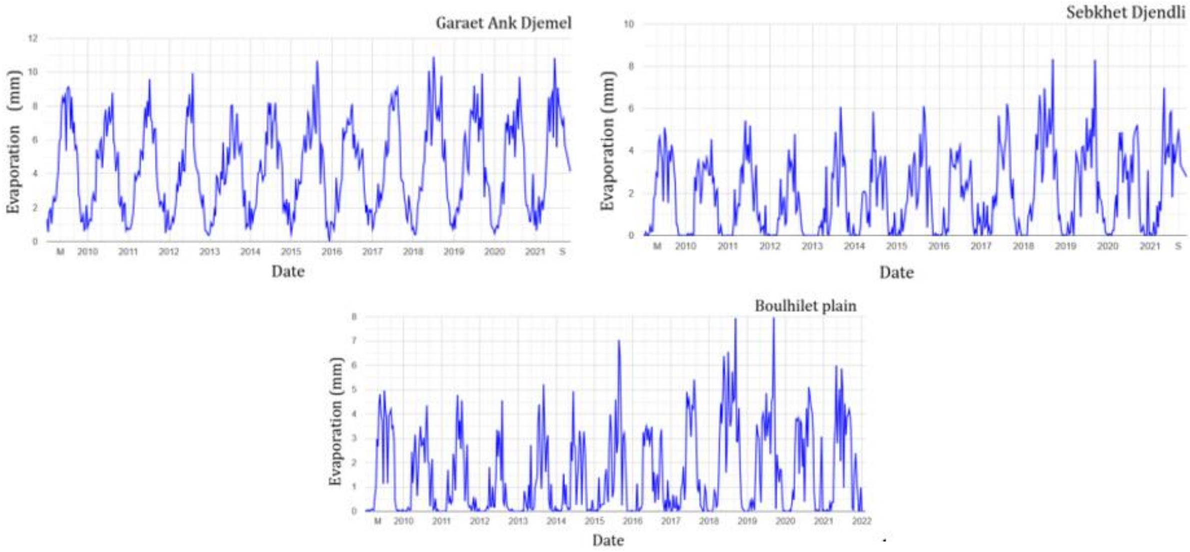

Figure 5. Evaporation across the study area

In addition, all sebkhas and gareats are temporary lakes with a very flat topography; they are located at a lower altitude than the rest of the plain (overdeepening). They receive floodwater and runoff as well as run-off water and form a generally shallow water table where they settle their troubles. During the dry season, these closed basins constitute ideal evaporation surfaces, so that the water table disappears, leaving a whitish crust of concentrated salts on the surface.

In the sebkhas

- *Major and trace elements*

The analyses of the samples taken from the trenches and boreholes showed average grades where the major elements (oxides) can be classified in decreasing order of magnitude as follows: SiO_2 (38%), CaO (15%), Al_2O_3 (12%), Fe_2O_3 (~ 5%), MgO (3%), Na_2O (~ 2%), K_2O (1%). The remaining elements (MnO, TiO_2 and P_2O_5) each constitute less than 1% (Figure 6)

- ✓ *SiO_2, Al_2O_3, Fe_2O_3*

Comparing the chemical analysis results, we notice that the high values of SiO_2, Al_2O_3 and Fe_2O_3 are provided by the samples from borehole SD1 (Djdli borehole). The latter is located near the mouth of the rivers coming from the north of Sebkha Djendli. The proximal detrital deposits, carried by run-off water, would be richer in quartz grains and iron and aluminium oxides in relation to the geological environment (presence of carbonate and sandstone rocks).

- ✓ *Na_2O, K_2O*

The average Na_2O content, exceeding 2%, is found in boreholes SD1 and SG1 (Gaaret Guellif borehole). The K_2O content (~ 1.5%) comes from the SD3 samples. These elements could result from the alteration of sodium and potassium aluminosilicates and/or the dissolution of halite contained in the sedimentary rocks in general and in the Triassic formations in particular, which are located not far from the sebkhas.

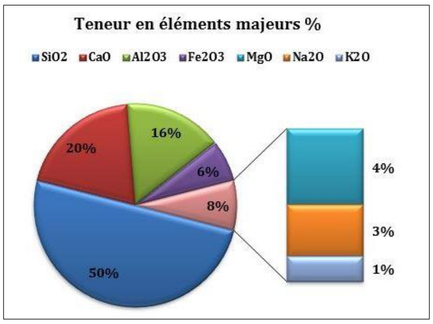

Figure 6. Major element ratios in sebkhas

Some of the authors have proposed mobility patterns of major elements during weathering [9], [13] and [17] evolving in a decreasing order according to the following scheme::

Ca^{2+}, Mg^{2+}, $Na^{+} > K^{+} > Fe^{2+} > Si^{4+} > Ti^{4+} > Fe^{3+} > Al^{3+}$ [13]

Gravity flow from surface waters to endoreic depressions is the main dynamic factor in the enrichment of Sebkhas sediments in certain chemical elements. Physico-chemical conditions (Eh, pH) also play an important role in the behaviour of mineralisation in a secondary environment.

The mobility of elements in a secondary environment, particularly metals, is at the origin of the dispersion haloes used in geochemical prospecting [2], [12].

Most of the trace elements have fairly low average levels. However, some elements such as Sr (702 ppm), Ba (224 ppm), Zr (124 ppm), V (105 ppm), Cr (98 ppm) and Zn (67 ppm) are characterised by relatively high average levels compared to the rest of the elements.

- *Calcimetry (58 samples)*

The calcimetric results obtained from the trench samples (Figure 7) are more reliable and correlatable in their natural and real context. This made it possible to understand the relationship between variations in $CaCO_3$ content on the one hand and facies changes in the vertical sequence of sediments on the other (well-cleared soil profiles without any contamination between horizons). However, the levels are generally low in the Sebkha with average values not exceeding 20%.

Indications of climatic variations can be seen in the presence of laminae within the deposit, the existence of traces of desiccation cracks marked by colours different from those of the host rock and the addition of eolian gypsum sand.

The succession and alternation of laminae pairs (light and dark) could be explained by the climatic contrast, dry and wet periods, influencing the watershed inflow [5].

The existence of thin beds of Ostracods with complete shells, interspersed in the soil horizons, indicates a non-displacement post mortem and would also inform on ecological and climatic variations sometimes favouring the proliferation of this microfauna (figure 7).

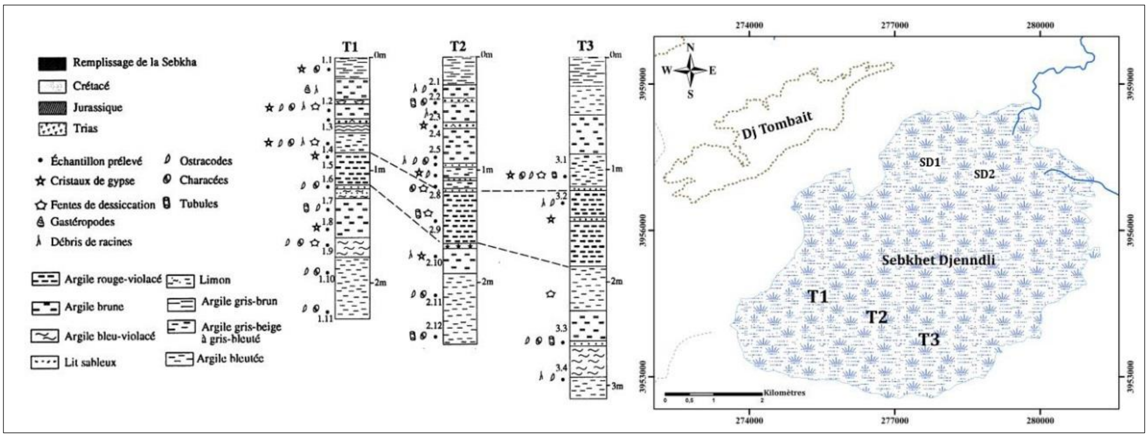

Figure 7. Soil profiles from the Sebkhet Djendli trenches (Marmi, 1995)

- *Electrical conductivity (70 water points)*

The work undertaken on Sebkhet Djendli concerns hydrogeological measurements from which a conductivity map has been drawn up (Figure 8). It appears that the salinity of the water increases progressively from the outside (periphery) to the inside of the Sebkha. Where it can exceed 10,000 µs. This observation refers to surface water at a depth of 15-20 m, as deep boreholes (60 m and more) drilled by mechanical probing have reached the freshwater table (conductivity ~1500 µs). This water table is probably separated from the upper (superficial) water table by an impermeable clay screen, thus isolating the two water tables.

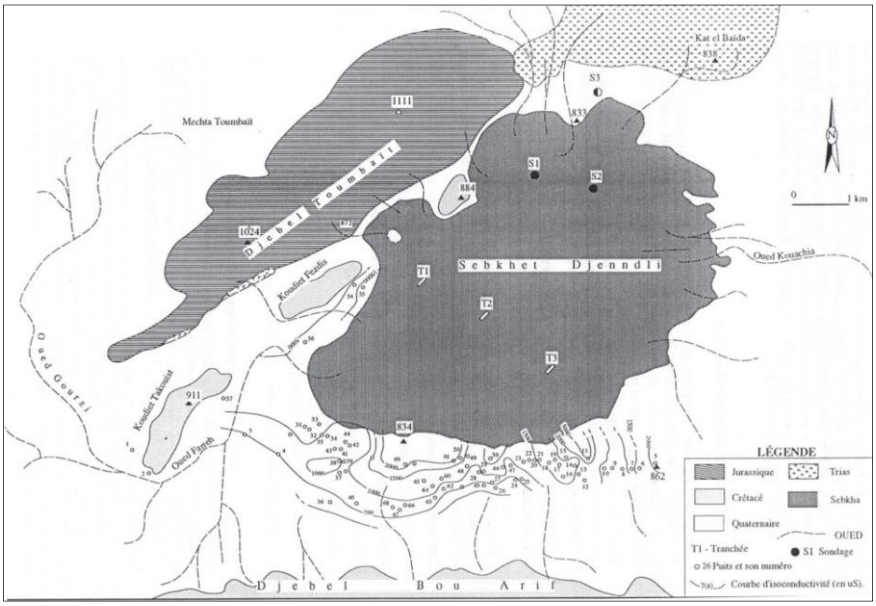

Figure 8. Electrical conductivity map (Sebkhet Djendli) (Marmi, 1995)

The salinity of the surface water could be induced by the leaching of the Triassic terrain in the vicinity (Djebel Toumbaït and Koudiet el Baïda foothills) during run-off, transporting dissolved salts to the Sebkha. In the dry season (June-September) the bottom of the Sebkha is covered with a whitish gypsum-salt pellicular crust.

In the Boulhilet plain

About 30 soil profiles were carried out across the plain, sampling five horizons at more or less regular intervals. Approximately 150 samples were collected from all the profiles.

Horizon 1

- *The distribution of «EC / Na»*

On both maps (Figure 9), the EC and Na anomalies are comparable and are located near the Sebkhas: Djendli, Garaets el Marhsel and Ank Djemel. However, the high values occur along a well expressed N-S corridor, passing through Garaet el Marhsel and skirting the Ank Djemel garaet in its western part. It is worth noting the presence of large outcrops of Triassic formations north of Sebkhet Djendli and north of Garaet el Marhsel.
Probably the anomalies of the high values of CE and Na would have as origin these saliferous deposits following their leaching by the waters, whose flows of the wadis are made towards the South. As for the strong anomaly just southwest of Sabkhet Ank Djemel, the source of these salts would be located on the edge of the southern flank of Djebel Bou Arif where triassic deposits were outcropping and the salts are transported via Oued Chemora-Boulhilet which has its source in the Timgad plain.

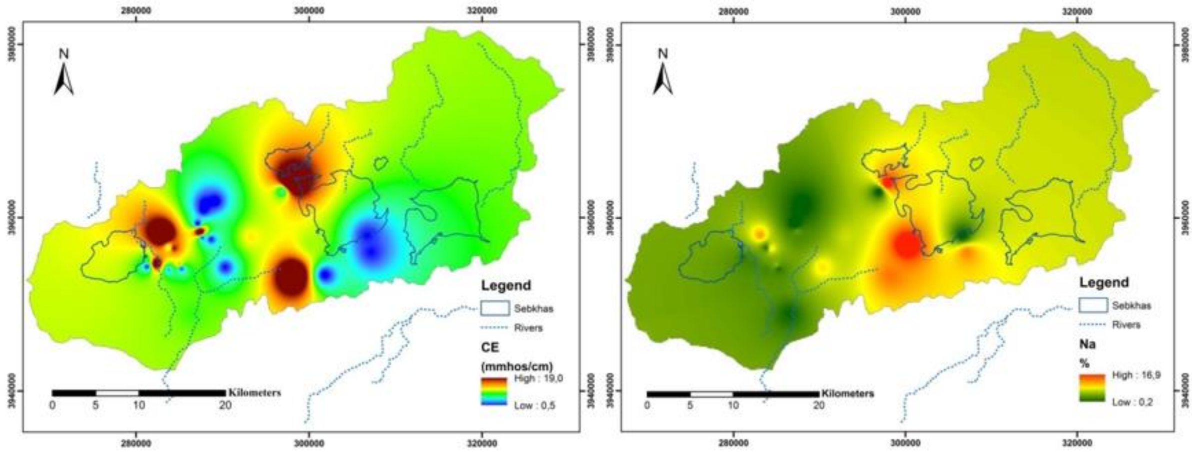

Figure 9. Distribution of electrical conductivity (EC) and (Na) across the soils of the sebkhas area of South Constantinois (Horizon1)

- *The distribution of «SO4 / gypsum»*

The two main anomalies of high SO_4 and gypsum values are located at the same places (superimposable anomalies), and the supply of these two elements of these zones would be respectively from the North, concerning the anomaly which is just west of Sbkhet Djendli and from the South for the anomaly which is located south-west of Sebkhet Ank Djemel.
The inputs would be carried respectively by the wadis coming from the North, washing the Triassic formations which outcrop just N-E of S. Djendli and Oued Chemora-Boulhilet. This last wadi has its source in the plain of Timgad and receives during its course several small wadis descending from the southern flank of Dj. Bou Arif. They then leach the salts from the Triassic deposits outcropping along the southern edge of Dj. Bou Arif, while feeding the Chemora-Boulhilet wadi which flows into the Boulhilet plain (Figure 10).

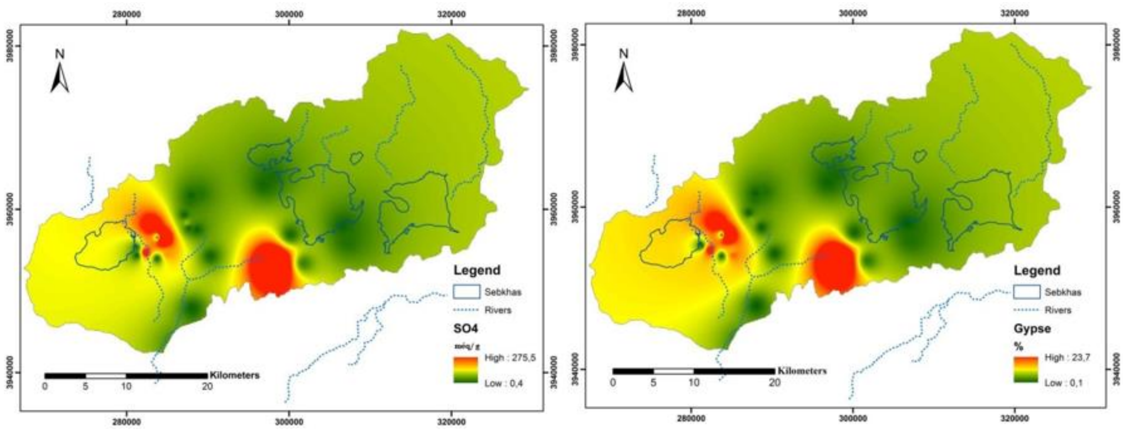

Figure 10. Concentrations of (SO_4) and (gypsum) in the soils of the sebkhas area of South Constantinois (Horizon 1)

Horizon 2

- *The distribution of «EC / Na»*

In horizon 2 (between 55 and 65 cm depth) there is no concordance between the locations of the high EC values on the one hand and Na on the other. The N-S anomalous corridor observed in the case of horizon 1, still remains expressed only for Na on horizon 2 (deeper). This enrichment in Na could be explained by the contributions coming from the North and South via the wadis and facilitated by infiltration through a more permeable soil of the upper horizon (Figure 11).

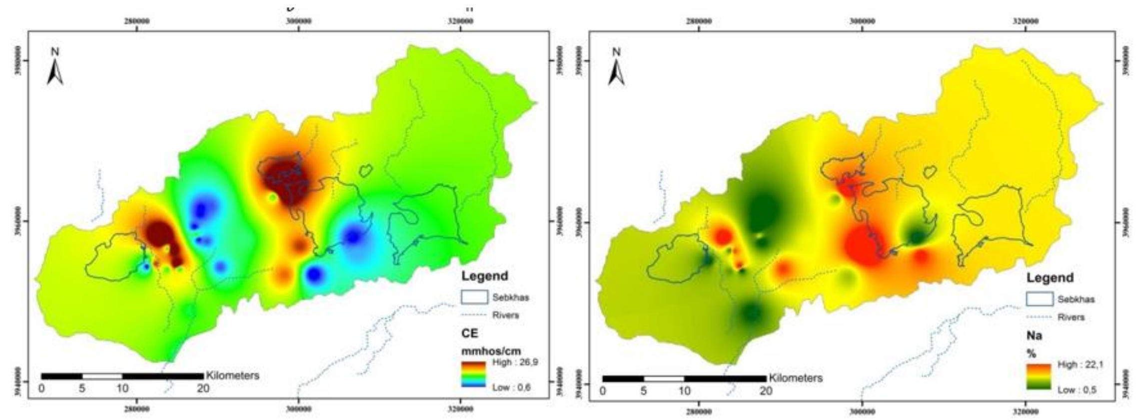

Figure 11. Distribution of electrical conductivity (EC) and (Na) across the soils of the sebkhas area of South Constantinois (Horizon 2)

- *The distribution of «SO_4 / gypsum»*

The high SO_4 and gypsum contents are located in two similar sites for both elements and are respectively, SW of Garaa Ank Djemel, at the mouth of Oued Chemora-Boulhilet (relatively more extensive anomaly) and NE of Sebkhet Djendli (less expressed and less developed anomaly) (Figure 12). The source and transport of these elements would be similar to those reported in the previous case (horizon 1).

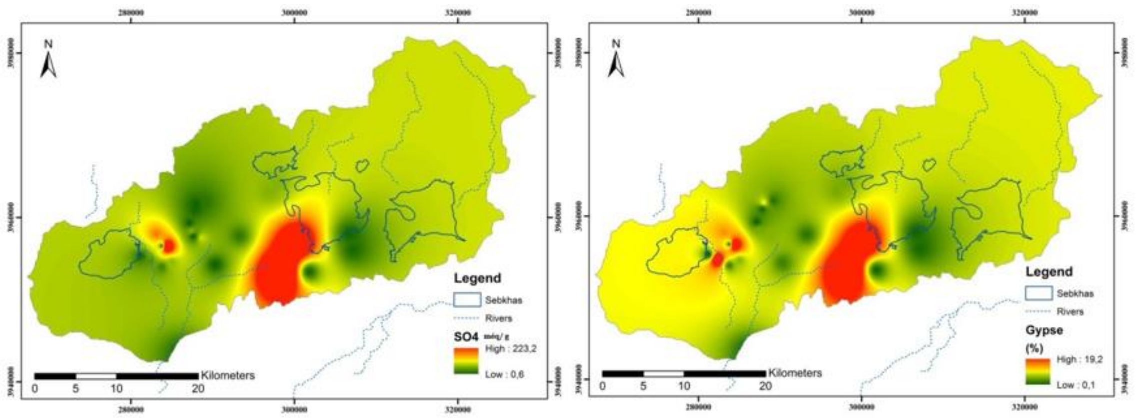

Figure 12. Concentrations of (SO_4) and (gypsum) in the soils of the sebkhas area of South Constantinois (Horizon 2)

Horizon 3

- *The distribution of «EC / Na »*

This is a deeper horizon than the previous horizons (Horizon 1 and 2), lying at about 90 to 110 cm depth. The mapping shows a large funnel-shaped CE anomaly, quite wide in its northern part, which narrows towards the south (Figure 13). On the other hand, the high Na values show an anomaly, relatively smaller than that of EC, located at the mouth of Oued Chemora-Boulhilet. So for these two elements their anaomalies are not concordant (not superimposable), this dissociation would be in relation with the evolution of the soil in depth which favours a perceptible percolation and an increase of the values with depth.

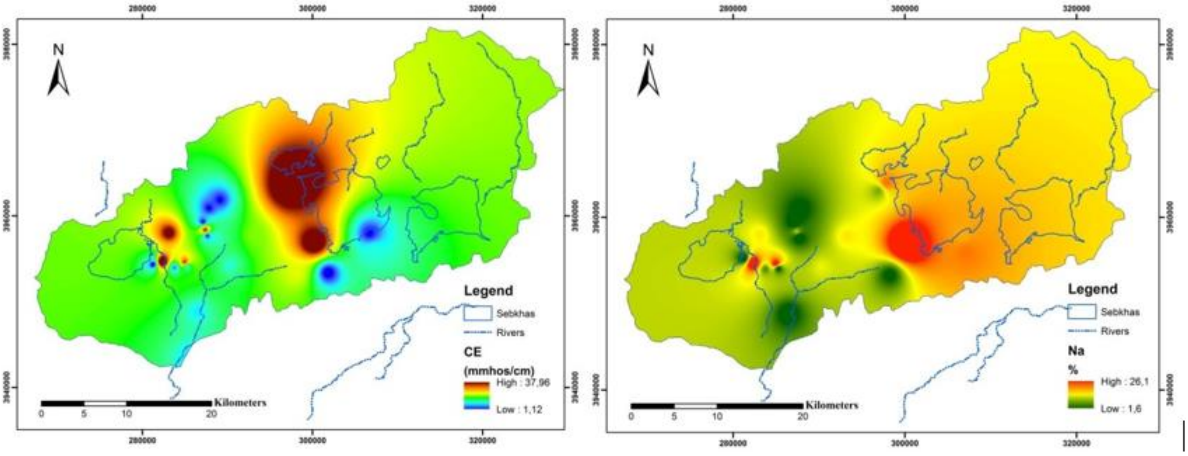

Figure 13. Distribution of electrical conductivity (EC) and (Na) across the soils of the sebkhas area of South Constantinois (Horizon 3)

- *The distribution of «SO4 / gypsum»*

For sulphates, the mapping shows a clear similarity between the spatial distribution of high levels of these two variables (anomalies), they are better expressed in the western part of the plain. However, a fairly small anomaly of high sulphate content stands out and is isolated at the mouth of Oued Chemora-Boulhilet (Figure 14).

It should be noted that the grades of these two elements decrease significantly with depth in the profiles.

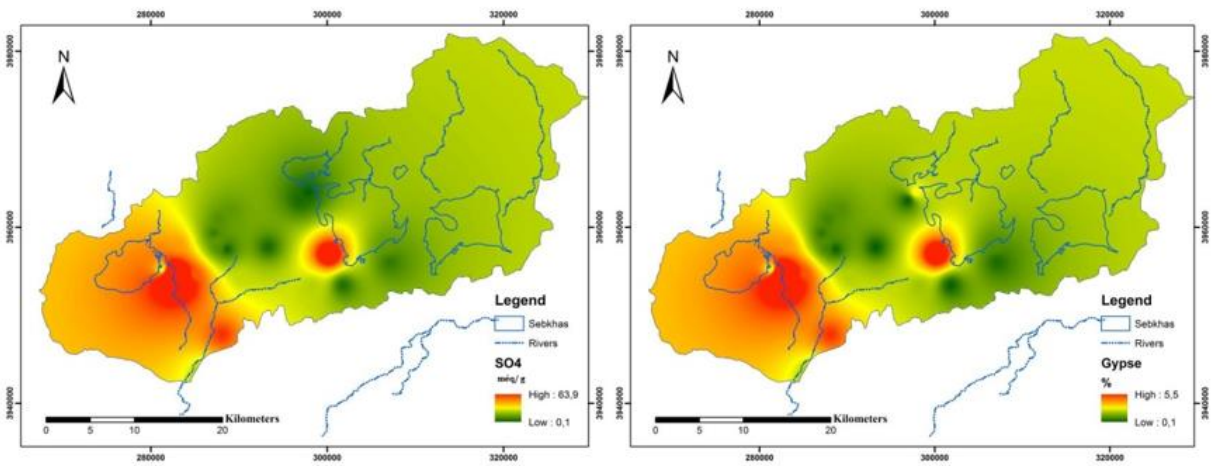

Figure 14. Concentrations of (SO_4) and (gypsum) in the soils of the sebkhas area of South Constantinois (Horizon 3)

- *The concentration of "Total $CaCO_3$" in soils*

The total limestone contents are certainly somewhat abnormal (relatively high) in the lower parts of the plain, after the glacis (east and west of Boulhilet, between Chemora and Boulhilet, west of Henchir Seffane and south of Coudiet Zrazer and between the glacis north of Sidi Bouzid -Thimendanine). These contents are characteristic of calc-magnesic soils; they are higher at depth (Figure 15): total base exchange capacity.

The $CaCO_3$ concentrations show the influence of the important calcareous stock surrounding the plain.

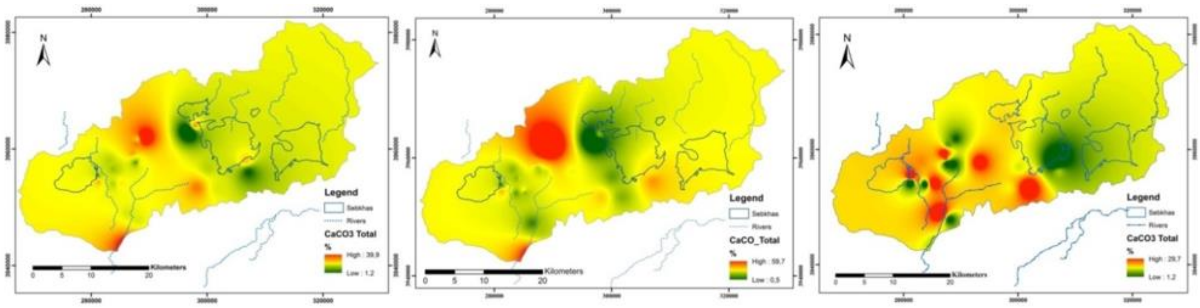

Figure 15.: Concentrations of $CaCO_3$ in soils of the Southern Sebkhas area (Horizons 1, 2, 3)

- *The « pH »*

The most relatively low pH values are found in the area between Sabkha Ddjendli in the east and Garaat Ank Djemel in the west, for all three horizons considered. However, at the level of horizon 2, this sector is characterised by lower values.
The pH is too high on the eastern edge of sebkhet Djendli as well as in the southern part of gareat Ank djemel (reaches a value of 8.9), it increases as one descends in depth (Figure 16).

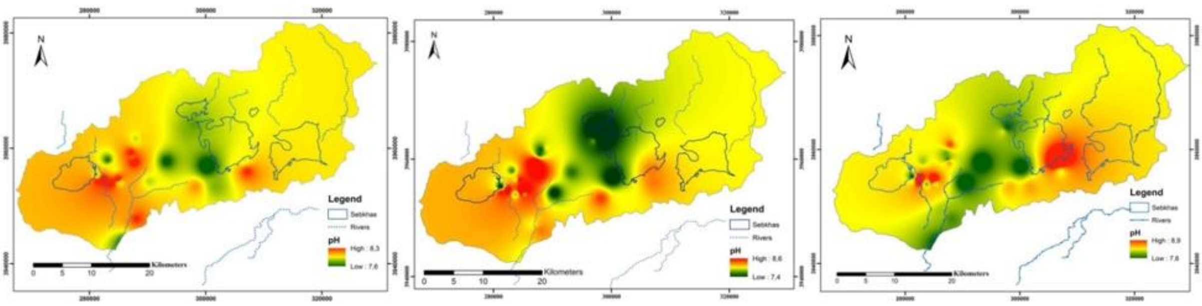

Figure 16. Distribution of pH across the soils of the sebkhas area of South Constantinois

If we summarise, EC and Na values increase in depth across the plain and on the contrary gypsum and sulphate concentrations decrease in depth (Tables 1 and 2). The values of $CaCO_3$ and pH remain globally less variable across the different horizons but in detail, these two parameters show a slight increase with depth (Tables. 1 and 2).

Table 1. The different parameters analysed and their vertical distribution (average values)

Parameters Horizons	EC (mmhos/cm (moy)	Na% (moy)	Gypsum % (moy)	SO4 méq/g (moy)	$CaCO_3$ total% (moy)	pH (moy)
Horizon 1	6,4	6,14	3,7	42,72	20,3	7,9
Horizon 2	8,8	8,3	3,6	36,7	21,8	8,0
Horizon 3	14,1	9,2	1,3	14,8	24,0	8,2

Table 2. The different parameters analysed and their vertical distribution (maximum values)

Parameters Horizons	CE (mmhos/cm (max)	Na% (max)	Gypsum % (max)	SO_4 méq/g (max)	$CaCO_3$ total % (max)	pH (max)
Horizon 1	19,0	16,9	23,7	276,0	40,0	8,3
Horizon 2	27,0	22,1	19,2	223,5	60,0	8,6
Horizon 3	38,0	26,1	5,5	64,0	61,0	8,9

DISCUSSIONS

Thematic mapping (performed by IDW interpolation), based on soil analysis data, facilitates the analysis and interpretation of the results. It makes it easier to visualise the spatio-temporal evolution of abnormal concentrations of the different variables. The soil sampling was carried out in the 1970s, when rainfall was relatively higher than at present. It is likely that this rainfall was the cause of the dissolution of the salts and consequently of their infiltration into the ground. The hydrographic network has played a decisive role in the contributions, by leaching of the surrounding geological formations and more particularly those of the Triassic period which are rich in salts and sulphates. The relatively high level of $CaCO_3$ reflects the dominance of the carbonate rocks surrounding the sebkhas zone, which constitute a source of calcium carbanate.

CONCLUSIONS

In the study area, the useful agricultural area is already limited and is further threatened by degradation processes (salinisation, sodification) and even by contamination with trace elements such as Zn, Cu, Cr, Ni, Ba..., especially the well water used to feed the inhabitants (AEP).
Through the mapping, the EC and Na contents increase with depth from the upper to the lower horizons (H1 to H3), whereas the gypsum and SO_4 contents decrease with depth (H1 to H3) through all the soil profiles.
In the first case, this can be explained by the solubility of Na, which facilitates its leaching from the superficial horizons to the deeper horizons in relation to the character of the soils of the different horizons where little evolved alluvial soils are generally dominant. In the second case, sulphates are not very soluble and tend to crystallise to give minerals that are retained in the superficial levels, which consequently results in their low percolation at depth.
The distribution of $CaCO_3$ will remain limited due to its low solubility and reduced rainfall over the region. The average pH value across the plain soils is around 8, but through the horizons considered, the pH increases with depth. Certain factors are responsible for these concentrations across the Boulhilet plain:

- The nature of the geological formations (the Triassic gypsiferous formations of Djebel Tombaït, the violet Mio-Pliocene marls of the Timgad basin and the south-western slope of Bou Arif and the large stock of limestone surrounding the plain),
- The irregularities of the climate, characterised by a drought that becomes more pronounced with each passing year,
- The wind action (wind deflation) is marked in all seasons and has become more pronounced especially in areas without vegetation. The existence of sebkhas and garâas, and their drying out for long periods, favours the deflation of salts and their spreading on the plain accentuates the salinity of the soils,
- Leaching by runoff and infiltration through horizons....etc.

RECOMMENDATIONS

- *If these halomorphic soils are left uncultivated, and under current climatic conditions, they will evolve very little or not at all.*
- *On the other hand, if they are worked and cultivated (e.g. some fodder crops adapted to clay textures and high salinity), the salts will be leached out and the soils will evolve into poorly developed soils or green soils (see profile N°16) [1].*

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EFFECTS OF LAND APPLICATION OF MUNICIPAL SOLID SEWAGE SLUDGE AND WASTE PLANT COMPOST ON WHEAT GROWTH AND SOIL ENZYMATIC ACTIVITIES

Tsend-Ayush ERDENEJARGAL, Hosam E. A. F. BAYOUMI HAMUDA*

Institute of Environmental Engineering and Natural Sciences, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Budapest, Hungary E-mail: ayush091999@gmail.com, E-mail: Bayoumi.hosam@uni-obuda.hu, +36303900813

With rapidly growing industrialization and urbanization, nowadays nations face countless problems; one of them is declining soil fertility. In this study we aimed to improve soil fertility and biological activity by adding organic amendments, which includes municipal solid sewage sludge (MSSS) and waste plant compost (WPC). Inappropriate utilization of organic matter can impact negatively on soil fertility and plant growth. A pot experiment study was conducted to investigate the potential of 6 weeks of consecutive application of municipal solid sewage sludge and waste plant compost response of wheat (Triticum durum) to different doses (0, 15, 30, and 45%: w/w) to restore brown forest soil functions. Plant growth, shoot biomasses and heights, ratios and chlorophyll content was considered. Soil fertility parameters including Soil pH, moisture content, total organic carbon, soil total nitrogen content and soil enzyme activities i.e. fluorescein diacetate, dehydrogenase, β-glucosidase, urease activity, and alkaline phosphatase as well as aryl-sulfatase were measured. Evaluating the results, it can be stated that organic waste has an improving effect on the enzymatic activities and plant growth parameters in all cases; therefore, it can be of great help to agriculture and crop production. It is shown that application of waste plant compost has more soil biological improvement than the municipal solid sewage sludge, with 15 and 30% organic waste.

***Keywords**: municipal solid sewage sludge, waste plant compost, wheat growth, soil enzymatic activities*

INTRODUCTION

Today, to face the quick increases in the global population due to the low education and influencing of the lifestyle, for example, unhealthy social life and bad economic conditions and unprotected environment conditions, and reduction on the agricultural areas and foot-staff production. These problems come up on a global scale as part of the global environmental problems which are caused due to, for example, the effects of climatic changes (i.e., the emissions of greenhouse gases) and environmental pollution. Now, we have to work on reducing environmental pollution (e.g., soil pollution) and improving the soil quality and crop production, and not least but also reducing the rate of organic waste disposal materials.
To come to this point, according to the recent studies, which show that by applying organic waste disposal materials in the field of agriculture as raw organic matter increases soil fertility and quality after the biodegradation processes carried out by the soil microbial activities. These microbial contents in soil are able to release the degradable enzymes to break down the complex organic matter to simple one or two carried out what is called mineralization.
Accordingly, the biogeochemical cycles can give the correct answer on soil microbiotas' ability to increase soil quality and crop productivity. During these studies, it is clear that the most critical tool in the process of biodegradation is the enzyme. Due to the beneficial impacts of soil biological properties, it is crucial to investigate the effect of waste organic matters on enzymatic production through enzymatic activity. This is the main point of the whole research. So, it is decided to do the thesis on the effects of

different organic waste materials on the production and activities of some essential enzymes that play a role in soil improvement.

Organic soil amendment

The amendments for the soil are basically a substance whose purpose is to change the soil's properties more willingly than for plant fertilizers. For example, soil with lots of clay or sand texture, benefits from the organic materials by improving its quality. Organic matter rich soils preserve water or moist more and hold up many nutrients. Most soil additions are made up of no-cost or low-cost materials including locally accessible manure and compost, home-grown compost, pine bark fines, leaves, grass clippings, cover crops, and food leftovers. Compost and manure products double as fertilizers with a guaranteed nutritional analysis, and soil amendments provide certain plant nutrients.

Common soil amendments and sources

Agricultural and food wastes, animal manure, grass clippings, and leaves are used to make commercial composts. Many commercial types of compost follow a composting protocol and regularly evaluate for content, quality, and pollutants. Pesticide residues in commercial compost pose very little harm [5]. Herbicides are only present for a brief time in soil and compost, and they seldom cause problems. Producers and sellers should test their composts on a regular basis and be ready to give test results. However, manure and commercial compost have been polluted with a few long-residual herbicides (aminopyralid and clopyralid) in recent years.

Urban sewage sludge

Rapid industrialization and population growth has resulted to the higher amount of municipal sewage sludge production day by day. It is one of the primary problems for any part of the world that how it could be disposed and its use in this massive volume of sewage sludge. There are many ways that it could be solved as beneficial by product, which include burning, landfill disposal or even using it as soil amendments in the landfills. It is known that municipal sewage sludge is very dense and rich in nutrient organic substance, which has lots of variable plant supporting or promoting components, including nitrogen, phosphorus and potassium fertilizers and micronutrients such as magnesium, calcium and sulfur. By encouraging microbial activity, recycling plant nutrients and enhancing the soils physicochemical qualities, sewage sludge can increase the soil health. For example, components in the sewage sludge can also promote the water retention, ion exchange and soil aeration. The main benefit of using sewage sludge as fertilizers in the agriculture is that it may replace the chemical fertilizers, with economically sustainable [1].

Nonetheless, applying the sewage sludge in the landfill might become hazardous for the environment due to its excessive chemicals and heavy metal contamination. Some negative changes in agricultural soil caused by sewage sludge additives, dependent on soil type, physicochemical features of communal sewage sludge, its rate and repetition of application. The high amount of heavy metal contamination might pollute the soil and affect plant development and soil microbiology. Therefore, the considering the effects of sewage sludge application is essential for the microbiota of soil and its properties.

Benefit of organic soil amendments

Using inorganic fertilizers for some time could bring to negative environmental impacts. It could lead to bigger problems like biodiversity loss in the soil, oxygen depletion, and in the worst case desertification. Hence, it is crucial to find a better solution for the sustainable management for reduction of environmental harmfulness.

Throughout the years researcher have been developing solutions to decrease the negative environmental impacts on horticulture, which to name a few are crop rotation, soil organic treatments and legume cultivation. Nevertheless, with the increasing population and food demand, chemical amendments have been established in a broad area [1].

Soil organic amendments could benefit in both increasing food demand and balancing sustainable healthy soil. In the previous studies, it has been proposed that consequence of the organic fertilizer is dependent on the soil characteristics, previous frequency of fertilization, type of the plant and the timing [2].

Soil enzyme activity and their shift after organic soil amendment

Soil microorganisms are primarily responsible for soil ecological processes. Enzymes are classified in the biology as transferases, hydrolases, oxidoreductases, lyases, ligases and isomerases. But mainly the enzymes go to hydrolases, but for the reason that of its location, it could be classified differently. Many factors affect the enzymatic activity, but mostly it depends on the presence or absence of the inhibitor and activator. Also the reaction of it is temperature reliant. Soil enzymes perform various functions. The ß-glucosidase supplies the microorganisms with energy in the form of glucose. The phosphatase helps break down phosphorus; the urease and the amidase provide ammonium. The sulfatase converts sulfur into plant-available sulfate. The higher the corresponding nutrient concentrations in the soil, the lower the enzyme activity is often; this is clearest with phosphatase and urease, less so with sulfatase. The urease activity on grassland is twice as high as under peas and ten times as high as conventional N fertilization. The ß-glucosidase is 80% higher under a red fescue-clover than under an all-grass stand. However, there are also indications that the P content does not influence the phosphatase activity in the soil. If the initial phosphate bioavailability is high, there seems to be a positive correlation with phosphatase activity.

MATERIALS AND METHODS

Soil Origin

In this research work, the soil was collected from the garden of Rejto Sandor Faculty of Light industry and Environmental Engineering, Óbuda University. The garden is located to the west of the faculty building and the soil is Ramann's brown forest soil, which was not been exposed to any chemical or other agricultural treatments before. Its geographical coordinate of the soil pick-up point was Latitude (Y) 47°31"59.46"N and Longitude (X) 19°1'57.53"E as in shown Figure 1.

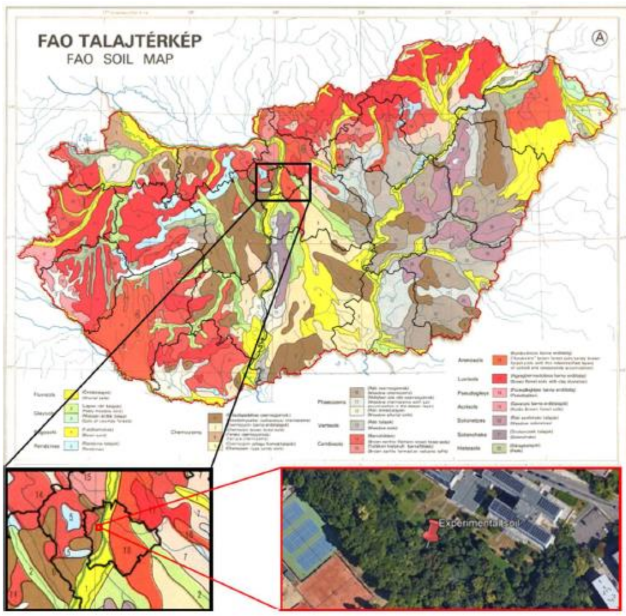


Figure 1. Collection point of the soil sample on soil map [3]

Using a garden shovel and plastic bag, around four kilograms of soil were taken from the topsoil, particularly from the depth of 0-25 cm. The collected soil was transferred to the laboratory and air dried for some weeks to remove excess moisture.

Plant residues, stones, and other debris or big particles were taken off by hand. A ≤ 2mm standard stainless-steel sieve was used for five minutes to homogenize the soil. Later, it was sent to Institute of Soil Science Centre for Agricultural Research, to measure some physicochemical characteristics of the soil. The results are shown in Table 1.

Table 1. Physicochemical characteristics of the tested soil

Tested parameters	Measurement units	Values
pH_{KCl}	-	7.13
EC	µS/cm	32.34
$CaCO_3$	m/m %	3.34
H	m/m %	1930
Total Nitrogen Content	mg/kg	18.76
NH_4-N	mg/kg	73.69
AL-P_2O_5	mg/kg	51.7
AL-K_2O	mg/kg	169
Al-Na	mg/kg	37.2
KCl-Mg	mg/kg	146
KCl-S	mg/kg	14.1

Communal sewage sludge

The wastewater sewage sludge was obtained from the Nyiregyhaza wastewater treatment plant, which processes communal sewage through aerobic digestion reactors. The domestic wastewater treatment plant sludge was transferred to the laboratory and stored in a refrigerator at 4℃. Its physicochemical characteristics were later examined as shown in Table 2.

Table 2. Physicochemical characteristics of municipal sewage sludge at Nyiregyhaza

Tested parameters	Measurement units	Values
pH_{KCl}	-	6.71
Dry matter content	%	53
Organic matter	%	21.7
Humus content	%	-
Total Nitrogen Content	mg/kg	7470
NO_3-N	mg/kg	-
NH_4-N	mg/kg	-
Mg	mg/kg	2507
Na	mg/kg	994
P_2O_5	mg/kg	28720
K_2O	mg/kg	3171
Zn	mg/kg	537
Cu	mg/kg	110.4
Mn	mg/kg	421
Fe	mg/kg	11308
Cd	mg/kg	2.3
Pb	mg/kg	66.9

APPLIED METHODS

The homogenized air-dried soil was carefully mixed with the compost from agricultural waste and domestic wastewater sewage sludge. The final mixture was containing organic amendments in the following percentages by weight: 0% (control), 15, 30, and 45%. The soil amendments and their replications are shown in Table 3.

Table 3. Soil organic amendments and replications

	Control	Sludge amendment			Compost amendment		
	0%	15%	30%	45%	15%	30%	45%
Replication 1	×	×	×	×	×	×	×
Replication 2	×	×	×	×	×	×	×
Replication 3	×	×	×	×	×	×	×
Overall	3	3	3	3	3	3	3
		9			9		

According to the above plan, recycled plastic cups were each filled with 250±5 grams of soil, and each cup was planted with seven wheat (common wheat: *Triticum aestivum* L.) seed. Every seed had minimum 1 cm distance from each other and the wheat seed was preliminarily selected based in their size, which are not less than 7 mm in length and not less than 4 mm in width (Figure 3). The seed was grown at 25±2℃ for 28 days. The exact amount of water was given to the plants every two days to maintain the soil moisture at approximately 45%.

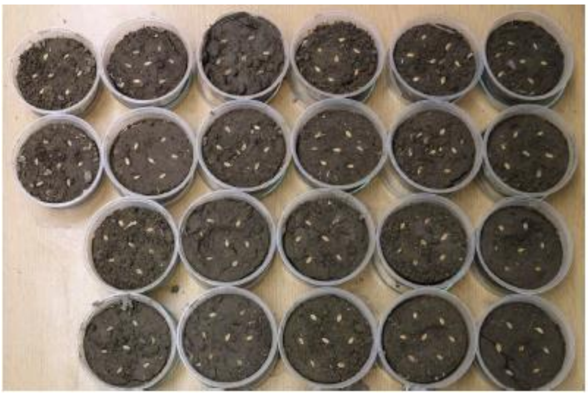


Figure 2. Planting the wheat after mixing with the compost and wastewater sludge

Soil pH and moisture content

The pH of control soil as well as both communal sewage sludge and compost amended soils were measured by using the method of Perez De Mora et al. [4]. After 28 days of incubation, the pH of both untreated and treated soils was examined after 60 minutes of shaking with the ratio of 1: 2.5g/ml-1. By modifying the procedure of Brzenzinska et al., [5] the moisture content of the amended and non-amended soils was calculated. Originally the technique was to use an incubation temperature of 105℃, which will make the process faster; however, it was dried at 28℃, to be more cautious. The chosen heat was also close to the natural conditions, so that would be easier to determine the complete dryness in the outside environment.

Total Organic Carbon

The total organic carbon in the treated and untreated soil was examined using the method of Walkley and Black et al., [6]. Briefly, it was evaluated by dichromate oxidation and titration with the addition of ferric ammonium sulfate, so that the organic matter in the sample is consumed upon potassium dichromate oxidation. One gram of soil weighed to the 500 ml Erlenmeyer flask, where 10 ml of 1N potassium dichromate solution and additional 20 ml of sulfuric acid was added later. Approximately all the components were slowly rotated for 60 seconds, by cautiously not leaving soil particles on the inside wall of the flask. After settling for 30 minutes, 0.2 grams of ammonium fluoride, 10 ml of phosphoric acid and exact 10 drops of diphenylamine indicator were poured into the previous mixture. 0.5 M ferrous ammonium sulfate solution was used as titrant until the colour turned from dull green to blue.

Total Nitrogen Content

The total nitrogen content of soil was determined by using the Kjeldahl apparatus as defined by Keeney and Nelson et al., [7] based on the Kjeldahl method. The nitrogen will react with concentrated sulfuric acid in the presence of copper (Cu^{2+}) salt as catalyst to increase the boiling point and increasing reaction rate as shown below:

$H_2SO_4 \rightarrow SO_2\uparrow$
$C, O \rightarrow CO_2\uparrow$
$H, O \rightarrow H_2O\uparrow$
$N \rightarrow (NH_4)_2SO_4$

Before basification, the diluted sulfuric acid and ammonium sulfate solution was neutralized with concentrated sodium hydroxide mixture. With the help of a strong base, it displaces ammonia from ammonium sulfate, where it can be easily removed from the solution by heating or boiling.

$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$
$(NH_4)_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2NH_4OH$
$2NH_4OH \rightarrow 2NH_3 + 2H_2O$
Organic N + $H_2SO_4 \rightarrow (NH_4)_2SO_4 + H_2O + CO_2$ + other constituents from the sample

Measurement of plant growth and plant dry matter

The growth of the plants was measured at the conclusion of the experiment, after incubating wheat seeds were modified and non-amended soils. Root length and stem heights were measured. To measure root length, small plastic cups were removed, and soil was gently shaken away. Roots are floated in sufficient amount of water in acrylic trays. This allows the roots to be arranged to reduce overlap and crossing of roots. Metal forceps and plastic pipette tips were used as instruments. Both root and stem height were measured with an ordinary ruler and measurement unit was centimeters. Relative dry matter content (%) compare to control plants was examined only on stem similarly to the detection of soil dry matter. It was dried until constant weight in an oven at 75℃ for around 10-12 minutes.

Chlorophyll intensity

During the experiment, the chlorophyll content of the leaves was determined by using the Walker et al., [8] method. All the samples were acetone extracted before measuring with spectrophotometer. The absorbance was measured with different wavelength: 647, 652 and 664 nm. The equations used for chlorophyll content calculations were:

Chlorophyll a (mM) = 13.19 X A664 – 2.57 X A647
Chlorophyll a (mM) = 22.10 X A647 – 5.26 X A664
Total chlorophyll (mM) = 7.93 X A664 – 19.53 X A647
Chlorophyll intensity expressed as acetone extracted: mg chlorophyll g-1 fresh weight.

INVESTIGATION OF ENZYMATIC ACTIVITIES IN SOILS

Dehydrogenase activity:

To measure the dehydrogenase activities in treated and non-treated soils, the method by Wolinska et al., [9] was followed. The procedure started with mixing six grams of soil with 0.12 grams of calcium carbonate and after four millimeters of distilled water and one millimeter of a 3.5% concentrated 2.3.5.-triphenyl tetrazolium chloride solutions were poured. The mixture was slowly mixed by rotating for 60 seconds, where later individually every sample was extracted with 25 milliliters of ethanol for precisely 60 minutes in the dark environment. Afterward, each sample was incubated for 20 hours at the temperature of 30℃ and then filtrated. Finally, with a wavelength of 485 nanometers, the absorbance of the soil extracts was measured. During the procedure, the dehydrogenase activity, and micrograms of generated triphenyl formazan per gram of soil were employed.

Catalase activity:
The method written in Feigl et al. [10], was used to detect the CAT activity in amended soils. In the experiment, two grams of soil were mixed with 40 milliliters of distilled water and 5 milliliters of 0.3% hydrogen peroxide. The soil suspensions were incubated for twenty minutes; it was filtrated one by one. Following to removal of the hydrogen peroxide from the sample, each suspension was titrated with 0.02M potassium permanganate. It was calculated by the reaction amount of permanganate in each dry soil weight.

Fluorescein diacetate hydrolysis:
For measuring the fluorescein diacetate hydrolysis, the modified method by Schnürer and Rosswall [11], which was firstly created by Zelles et al. [12] was used. A spectrophotometer at a wavelength of 490 nanometers was used for the detection.
Urease activity: The measurement of urease activity (μmol NH4 + -N g-1 dry soil h-1) was done in accordance with, the method of Nannipieri et al., [13].

Phosphatase activity:
Phosphatase activity (μmol p-nitrophenol (PNP) g-1 dry soil h-1) was measured according to Tabatabai and Bremner et al., [14].

Beta-glucosidase activity:
β-glucosidase activity (μmol p-nitrophenol (PNP) g-1 dry soil h-1) was detected by the procedure which is declared by Masciandaro et al., [15].
Arylsulfatase activity: The activity of arylsulfatase (μmol p-nitrophenol (PNP) g-1 dry soil h-1) was measured by a method developed by Tabatabai and Bremner [16]. After the incubation of the soil with PNP sulfate, absorption of p-phenol was measured at 400 nanometers.

STATISTICAL ANALYSIS

As stated before, three duplicates in triplicate were used in the research work, which is placed in a randomized block design. To calculate the statistically significant differences between treatments, a correlation based on a single classification was implemented. The standard deviation in each value was calculated at $P < 0.05$.

RESULTS AND DISCUSSIONS

Soil pH and moisture content

Soil pH is an important parameter, which plays an essential part in the nutrient availability of the plants. Based on their pH value, soils are classified as acidic, neutral, and alkaline soils. As mentioned before, the soil used in this research was assigned a soil based on its pH value of 7.13. The soil pH value before and after organic amendments was comparable, but there was a slight change in its pH value. So, therefore, it difference was not significant. It was found that by adding the organic matter (the wastewater sludge or the compost material) to the soil, the moisture content in each amendment was increased. This increase in soil moisture content was significant differences from the control (the untreated sample). Also, by increasing the application rates of organic matter the moisture content increase. Also, statistically, it was found that there are differences between the application of wastewater treatment and the application of compost to the brown forest soil. The increase of the soil quality and consequently facilitating plant growth is the main importance of the soil organic amendment, wherein this study, the collected topsoil was amended with 15, 30, and 45% of wastewater sludge and compost from agricultural waste. The moisture content of the organic amendments at different concentrations was measured in comparison to non-amended experimental soil (control). From Figure 3, it could be seen that the time required drying a constant weight increased in correlation with an increased amount of organic share. For instance, non-amended soil reached complete dryness after ten hours, while 45% compost amendment soil required far more prolonged time, i.e., twenty-five hours to reach constant weight to complete dryness. Wastewater sewage sludge amendments always presented shorter time duration than sludge amendments to become completely dry. It reflects the theory that the increased organic matter content leads to increased moisture retention both in compost and sewage sludge. It could be also clearly noted that the proportion of the variable had a strong relationship.

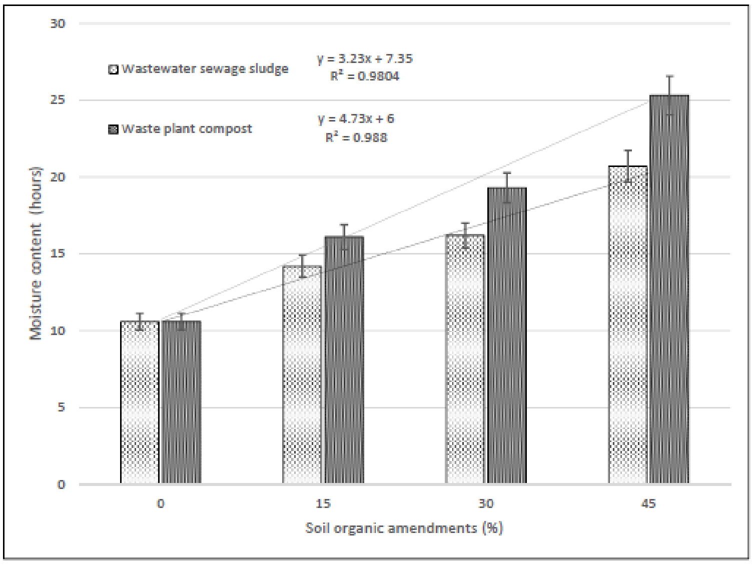
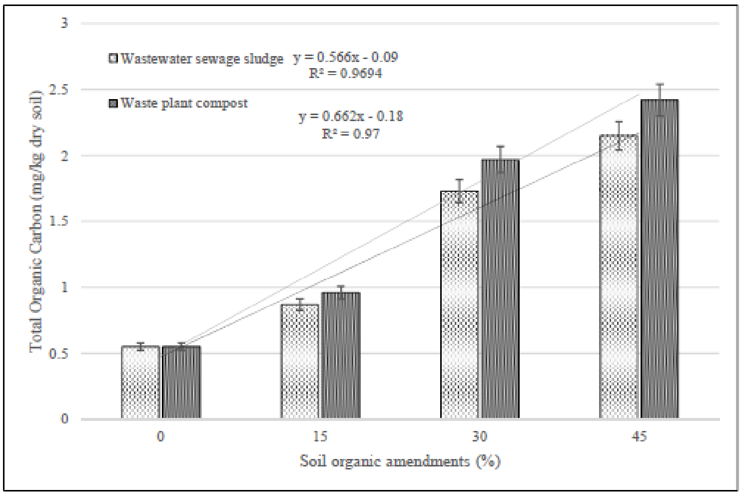


Figure 3. Moisture content (%) at different concentrations of organic amendments

Total Organic Carbon

Therefore, there were no significant differences between the two amended soils at a 15% application rate, compost amended soil had always a higher amount of organic carbon. From the coefficient of determination, it could be stated that the values are not significantly high or low at some point. However, as shown in Figure 4, both 30% and 45% of treated soils significantly differed between the amended soils. The results could indicate that starting from the treatment 15%, the organic carbon in soil was rapidly increasing. Compared to the control soil the organic amendments are without doubt highly affecting positively,



Total Nitrogen Content

The results of TNC (Figure 5) were continuously increasing along with the rising amendment rates, which are shown in both wastewater sewage sludge and compost from agricultural waste. There was significant difference at all treated soils, although plant compost had always a higher amount than sludge. The coefficient of determination was close to 1, which means the variable was accurate as predicted.

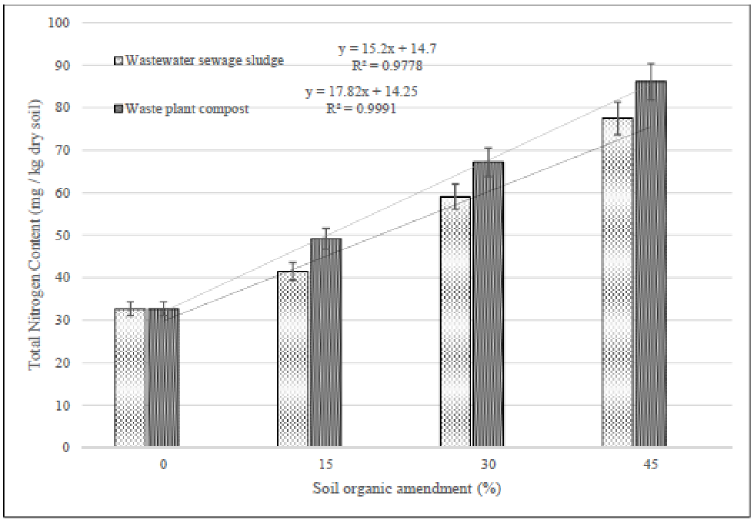


Figure 5. Total nitrogen content (TNC: mg/kg dry soil) at different concentrations of organic amendments

ENZYMATIC ACTIVITIES

Dehydrogenase activity

For the result of dehydrogenase activity (Figure 6), there was a significant discrepancy at all rates, excluding the control soil. It was most effective at 30%. Although the dehydrogenase activity in the highest amended soils had decreased drastically, waste plant compost had always higher value than the other amendment.

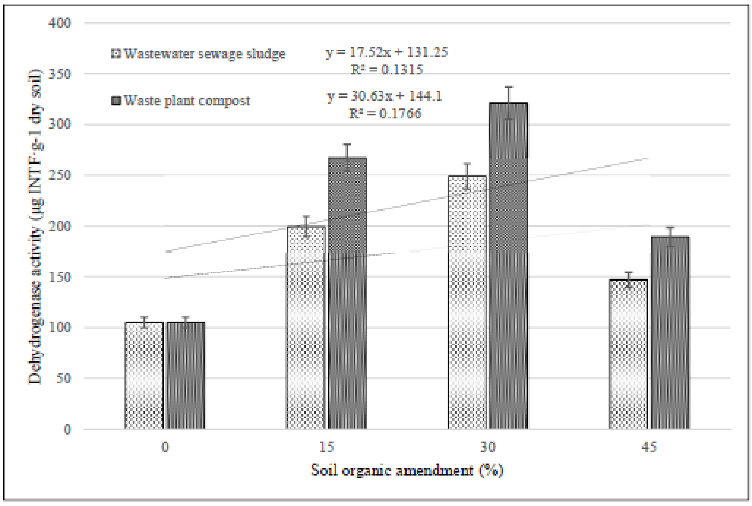


Figure 6. Dehydrogenase activity (µg INTF·g-1 dry soil) at different concentrations of organic amendments

Catalase activity

Unlike the other enzyme activity (Figure 7) results, catalase activity remained elevated with the increasing amount of organic amendments, especially with 45% of sludge and compost amendments. There was no significant difference between the two amendments. Treating soil with organic amendment helped the expanded catalase activity very effectively.

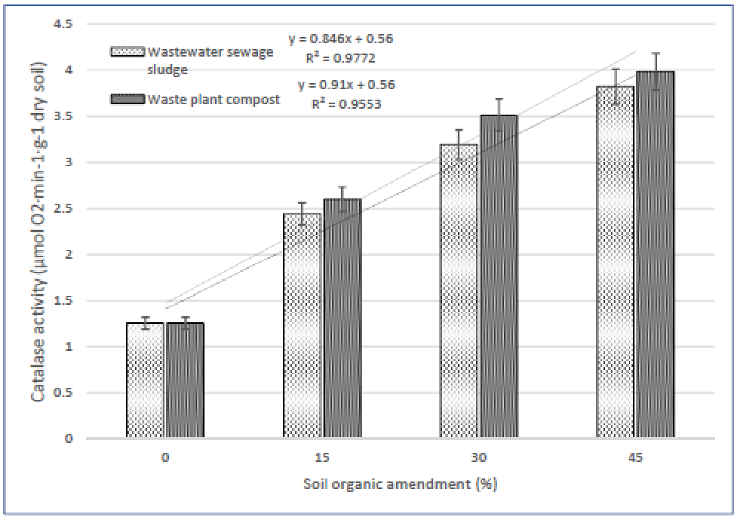


Figure 7. Catalase activity (μmol O2·min-1·g-1 dry soil) at different concentrations of organic amendments

Fluorescein Diacetate

The end result of Fluorescein diacetate activity was very similar to the dehydrogenase activity, in which the results were elevated with 15% and 30% amendments and then significantly decreased with 45% amendment, especially in the case of sludge amendment. Figure (8) shows, that there is a significant difference in all the treated soils, but compost treated soil was lower than the other one, only at the rate 45%.

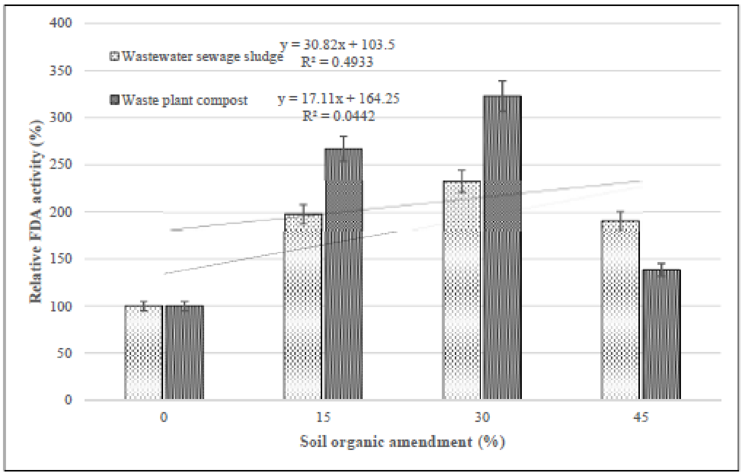


Figure 8. Relative fluorescein diacetate (FDA) activity (%) at different concentrations of organic amendments

B-glucosidase activity

From the data in Figure 9, it can be seen that B-glucosidase activity was increasing with a minor significance at 15% and 30%, whereas a high amount of significance was detected at 30%. At 30%, the compost amended soil had far better activity than the sewage sludge amended soil, although it fell remarkably at 45%.

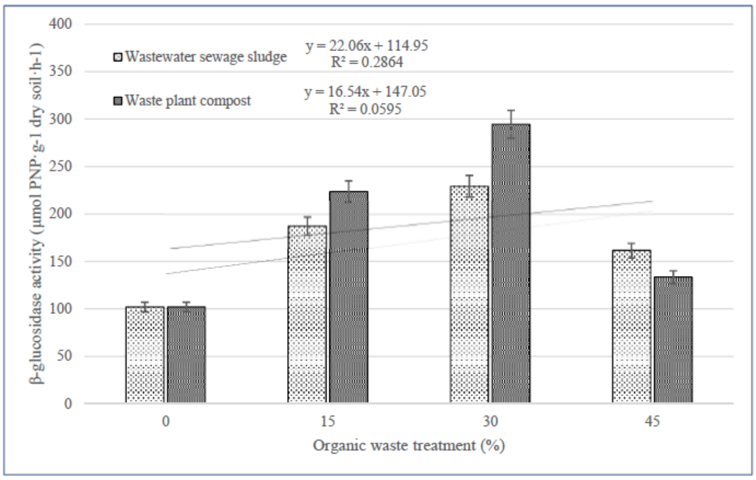


Figure 9. B-glucosidase activity (µmol PNP·g-1 dry soil·h-1) at different concentrations of organic amendments

Urease activity

From the bar chart (Figure 10), it can be seen that at 15% the results were slightly increasing, but at the 30%, it increased rapidly compared to the 15% amended soil. There was no significant difference between treated and untreated soil at 30%. At 45% the plant compost had a lower value than sewage sludge and the gap between the values was significant.

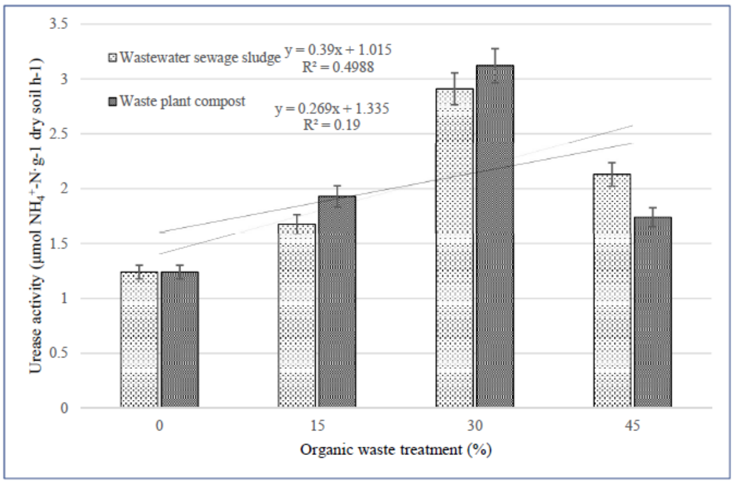


Figure 10. Urease activity (µmol NH4+-N·g-1 dry soil h-1) at different concentrations of organic amendments

Alkaline phosphatase

Figure 11 indicates that at 15%, both treated soils had a high amount of alkaline phosphate activity, which is not much lower than the double concentrated (30%) soil. But as same as the other enzyme results, it declined.

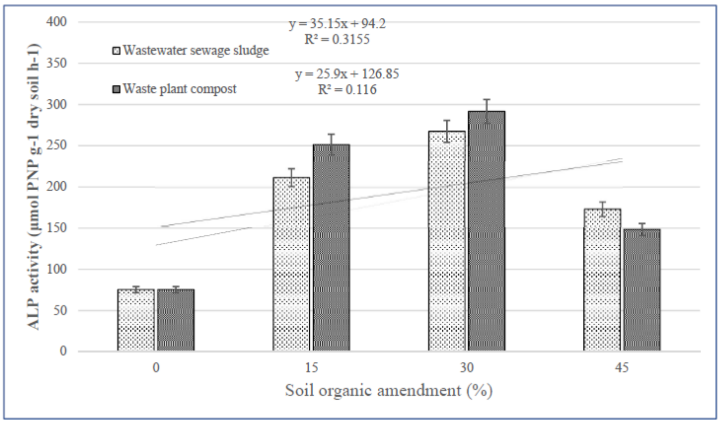


Figure 11. Alkaline phosphatase activity (µmol PNP g-1 dry soil h-1) at different concentrations of organic amendments

Aryl sulfatase

The results in Figure 12 show same tendency of reaction such as it was found in the activity of alkaline phosphatase, meanwhile at the amendment at 15%, the results had visible significant difference. At 15 and 30% the activities were in a high amount, until the results of 45% amended soil got equal as one half of the 30%.

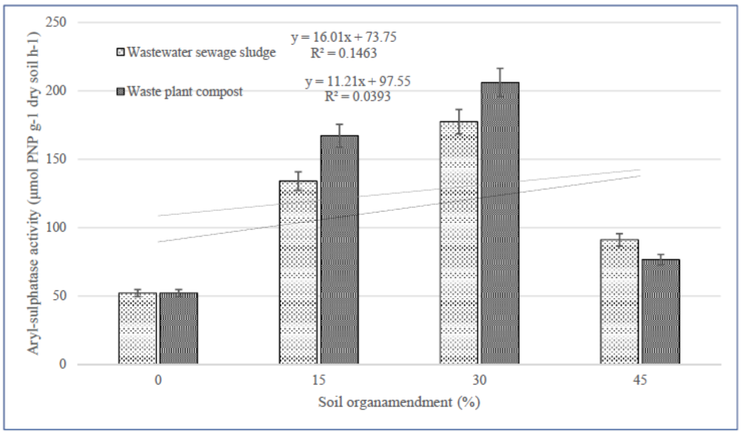


Figure 12. The degree of aryl-sulfatase activity (µmol PNP g-1 dry soil h-1) at different concentrations of organic amendments

PLANT PARAMETERS

Figure 13 shows wheat growth after twenty-eight days, where all of the seeds have successfully grown without any issue. The root length was measured after the measurement of stem height.

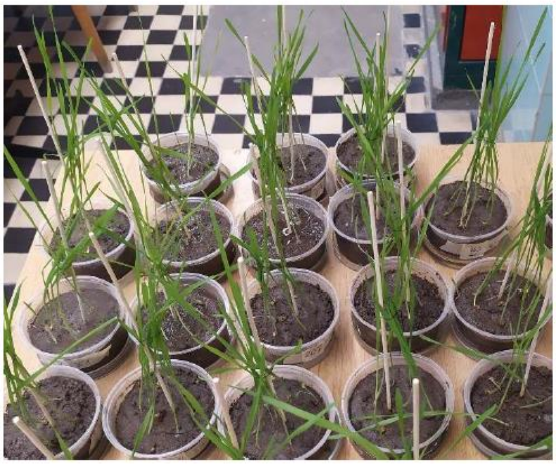


Figure 13. Wheat growth after four weeks

Root length

The Figure 14 shows that root length was longer with the elevated concentration of compost and sewage sludge till 30% and it became shorter at 45% amendments. These results were consistent with soil enzyme activities. According to the chart, at the concentration 15%, the significance between the two amendments was noticeable, but it was almost equal at the highest amendment 45%. The factors affecting negatively on root length could be explained, that the amount of organic substances were too high.

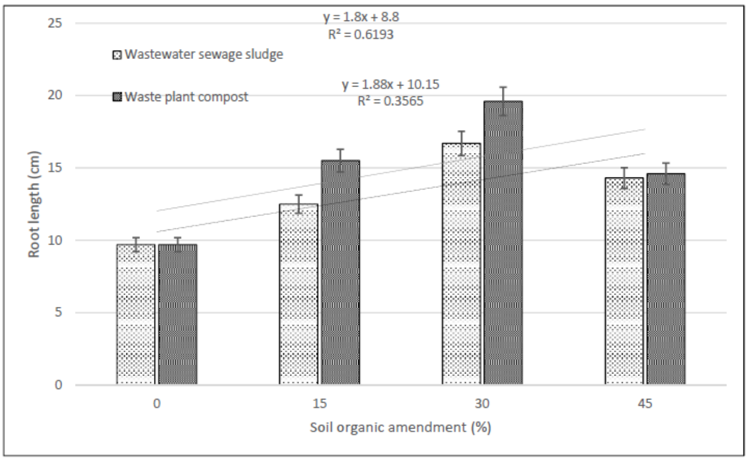


Figure 14. Root length of the wheat plant at different concentrations of compost and sludge amendments

Stem height

Little different than root length, stem height at the amendment 45%, did not fall drastically. There was no significant difference between the two treated soils, except at the highest concentration. It could be seen at the 45% amended soils; wastewater sewage sludge had declined tremendously compared to the 30% sludge amended soil, but not the same fall was seen for compost amended soil (Figure 15).

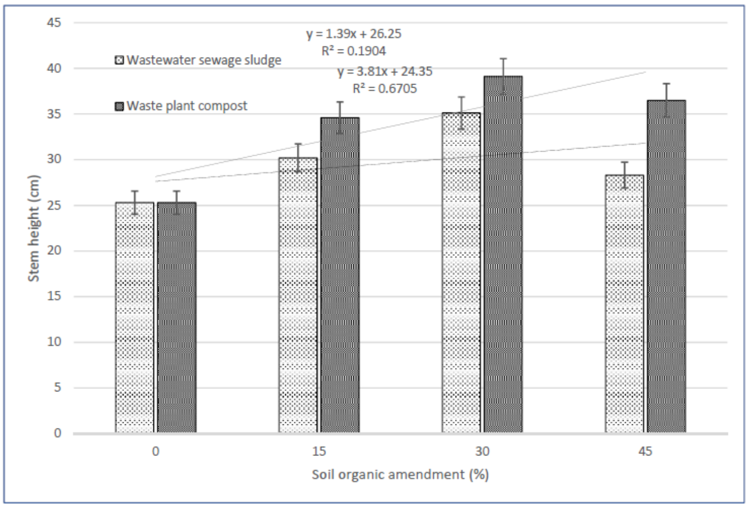


Figure 15. Root length of the wheat plant at different concentrations of organic amendments

Relative dry matter

The value of relative dry matter (Figure 16) of the wheat was pretty much the same as the enzyme and plant growth findings, where there was no significant difference between the communal sewage sludge treated and compost treated soils with the same concentration

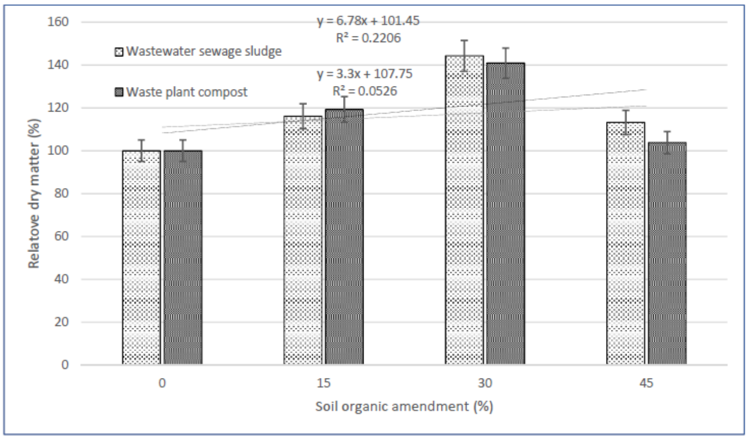


Figure 16. Relative dry matter (%) of wheat plant at different concentrations of organic amendments

Chlorophyll content

The result in the Figure 17 shows now significant difference in all rates between the both treated soils. However, communal wastewater sludge had higher amounts at 30 and 45%. The results are lowered at the highest concentration, which almost had the same value as the 15%. It was sudden that the result of the waste plant compost declined at 30%, thus both amendment was almost the same in 45%. The result was close to the dry matter of the plant, which might be explained that they are affected by same thing.

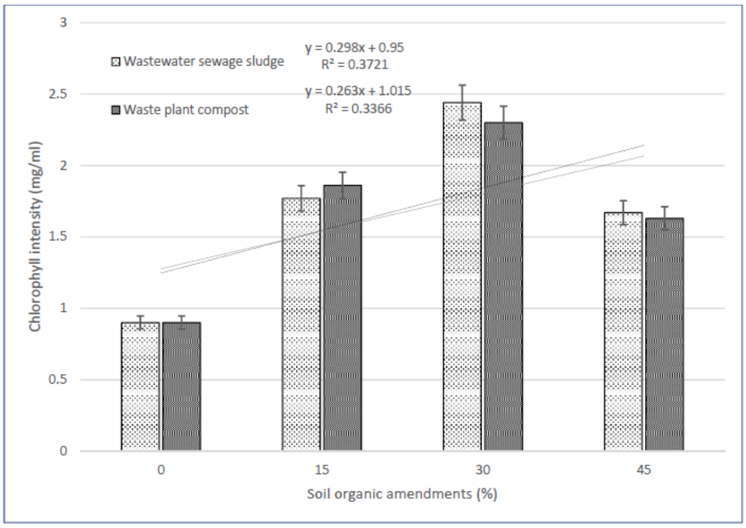


Figure **17.** Chlorophyll content (mg/ml) of green shoot of the wheat plant at different concentrations of organic amendments

CONCLUSION AND FURTHER TASKS

It could be countless to name the beneficial effects of microfauna on biological processing. The chosen two kinds of soil organic amendments: municipal sewage sludge and compost from agricultural waste, can affect the soil and its properties by promoting changes in its physical, chemical, and biological characteristics. In the present studies, it was implemented that two parallel amendments of communal sewage sludge and garden waste compost were at the rate of 15 and 30%, which improved the soil fertility and nutrients. The result showed that dehydrogenase and catalase activities tend to be higher with the amended soil than the non-amended (control) soil. A high concentration of applied sewage sludge and compost indicated a toxic effect on both soil microbiomes and plant growth. From these results, it could be suggested that the biological activities of soil are only moderately, however favourable affected by the organic amendments. A low amount of application in the landfill of municipal sewage sludge and compost could be environmentally friendly and sustainable management for economics. Because low doses of additives seem to provide macronutrients, and not have an excessive amount of heavy metal pollution. Generally, all these results persuade that sufficient soil organic amendments could lead to sustainable agriculture fertilizer. For further tasks, the municipal sewage sludge and compost from agricultural waste could be tested for different types of soil where agricultural activity can take place. For the experiment, only common wheat was used, however, in the further examination, variety of crop plants can be used to detect the enzymatic activities. Also, detecting broad area of soil characteristics could make it is easier to determine and compare the enzymatic results of sewage sludge and compost. It would be much more effective to take the experiment for a prolonged time, and take the soils from different seasons. Because in the previous studies, it was mentioned that environmental factors directly affect the enzymes in the soil. Municipal sewage sludge and compost from agricultural waste might be studied for various types of soil where agricultural activity can take place in future jobs. Only ordinary wheat was employed in the experiment; however, different crop plants can be used to detect enzymatic activity in the future. Furthermore, identifying a wide range of soil properties may allow determining and comparing the enzymatic outcomes of sewage sludge and compost more straightforward. It would be far more effective to carry out the experiment over a longer time and collect soil samples from several seasons.

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Article submitted to the Proceedings Book of the VIth. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

ECO-INNOVATION AND ENVIRONMENTAL AND ECONOMIC MANAGEMENT

Yasmin HAMUDA1, Hosam E. A. F. BAYOUMI HAMUDA2*

*1Tomori Pál College, Budapest, Hungary, E-mail: hamuda.jasmin91@gmail.com, 2Institute of Environmental Engineering and Natural Sciences, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Budapest, Hungary, *E-mail: Bayoumi.hosam@uni-obuda.hu, +36303900813*

The concept of eco-innovation has begun to be considered as a solution to preventing environmental damage, since the 1990s. However, the effect of eco-innovation on environmental and financial performance has received limited attention. Eco-innovation is defined as new ideas, behavior, products, and processes that contribute to a decreased environmental burden as well as the economic management. Eco-innovation is expected to reduce amounts of environmental wastes in soil and water, air pollution, and material resource usage from economical point of view. However, the effect of eco-innovation on environmental and financial performance has received limited attention. Eco-innovation is considered as effective tools as it enhances energy efficiency and cleaner production, which in turn lowers carbon emission. Quality institutions have been considered as it enhances the quality of environment. Green technology innovation is essential to reducing the pollution emissions of enterprises. Under stronger environmental regulation, import trade has a significantly positive effect on green technology eco-innovation. Environmental regulation can enhance the technology spillover effect of import trade in high absorptive capacity regions and high R&D investment regions. How does environmental regulation affect green technology eco-innovation? Under different levels of environmental regulation, do the import trade behaviors of enterprises have different impacts on green technology eco-innovation? What influencing mechanisms are involved? The work of this thesis will try to answer these questions. How environmental regulation affects green technology eco-innovation needs more discussion. Moreover, few scholars have analyzed how environmental regulation affects green technology innovation from the perspective of import trade. The results of this paper show the following: First, there is a nonlinear relationship between environmental regulation and green technology innovation. When environmental regulation intensity is lower than the inflection point, environmental regulation will promote green technology innovation; when environmental regulation intensity is higher than the inflection point, environmental regulation will inhibit green technology innovation. Second, environmental regulations affect the technology spillover effects of import trade. When stricter environmental regulations are in place, import trade can significantly promote regional green technology innovation. Third, there is significant regional heterogeneity in the impacts of environmental regulation on the technology spillover effects of import trade. In regions with high levels of absorptive capacity and high R&D investment, the interaction between environmental regulation and import trade has a significantly positive effect on green technology innovation. This paper analyses the nonlinear relationship between environmental regulation and green technology innovation and discusses which kind of environmental regulation intensity is most beneficial to green technology innovation.

***Keywords**: eco-innovation, environmental management, economic management*

INTRODUCTION

The achievement of sustainable economic growth and green growth is the critical policy of many countries worldwide, and they are trying to eliminate this environmental pollution in their countries. To develop green growth strategies for emission control, it is necessary to adopt new technologies that reduce environmental pollution. Globally, many countries are trying to achieve carbon (C) neutrality targets by using environment-friendly technology and green growth. This study investigates the impact of green growth, income, environmental taxes, environment-friendly technology, renewable energy, and financial development. Environmental degradation can be controlled by environment-friendly technologies, renewable energy resources, and green growth strategies.

The combined effects of climate change, land degradation, cropland losses, water scarcity and species infestations may cause projected yields to be 5-25% short of demand by 2050, and 600 million additional people could be affected by malnutrition as a direct result of climate change by 2080. The rapid increases in ecological footprint and air pollution have followed the fast expansion of the global economy. Population and income growth, urbanization, changing consumption patterns, stagnant yields, demand for land, feed, and biofuels, and the impact of climate change, biodiversity loss and environmental degradation are driving limited resources of food, energy, water and materials towards critical thresholds. Additionally, various factors, e.g., energy supply security, energy dependency, climate change, energy price volatility, and environmental disasters, encouraged many developed and emerging economies to divert their attention to green growth and sustainable economic growth.

The adoption of green growth strategies and technologies is playing an inevitable role globally, and protecting the environment and natural resources is essential for future generations because future generations must be provided with a pollution-free environment. Sustainable economic growth and poverty reduction objectives can be achieved through green growth strategies.

The concept of eco-innovation has begun to be considered as a solution to preventing environmental damage, especially since the 1990s. Eco-innovation is expected to reduce amounts of environmental wastes in soil and water, air pollution, and material resource usage from economical point of view. However, the effect of eco-innovation on environmental and financial performance has received limited attention (Liu et al., 2022). There are three main reasons for conducting this study:

The first is concern about the need to reduce environmental impacts. The concept of eco-innovation emerges when business practices are harmonized with environmental expectations. Eco-innovation is defined as new ideas, behavior, products, and processes that contribute to a decreased environmental burden (Rennings, 2000). While factors such as global agreements, market conditions, technologies, and regulations have important implications for the environment, eco-friendly investment can still be considered an additional charge for companies. New technologies have significantly changed production concepts. It has been a matter of curiosity to us how this situation will change financial and environmental performance. There is ambiguity as to whether eco-innovation creates a positive environmental and financial contribution. Since businesses are economic units, cost must be the priority in all their investment decisions. Therefore, determining whether eco-innovation meets economic expectations as well as environmental expectations is of great importance to decision-makers.

A second reason for this study is to explore this question. However, Porter & Linde (1995) claim that these investments can be turned to an advantage through eco-innovation. Porter’s hypothesis has been corroborated in terms of eco-product innovation by the research of Cleff & Rennings (1999). Horbach et al. (2012) determined that the cost saving is a motivation for the introduction of eco-innovation. Cheng et al. (2014) illustrated the influence of eco-innovation on financial performance. Costantini et al. (2018) identified that eco-innovation, which directly reduces the environmental impacts of production, also creates an indirect positive environmental impact in other sectors through intermarket transactions. There are some studies showing that eco-innovation affects performance, the literature evaluating the effect of eco-innovation on performance is insufficient (Munodawafa & Johl, 2019).

Within the scope of the study, we investigate the effect of eco-innovation on the performance of companies. Researchers investigate different aspects of eco-innovation in the literature. While eco-innovation has been measured as eco-product and eco-process innovation by Horbach et al. (2012) and Rennings & Rammer (2011), it has been measured as eco-product, eco-process, and eco-organizational innovation by Cheng & Shiu (2012), Cheng et al. (2014), and Rennings et al. (2006). A large part of the literature on eco-innovation is about product, process, and organization (García-Granero et al., 2018). As distinct from these studies, it was consider eco-innovation in terms of “eco-product,” “eco-process,” “eco-organizational,” and “eco-marketing,” from a holistic perspective. On the other hand, the impact of eco-innovation on financial and environmental performance has not been thoroughly researched in developing countries. A significant number of eco-innovation studies have been conducted in developed countries by Horbach et al. (2012) and Lee & Min (2015).

The third reason for this study is to contribute to filling this gap. Thus, the aim of this research work is to determine the impact of eco-innovation on environmental and financial performance in a developing country and contribute to the Porter's hypothesis.

RESEARCH HYPOTHESES

H1: Eco-innovation has positive effects on increasing economic performance.
H2: Eco-innovation has positive effects on increasing cost performance.
H3: Eco-innovation has positive effects on increasing resource saving.
H4: Eco-innovation has positive effects on pollution prevention.
H5: Eco-innovation has positive effects on increasing recycling.
Overall, these research hypotheses enable the study to determine the effects of eco-innovation on performance. Eco-innovation improves businesses' economic (H1) and cost (H2) performance. These factors are considered as financial performance in the study. Moreover, eco-innovation improves businesses' environmental performance (H3, H4 and H5). Environmental performance is evaluated as resource saving, pollution prevention, and recycling in the study. Accordingly, a research conceptual model is presented in Figure 1.

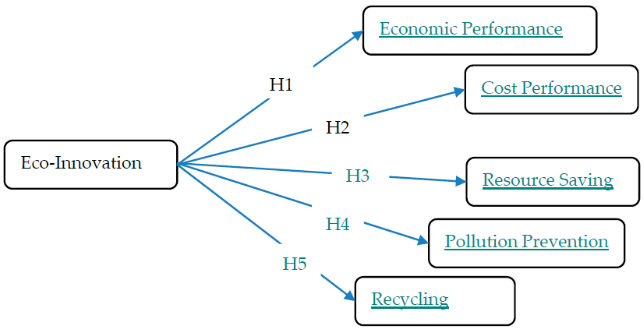

Figure 1. Conceptual model

In line with this research, it will be clarified whether eco-innovation will create financial benefits along with environmental benefits within the framework of economic and cost performance, resource saving, pollution prevention, and recycling. It has been determined that research in this area is inadequate in developing countries. Drawing on these insights and the identified research gap, this diplom-research work seeks to understand whether eco-innovation has an impact on the environmental and financial performance.
Measuring environmental issues on sustainability and their influence on economic, social, and human wellbeing becomes clear; particularly while considering both economic growth and quality life together (Jordan et al. 2010). Quality of life-wellbeing could be compromised due to some socioeconomic and environmental factors, i.e., inequality, poverty, and environmental change, etc. At present, the growth scenario has failed to address environmental pollution and income inequality issues that hamper the sustainability of the environment (Zhao et al. 2021). Conversely, objective wellbeing takes account of fundamental economic, social, and environmental essentials, therefore, directly measurable (Talberth et al. 2007).
Sustainable development is termed as satisfying human needs without compromising natural and social capital. Therefore, the goal of sustainability is to achieve wellbeing by preserving the natural environment. There are different schools of thought in environmental sociology regarding the interactions between economic growth, degradation of the environment, and wellbeing. Modernization theories, including economic and ecological modernization, are in favor of the positive role of economic growth in achieving sustainability and wellbeing (Knight & Rosa 2011).
Urbanization means shifting rural population to urban areas for better living standards (Wang et al., 2020a, 2020b, 2020c), which is closely linked with environmental pollution (Wang et al., 2018a, 2018b, 2018c). Industrial activity in urban areas attracts more people for jobs, leading to increased

population density in the cities. Due to urban agglomeration in different cities, it demands more energy, groundwater, and land, which in turn affects the environment and air quality of urban population. As the urban area population increases, it may extract natural resources and severe impact on the ecosystem by reducing the carrying capacity (Coffin, 2007). However, urban expansion still has a titrative effect on emissions in order reduce the environmental impact it should to switch its activities from metropolitan areas to marginal regions (Wang et al., 2018a, 2018b, 2018c).

Similarly, economic growth may harm the ecology and air quality of a country (Ahmad et al., 2021). The growth of country depends on the scale production of goods and services, and it has a closely link with energy consumption and efficient technology (Plank et al., 2020). The different modes of urbanization may thus have different types of urbanization PM2.5 pollution roles. Therefore, it is important to recognize the various impacts of different urbanizations Factors related to PM2.5 and carbon dioxide (CO_2) emissions (Zhu et al., 2019).

The relationship between economic growth and air pollution has long-standing debate among the researchers. The pioneered work by Grossman & Krueger (1991) was the first study to examine the Environmental Kuznets Curve (EKC) empirically and found its existence. Globalization helps developing nations to deal with the rest of the world by improving their economic development and addressing their nation's deprivations (Kabeer, 2004).

Endogenous growth theory believes that innovation is the most important source of productivity growth, and a large volume of empirical research has proved that innovation has a significant and positive effect on productivity growth (Baumann & Kritikos 2016; Lopez-Rodriguez & Martinez-Lopez, 2017). In recent years, there has been a growing body of studies paying attention to the influence of innovation on green total factor productivity (GTFP). However, the extant research conclusions regarding the relationship between innovation and GTFP are relatively mixed. Most empirical studies show that innovation is a critical driver of GTFP growth. Additionally, several studies proved that different types of innovations had distinct influences on GTFP. Cheng et al. (2018) used China's manufacturing panel data to test the effects of three different types of research and development (R&D) investment (i.e., independent R&D, domestic technology introduction, and foreign technology introduction) on GTFP and found that there was a significant industrial heterogeneity in the effects of various kinds of R&D investment on the green growth of China's manufacturing. More recently, some scholars realized that the relationship between innovation and GTFP may be non-linear. That is, the effect of innovation on GTFP would be contingent on other factors. However, the estimation strategy of constructing a linear interaction term between technological innovation and environmental regulation cannot effectively solve the problem of a structural break in the impact of innovation on GTFE (Huang et al. 2019a; Zhou et al. 2019).

DEFINITIONS AND CONCEPTS OF ECO-INNOVATION

Eco-innovation is the process of developing new products, processes or services which provide customer and business value but significantly decrease environmental impact (James, 1997). Eco-innovation is one of several approaches towards sustainable design. The concept of eco-innovation was first developed by Fussler & James in 1996 and defined as the reduction of negative environmental impacts while providing new products and processes as a benefit to the customer and the business (Hojnik & Ruzzier, 2016). Eco-innovation contributes to environmental responsibility and sustainability goals through the realization of new ideas, behavior, products, and processes (Rennings, 2000). Arundel & Kemp (2018) described eco-innovation as a new or significantly improved product, process, or business method that helps to reduce environmental risks, pollution, and the negative effects of resource use instead of traditional methods that do not take into account environmental impacts. Schumpeter (2017) defined innovation as a new product, process, or method of production; a new market or source of supply; or a new form of commercial business or organization. Thus, eco-innovation differs from traditional innovation practices because of the environmental perspective.

The resource-based view (RBV) asserts that the maintaining of firms' competitive advantage lies in it having heterogeneous resources that are valuable, rare, inimitable, and non-substitutable (Barney, 1991). The resource-based view (RBV) provides a valid theoretical basis for examining the relationship between resources, capabilities, and performance. This theory provides a holistic view of eco-innovation (Cheng et al., 2014). Hart (1995) argued that RBV involves an omission since it systematically ignores the natural environment. This omission rendered the existing theory insufficient to identify sources of competitive advantage. Thus, Hart (1995) developed the natural-resource-based view (NRBV) of the firm to overcome this shortcoming. Hart (1995) indicated that strategy and competitive advantage are rooted in capabilities that facilitate environmentally sustainable economic activity. Businesses that develop their skills toward addressing environmental problems in the face of natural environmental challenges will achieve a competitive advantage. This results in lower production costs. Along with pollution prevention and product stewardship capabilities, businesses should work on introducing cleaner production methods. Developing or using cleaner production technologies requires companies to have eco-innovation capability (Munodawafa & Johl, 2019). Most OECD (Organisation for Economic Co-operation and Development) countries recognize eco-innovation as an important solution for today's environmental challenges such as climate change and energy security. In addition, many countries are considering eco-innovation as a source of competitive advantage in the market of rapidly growing environmental products and services (Ekins, 2010)

Eco-innovation is valuable by companies seeking for a way to reduce negative environmental impacts whilst creating a positive competitive advantage. While eco-innovation was handled by Rennings & Rammer (2011) and Horbach et al. (2012) through the subcategories of eco-product and eco-process, it was considered by Cheng & Shiu (2012), Cheng et al. (2014), and Rennings et al. (2006) as eco-product, eco-process and eco-organizational innovation.

Eco-product innovation refers to the reduction of environmental impacts through the significant improvement of new or existing products or services (Reid & Miedzinski, 2018). This innovation aims to reduce environmental impacts (Cheng et al., 2014), improve environmental performance, meet the market's environmental expectations, and increase resource efficiency whilst achieving optimal environmental benefits in the whole product life cycle (Dong et al., 2014). Cleff & Rennings (1999) conducted research in the German industry to determine the dynamics of eco-product and process innovations. Data were collected from the Mannheim Innovation Panel and a telephone survey. Multivariate analysis findings indicated that more than 50% of the companies were focusing on environmental product innovation and there was a significant relationship between environmental products and market objectives.

Eco-process innovation, which requires a change in business processes and systems (Cheng et al., 2014), increases productivity, reduces greenhouse gas emissions, and reduces resource costs (Kemp & Arundel, 1998). Additionally, it replaces harmful inputs, optimizes the production process, and reduces the negative effects of production output. Clean production, zero emissions, zero waste, and material efficiency are realized within the scope of this kind of innovation (Sehnem et al., 2016). Horbach et al. (2012) illustrated that energy and cost savings are the main motivation of the eco-process.

Eco-organizational innovation refers to the business method, process redesign, and responsibilities within the company to reduce environmental impacts (Rennings et al., 2006). This innovation contributes to the technological development of the company and supports the technological innovation factors (Frondel et al., 2007). The business method is the way of doing business in organizations and supports the emergence of product and process innovations; thus, it is important for creating a positive environmental impact. As a result of research conducted for 245 companies in China, Dong et al. (2014) found that eco-organizational innovation had a significant effect on environmental performance and competition. Eco-organizational innovation offers the required infrastructure to gain an environmental perspective and implement innovative applications.

Eco-marketing innovation involves all dimensions of product design or packaging, product placement, product promotion, and prices. According to this, the techniques that lead people to buy eco-innovative products are the main subject of eco-marketing innovation (Sehnem et al., 2016). The buying decision of customers is not only affected by cost, quality, and delivery, but also by the firm's green image and sustainability. Despite its importance, eco-marketing innovation is one of the least emphasized eco-innovation types in the literature (García-Granero et al., 2018). The business may fail because the market is not ready to accept the use of eco-innovative products since these products are not adequately promoted to customers or the eco-marketing activities are inadequate (Fisk, 2010). Characterizing a new product or service as an innovation depends on market success.

Marketing plays an important role in changing consumer behaviors towards ecological products, raising consumers' awareness of resource-saving products, and transferring the benefits of products with reduced environmental impact to consumers. With eco-marketing, consumer-buying behavior is affected in the desired direction and the product can hold on to the market. Therefore, eco-marketing innovation plays an important role in the success of eco-innovation applications.

Porter & Linde (1995) argued that the environmental investments imposed by environmental regulations are seen as costly by companies, but it is possible to turn this into an advantage with eco-innovation. Accordingly, innovative solutions bring about material and energy productivity and reduce the costs incurred by environmental investments. In another study by Cleff & Rennings (1999), the Porter hypothesis is only validated within the scope of product innovation. Pujari (2006) revealed that a new eco-product influences the marketing performance in North American companies. Similarly, Setiawan, et al (2019) determined a positive impact of eco-innovation on marketing performance for Indonesian food SMEs (Small & medium-sized enterprises). Eco-organizational innovation has a positive effect on financial performance in German companies according to Rennings et al. (2006). Aboelmaged (2018) indicated that eco-innovation has a direct impact on hotel performance in the United Arab Emirates. Accordingly, decision-makers can contribute to the hotel's financial (market share, sales) and nonfinancial (image, loyalty) performance through eco-innovation. Rabadan (2019) determined that cooperation in the development and use of eco-innovation is important for performance in the small Spanish companies. Accordingly, companies can improve the sales, profitability, and cost reduction through eco-innovation. Doran & Ryan (2012) found that eco-innovation is more important than non-eco-innovation in determining the Irish company's performance. Cheng et al (2014) and Cheng & Shiu (2012) argue that all eco-innovation types contribute to the financial performance composed of return investment, profits, market share, and sales. Zhang et al. (2019) revealed a positive and significant relationship between green innovation and company performance, as measured by net profitability and growth sales in Chinese manufacturing companies. Despite all these findings, Ghisetti & Rennings (2014) determined that eco-innovation has no profound effect on profitability in the German industry. This is supported by the literature finding that eco-innovation provides positive financial outcomes. It was considered that eco-innovation as economical; the following hypotheses are proposed.

Eco-approaches bring the advantage of economic savings based on sustainable mobility and resource productivity. Accordingly, eco-innovations create a positive environmental benefit along with economic savings. Business methods, products, and processes that decrease environmental impacts lead to a reduced ecological footprint. Eco-innovation ensures the reuse of waste or prevents waste at the beginning of the production process. Eco-innovation applications are aimed at reducing costs or material consumption, minimizing management costs, and utilizing energy and resources more efficiently. These produce a longer product life and financial and environmental benefits (Authority & Alle, 2012).

Eco-efficiency practices caused by eco-innovation create less resource use in terms of products and services, as well as less waste and pollution (Carrillo-Hermosilla et al., 2010) As a result of eco-innovation, internal costs and material consumption are reduced, management costs are minimized, and energy and resources are used more efficiently. Eco-innovation brings about a positive environmental impact along with resource saving (OECD, 2012).

According to the study conducted by Lee & Min (2015) on the Japanese production industry, eco-innovation applications seem to reduce carbon emissions and improve financial performance. Dong et al. (2014) revealed that eco-organizational innovation is most common in Chinese companies, followed by eco-process, product, and end-of-pipe innovation. The results of the research illustrate that all types of eco-innovation have a significant effect on environmental performance and competitiveness. Costantini et al. (2018) determined that eco-innovation is effective in the transition to a sustainable low-carbon economy for production companies in EU countries. According, the eco-innovation directly and indirectly affects the reduction of environmental pressures. The power of this effect differs in the entire supply chain depending on the type of technology used and the level of pollution. As a result of their work to explain the relationship between eco-innovation and "eco-preneurship" Collaboration between eco-preneurs, consumers, and producers leads to long-term sustainability. Fernando & Wah (2017) argue that eco-innovation creates a positive environmental impact. As a result of their study of Malaysian GreenTech companies, they identified a positive relationship between eco-innovation dynamics and environmental performance.

Accordingly, market focus, regulation, and technology positively affect environmental performance. Thus, eco-innovation improves business sustainability. It was explained that environmental performance through resource saving, pollution prevention, and recycling dimensions. According to the literature, eco-innovation has the potential to contribute to environmental performance, so it creates positive environmental effects. Environmental impact can be estimated through evidence and should not be made on assumptions, and these need to be based on a robust understanding of the socio-economic effects of public and industrial intervention. Innovation is expected to diminish amounts of waste, air pollution, and material resource exhaustion and to increase the reuse of other materials, in order to facilitate in the successful transition to circular economy.

CIRCULAR ECONOMY AND BLUE ECONOMY

Waste volumes can be looked on as a resource. Such thinking would also lead us closer to solving the problem of waste. The concept of waste management is alone becoming insufficient for solving waste problems and is even likely to be replaced with the concept of resource management in the future. The circular economy is a regenerative system in which resource input and waste, emissions and energy leakage are minimized by slowing, closing and narrowing energy and material loops. This can be achieved via long-lasting design, maintenance, and repair, reuse, remanufacturing, refurbishing, recycling and up-cycling. This contrasts with the linear economy, which is a ‘take, make, dispose’ model of production (Figure 2).

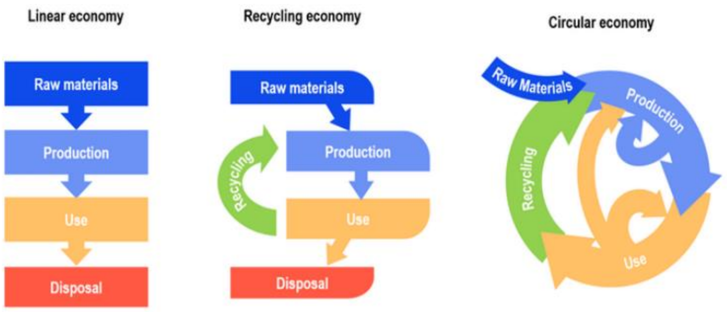

Figure 2. From linear economy to circular economy (Source: https://theconversation.com/the-planned-national-waste-policy-wont-deliver-a-truly-circular-economy-103908)

The circular economy is based on three following principles:
Design out waste and pollution
Keep products and materials in use
Regenerate natural systems

ENVIRONMENTAL INNOVATION

Environmental degradation is an important issue in the field of economics and has got considerable attention from different researchers and economists since decades. Countries are facing major problems of global warming due to continue increase in carbon emission. Several factors have been identified recently that cause environmental degradation where governments are trying to tackle these problems that influence environmental quality by Shahbaz et al. (2013). The impact of trade openness on environment has also explored by enormous researchers in the prevailing studies but got mixed results and conclusions.

Le et al. (2016) illustrate that openness to trade increase carbon emission and degrade environmental quality. On the other hand, Jayanthakumaran & Liu (2012) argue that openness to trade is an important factor that enhances environmental quality through composition, trade and technique effect. It was argued that trade openness positively affects carbon emission, and this effect varies on different levels of carbon emission; however, they show that the indirect effect of trade openness on emission is positive while indirect effect is negative. The impact of innovation on environmental quality has also been debated by several scholars in the preceding literature. Rennings (2000) argues that environmental innovation is a modified process, systems or practices which give benefits to the environment. It was emphasized that innovation increases sustainable development toward cleaner production. Dauda et al. (2019) illustrated that innovation reduces carbon emission. Yuan et al. (2021) studied green innovation and institutional quality on carbon emission. They have found that green innovation reduces carbon emission and that institutional quality has a moderating negative association between carbon emission and innovation. Hodson et al. (2018) noted that energy efficiency is increased by innovation, and then, it in turn reduces carbon emission. While Mensah et al. (2018) studied this association and found inconclusive outcomes for some individual countries in their sample. Additionally, some studies argued that excessive innovation may increase emission; however, if there is strict regulation regarding environmental quality in countries, it will lead to green paradox and will effect economic growth negatively. However, if there is a high potential, it will lower carbon emission though excessive innovation by Huiqing Wang & Wei (2019).

Economic growth has been considered as a key driver of emission over the past several decades. Grossman & Krueger (1995) argue that the relationship of economic growth and carbon emission depicts a U-shaper reversed link. The EKC (environmental Kuznets curve) suggests that there is environmental issue in countries in the early phase of growth by Liang and Yang (2019). On the other hand, some researchers have shown interest in the linkage between financial development and carbon emission such as Shahbaz et al. (2013). Some studies illustrate that an increase in financial development increases carbon emission such as Diallo & Masih (2017), while some argues that financial development is an important factor for economic growth of a country. Likewise, some environmental economists argue that financial development enhances the quality of environment because well-structured financial institutions with sound policies provide support to green technological innovation and renewable energy projects, which are useful to protect environmental quality. However, some authors support the negative impact of financial development on environmental quality such as Lee et al. (2015); Khan et al. (2020a, b); Jiang & Ma (2019).

Likewise, the impact of foreign direct investment on carbon emission has also been investigated widely by several researchers.

Some researchers show that the inflow of foreign direct investment is harmful for environmental quality such as Zhu et al. (2019); however, some researchers state that the inflow of foreign direct investment (FDI) reduces emission by Huang et al. (2019). Institutional quality is another crucial factor that positively contributes to environmental quality. Normally, environmental degradation in developing countries is associated with the poor quality of institutions such as political institutions because poor level of institutions weakens the regulations regarding environment by showing a bias implementation of environmental regulation and policies. The institutions and governance might be required to efficiently explore the trade environment relationship (Bekhet et al., (2020) as institutions of a country play an important role to provide policies related to trade, which might be helpful to protect environmental quality. A lot of researchers are in favor of positive impact of institutional quality on environmental quality such as Ali et al. (2019) and Ibrahim and Law (2016) argue that high-quality institutions and good governance enhance the quality of environment. Wu et al. (2021) illustrated that quality institutions above the threshold level do not contribute significantly for environmental deterioration in spite of growing transportation and increasing industrialization. Based on the ongoing debate on trade environment relationship, the current study explores the association of innovation, quality institutions and trade openness with carbon emission. Therefore, it has been a challenge for the government and policy makers of a country that how to protect the quality of environment as well to ensure higher economic growth through trade openness. The findings of Khan et al. (2022) showed that trade openness have a negative impact on carbon emission in our sample and models in the presence of innovation and institutional variables. We also explore the role played by institutions in this association to know whether the quality of institutions is important to protect and enhance environmental quality as well to achieve the economic growth in the presence of high level of trade.

INNOVATION AND CO_2 EMISSION

Europe is the world's third-largest carbon emitter after China and the USA. However, it takes steps for environmental protection by implementing effective limitations on greenhouse gases. The ecological concerns of the central-eastern region are quite similar to pan-European ones. The most important of them is climate change, caused by CO_2 emissions increasing the greenhouse effect in the atmosphere. These are expected to be 50% higher than preindustrial levels by 2030, with a temperature rise of 1.5 to 4.5°C (Qiang et al. 2019).

Innovation has been considered one of a new factor in the growth environment nexus, and it has been argued that it significantly contributes to environmental quality. For instance, a study conducted by Hodson et al. (2018) states that innovation reduces carbon emissions owing to efficient use of energy and cost-effective ways to lower the emissions of carbon dioxide. Similarly, Cagno et al. (2015) have conducted a study where they illustrate that innovation advances the efficiency of energy and thus reduces the use of nonrenewable energy use, which in turn reduce pollution. Alvarez-Herranz et al. (2017) studied the nexus between economic growth, innovation and carbon emission. They state that innovation helps move the economy to the use of sustainable energy sources and production.

Likewise, Cai and Zhou (2014) argue that innovation is an important factor which helps mitigate environmental pollution. Countries are trying to enhance innovations to response climate changes Carraro & Siniscalco (1994). However, on the other hand, Dauda et al. (2021) have studied innovation, carbon emission and trade openness in African countries for the period of 1990–2016. They have employed fixed-effect and GMM models where their findings validate an inverted U-shape association between carbon emission and innovation at the panel level in some countries, while renewable energy use reduces emission in the panel. They also found that human capital reduces carbon emission in some individual countries as well in the panel. Their results also confirm pollution haven hypothesis, halo effect and environmental Kuznets curve. Similarly, Mushtaq et al. (2020) have studied the impact of economic growth and income inequality on carbon emission in China through the moderating role of innovation at regional and national levels. They have collected data for the period of 1995–2015 and employed panel econometric techniques. They found that income inequality and economic growth affect carbon emission in China where innovation has a moderating role in this association. Consequently, Tobelmann & Wendler (2020) have studied the impact of innovation on carbon emission in EU-27 countries for the period of 1992–2014. They have employed GMM model and proxies patent application for innovation. They found that innovation has no contribution to reduce carbon emission, while general innovative activities do not influence carbon emission. They further indicate that this effect might be small comparatively to the effects of increased economic activities. They also conclude that the effect of innovation varies across different countries and regions with less developed countries showing higher level of heterogeneity. Likewise, Cansino et al. (2019) have studied technological progress and quality institutions on environment. They have found that income and greenhouse gas emission are adjusted to traditional EKC hypothesis. They states that technological progress and quality institutions enhance environmental sustainability, while foreign direct investment (FDI) and international trade have a negative impact on environment.

ECONOMIC GROWTH AND CARBON EMISSION

Over the last few decades, environmental deterioration has accelerated significantly. Environmental degradation has been a subject of research across the world because of its impact on billions of people. However, there has been no international agreement on lowering the utilization of energy and CO_2 emissions (CO_2), while demand for fossil fuels grows in emerging economies. On the other hand, the recent COP26 summit brought all parties together to accelerate action toward reaching the goals of the Paris Agreement and the UN Framework Convention on Climate Change. Although previous research shows that international trade promotes positive socioeconomic outcomes, other experts argue that it contributes to natural resource shortages and ecological deterioration. Thus, the current research considers the effect of international trade, renewable energy use and technological innovation on consumption-based carbon emissions (CCO_2), coupled with the role of financial development and

economic growth in the BRICS economies between 1990 and 2018. Moreover, this research utilizes the common correlated effects mean group (CCEMG), augmented mean group (AMG) and Dumitrescu and Hurlin (2012) causality methods to assess these interrelationships.
The relationship between environmental quality and economic growth is widely studied by large number of researchers by using EKC (environmental Kuznets curve) framework. Based on the EKC framework, real output degrades environmental quality till a certain level of growth and then pollution becomes decreasing when GDP reaches a certain level. Hence, such association is an inverted U-shape Grossman & Krueger (1995). As a result, people of countries demand the government for environmental laws to enhance the quality of environment. Individuals turn to be highly concerned at a higher income level about health issues and hence insist on environmental quality that leads to policy implication to restrain carbon emission and enhance environmental quality. Additionally, if there is a smooth development of the economy composition, which is largely moved from polluted industries to innovative activities and production, as well service-oriented production, the pollution in those countries will have enough minimization. Some other studies have used the absence or presence of EKC using different methods and pollutants. Osobajo et al. (2020) examine the impact of energy consumption and GDP on carbon emission. They employed fixed-effect and OLS models to the data for 1994–2013. They found a bidirectional causal relationship of these variables with carbon emission while unidirectional relationship of energy with carbon emission. The findings of OLS model and fixed-effect model show that GDP and energy consumption increase carbon emission. Abid (2016) has tested environmental Kuznets curve in MENA and European Union counties. They have used GMM model where their findings show a monotonic increasing impact of GDP on carbon emission in both samples. Tamazian & Rao (2010) studied the relationship between economic growth and environmental quality. They have also focused on the impact of financial and institutional quality on environment as well. Their findings support the EKC hypothesis and state that financial development and institutional quality are important for environmental quality development. Since the last few years, the CO_2 emission-economic growth nexus (with other variables) have been discussed internationally with its importance for human wellbeing.

ECODESIGN AND ECO-INNOVATION

Ecodesign aims to reduce the environmental impact of the product throughout its life cycle: from materials extraction, through production processes, packaging and transport, product use phase, and finally to end-of-life disposal. Ecodesign includes the use of quantitative environmental analysis tools such as Life Cycle Analysis (LCA) tools. The results from Ecodesign are limited because it is a design specific activity that focuses on the redesign or optimisation of existing products. The changes to the products tend to be incremental and result only in percentile reduction of the overall environmental impact of the products (Hoed, 1997). Ecodesign can improve a company’s competitive advantage by supporting expansion into new markets, through the launch of new versions of products with environmental attributes which consumer’s desire.

LIFE CYCLE THINKING

The depletion of some natural resources, rising commodity prices, environmental regulations that constrain the use of the artefact, in line with the requirements of eco-compliance and the need to continually reduce costs are driving companies to seek new ways to optimize their consumption that can be controlled from the design phase through a PLM environment.
Sustainable design is not one-size-fits- all concepts, but must be adapted on the life cycle (Figure 4) profile of the specific product, the business strategy, and the culture and capabilities of the organization. Further, it can be applied to both goods and services (Dobbs & Cormican, 2007). In this study, drawing on the insights of the DATA: Oslo Manual (2005) prepared by the OECD and European Commission, it was evaluated eco-innovation as including the concepts of eco-product, eco-process, eco-organizational, and eco-marketing innovation dimensions.

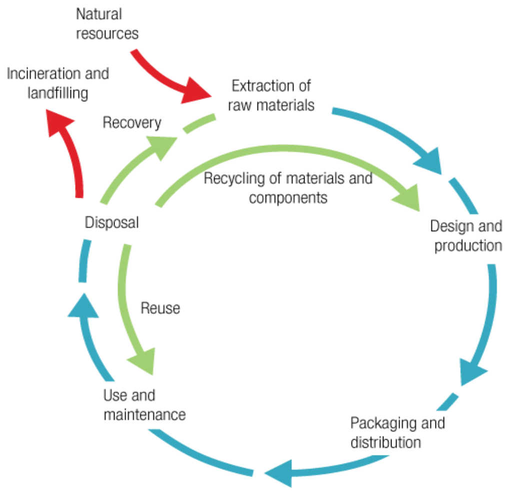

Figure 4. Life Cycle Thinking (Source:www.lifecycleinitative.org)

GREEN GROWTH

Sustainable economic growth and poverty reduction objectives can be achieved through green growth strategies. The economic growth and development of any economy can be threatened by the Depletion of natural resources and envi ronmental destruction. In 2005, the United Nations proposed green growth as the ultimate solution to achieve sustainable development. The Organisation for Economic Co-operation Development (OECD), 2012 defines green growth as a new means of fostering development and economic growth in a country while causing no harmful impact on the environment or people living in it (Wang et al. 2020).

Green growth has drawn the attention of the masses around the world, and a plethora of research has been conducted to understand the concept of green growth in different countries across the globe (Wang & Shao 2019). Green growth provides a solution to the environmental crisis and helps achieve sustainable economic growth while flourishing the interests of the population (Barbier 2016). Green growth promotes cleaner energy sources and reduces environmental pollution by lowering the emission of CO_2 and other GHGs (Sandberg et al. 2019). Several authors have argued about multiple determinants of green growth, but have agreed on all factors that help develop and sustain economic, environmental, and social interests (Hao et al. 2021).

Scholars (Hao et al. 2021) have recently emphasized the role of technology in promoting green growth development. However, the effect of technological innovation on green growth is much debated in the field. Therefore, based on the aforementioned contradictory literature and with purpose of exploring the impact of technological innovation on green growth in the context of a developing country, Abid et al. (2022) propose the following hypotheses:

Hp1: Patent application is positively related to green growth.

Hp2: R&D is positively related to green growth.

Hp3: Green forms of organizational innovation (i.e., Environmental Management Systems: EMS) are positively related to green growth.

Hp4: Energy consumption is negatively related to green growth.

Hp5: Population growth is negatively related to green growth.

GREEN ORGANIZATIONAL INNOVATION AND GREEN GROWTH

Daunting environmental challenges call for organizational support to preserve and protect the environment. Environmental Management Systems (EMSs) are the environmental sustainability tools that help organizations address environmental challenges and ensure environmental sustainability. A number of EMSs exist, but ISO 14001 is the most adapted management standard worldwide.

ISO 14001 was established in 1996 by the International Organization for Standardization (ISO), and it has been revised over the years. ISO 14001:2015 is the latest version with a set of updated requirements to improve environmental performance (da Fonseca 2015). After ISO 14001, the second most famous EMS standard is the Eco-Management and Audit Scheme (EMAS) designed and established by the European
Regulation EC 1221. EMSs make organizations follow specific rules to handle environmental management aspects both internally and externally (Chiarini 2017).
According to Könnölä & Unruh (2007), EMS is a substantial part of managerial innovation, ensuring efficiency in process control, production improvement, and product quality. Hence, EMS can be seen as a management standard applied to the whole industrial network. Curkovic & Sroufe (2011) argued that EMS is not just a part of environmental improvement; an organization can also use EMS to create a positive public image and involve managers from different hierarchical levels to engage in innovation.
Similarly, the said EMS is a key instrument introduced to promote product innovation. The research conducted by Kammerer (2009) reveals that green practices (drawn from EMS) and innovations in an organization share a positive relationship. EMS ensures environmental efficiency and enhances organizational innovation capabilities (Darnall 2006).
The literature shows the importance of EMS in environmental protection and sustainable development, but despite adopting ISO-14001, contradictory results worldwide make it controversial. There is no globally unified EMS result (D’Souza et al. 2019), which has forced this study to incorporate EMS into its framework and verify its role in green growth development in Pakistan with other variables. There is a direct relationship between EMS and green growth, and it is presented in Figure 5.

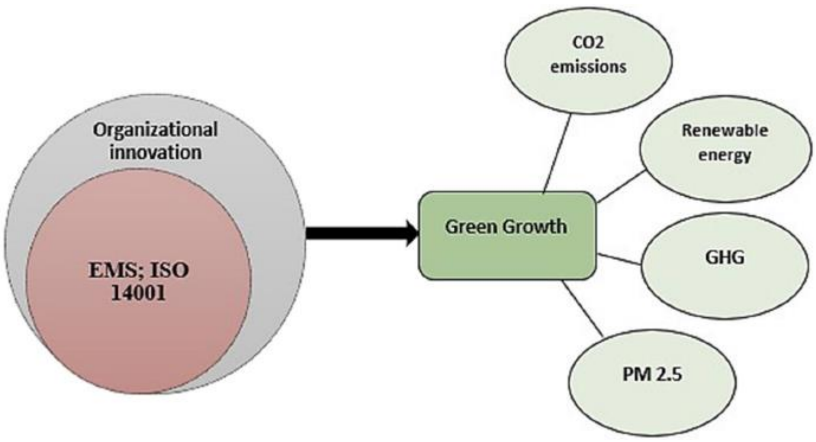

Figure 5. EMS and green growth (Source: Abid et al., 2022)

Air pollution is the most important driver of global warming, despite the fact that there are numerous forms of pollution. Greenhouse gas emissions (GHGs) are at the heart of air pollution, which are largely propelled by CO_2 emissions. Because CO_2 is seen as the greatest threat to the environment, governments have established commitments through the recent COP26 to further accelerate their efforts toward achieving the objective of the Paris Agreement and the UN Framework Convention on Climate Change, which is to minimize the emission level. CO_2 emissions have become the subject of numerous studies aimed at comprehending the factors that drive it. The bulk of this research used the STIR-PAT or Environmental Kuznets Curve (EKC) frameworks to examine population and income, concluding that these economic indicators are the primary cause of CO_2 emissions. However, these studies are not completely helpful, considering that the ultimate objective of any study is to advise policymakers on the implementation of relevant policies.
Abid et al. (2022) used the following analytical model summarizing all the hypotheses and variables used in the study which is reported in Figure 6.

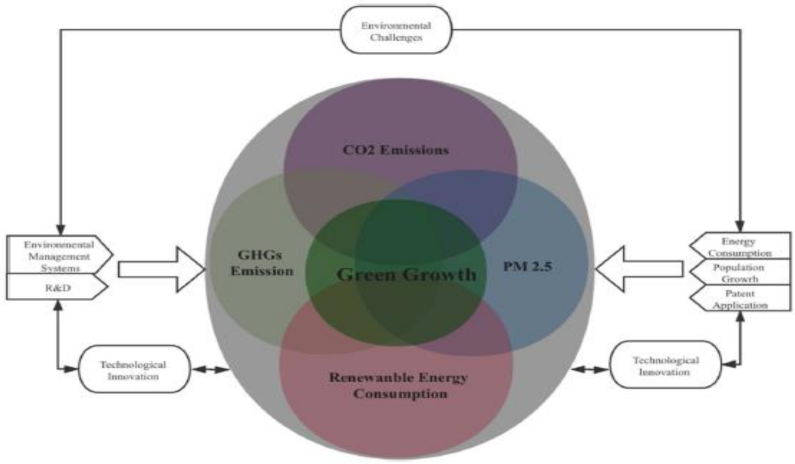

Figure 6. Conceptual model (Source: Abid et al., 2022)

TECHNOLOGICAL INNOVATION AND ENVIRONMENTAL CHALLENGES

Technology is one of the prime factors that organizations have been using to excel in performance and constantly impact humans and the environment (Li et al. 2019). Environmental awareness has made policymakers realize that technology intensifies environmental issues, and progress leading to environmental catastrophes is not advisable. Therefore, a shift has been observed to upgrade traditional technology to green or clean technology through resource efficient innovation and to substantially reduce environmental pollution (Schiederig et al. 2012).

Green innovation(Tseng et al. 2013) is divided into four categories:

managerial,

product,

process, and

technological innovation.

Technological innovation preserves environmental interests through the deployment of green technology that accelerates the process of green growth, which ultimately reduces the potential threats of climate change to human lives (Li & Long 2020). Johnstone et al. (2010) suggested that technological innovation is imperative for green growth development. Danish & Ulucak (2020) examined how technological change affects green growth in BRICS countries.

Using CO_2 as a proxy for green growth, the authors argued that technology is critical in green growth transition.

Ahmad et al. (2020) considered technological innovation to be an essential determinant of green growth. They stated that technological innovations transform traditional technology into a cleaner one to protect the environment and improve operational efficiency. This study is endorsed by previous research by Aghion et al. (2016) who argued that technological innovation should be blended into policy plans to promote green growth. Figure 7 presents the relationship between technological innovation and green growth.

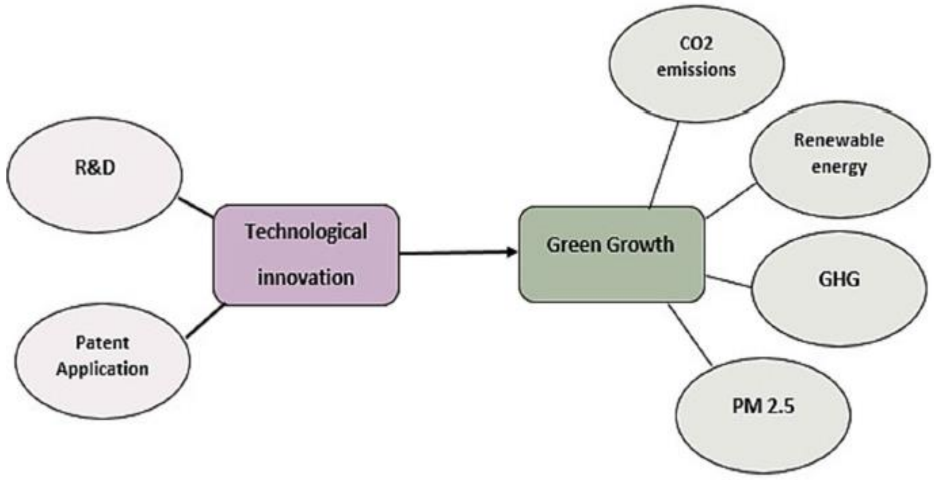

Figure 7. Technological innovation and green growth (Source: Abid et al., 2022)

Technological innovation is a tool to address environmental challenges, reduce the potential climate change threats posed to human lives, and sustain economic interests (Li & Long 2020). Technological innovations have played a crucial role in transitioning society from a traditional economy to a green one. Technological innovation supports green energy production so as to channel the development of green growth and help transform technological practices in operations and production processes within organizations (Umar et al. 2020).

According to Song et al. (2019), transformative technology innovation helps meet national energy demands by promoting cleaner technologies that reduce CO_2 and other harmful emissions.

Wang et al. (2021) suggested that technological innovation acts as a catalyst to boost green growth. In addition to technological innovation, some organizational innovations, such as Environmental Management System (EMS), can help firms reduce the impact of their production. EMS is one of the widely adapted environmental sustainability tools that help public or private organizations engage in systematic processes to tackle and solve environmental issues and lower harmful impacts (Coccia & Watts 2020). However, many researchers have given less attention to renewable energy sources and green growth and their impact on CO_2 emission. More attention is warranted to assess the impact of technological innovation, green growth, and renewable energy sources on CO_2 emissions. Less energy is used when an economy adopts efficient technology. Changing the energy structure and adopting renewable energy are highly associated with technological innovation. Renewable energy sources are the fastest-growing energy sources.

Although the nexus between CO_2 emission-growth-environmental taxes and renewable energy is well studied in various analyses, their results are inconclusive; a more deep investigation is required to re-examine the association between energy-growth and CO_2 emission.

COOPERATIVE GREEN INNOVATION

Environmental quality development is one of the most important environmental challenges that have been confronted by innovations (Zhang et al. 2017). The green innovations, environmental policies, and carbon taxes are the tools to achieve sustainable development goals (SDGs) in the mitigation process. Cooperative green innovation is an important tool to cope with global climate change and this study highlights cooperative green innovation with game theory. Some interesting conclusions are achieved. First, emission tax stimulates the innovation for all firms. Second, free-rider phenomena appear in cooperative green innovation. When the cooperative green innovation requires big investment, firms have intention to launch free-rider. Finally, the underinvestment of cooperative green innovation exists (Nie1 et al., 2022). Therefore, cooperative green innovation seems very popular and pushes the technologies to reduce emission. It is necessary to further investigate cooperative green innovation to dig out the difficulties in cooperative green innovation and to encourage cooperative green innovation.

Green innovation is attracting more and more importance all over the world in recent years (Bhatt & Singh 2020; Wang et al. 2020). On one hand, green innovation both improves energy intensity to a great degree (Wurlod & Noailly 2018; Wen et al. 2021) firm's performance (Zhang et al. 2019) and promotes corporate advantages in competition (Nie et al. 2021b). On the other hand, green innovation is affected by multiple factors, including social preference (Bhowmik et al. 2018), corporate governance (Amore & Bennedsen 2016), taxes (Chen & Nie 2016), subsidy policies (Chen et al. 2020a; Yang et al. 2019b), environmental policies (Chen et al. 2017; Brunel 2019; Chen et al. 2020b), market power (Nie et al. 2021a; Chen et al. 2021) and so on (Sun & Nie 2015).

Acemoglu et al. (2016) considered green innovation and suggested policies combined with subsidy and environmental tax to improve green innovation. Wang et al. (2017) argued that green insurance improves green innovation investment because insurance reduces the risk of uncertainty in innovation. Nie & Wang (2019) argued that resource constraints deter innovative investment, including green innovation and cost reduction R&D.

Yang et al. (2020) recently developed optimal subsidy policy to promote green technology. Nie et al. (2019a) considered green innovation under trading energy efficiency and concluded that trading energy efficiency improves green innovation. Moreover, Nie et al. (2019a) argued that trading energy efficiency combined with carbon tax promotes innovation to a great degree. Chen et al. (2020b) compared the effects of tax on green innovation with cap-and-trade system and concluded that cap-and-trade system is more efficient than carbon tax to stimulate green innovation. Wang et al. (2021) addressed green finance affecting innovation and found that ordering finance promotes innovation. Recently, Song et al. (2019) examined the large-scale data affecting green innovation. Martínez-Ros & Kunapatarawong (2019) found that knowledge has significant impact on green innovative investment and suggested to make use of all information.

Actually, institution affects green innovation extensively and it is important to establish mechanisms to incentive green innovation. Yuan & Xiang (2018) identified that environmental regulation improves green innovation for Chinese manufacturing. Sun et al. (2019) further argue institutional quality has significant effects on green innovation and energy efficiency. Stucki et al. (2018) summarized various institutions impacting green innovation and proposed some new policies. Nie et al. (2017) compared various types of subsidy affecting green innovation and show that output subsidy is better than input subsidy. Contrary to the complete information, under uncertain situation, Chen et al. (2020a) showed that input subsidy reduces the risk and recommended input subsidy for agricultural sector and other industries with high risk to promote innovation intention.

Especially, because renewable energy consumption has very low emission in practice, a special type of green innovation, renewable energy development, is attached importance by scholars (Yang et al. 2019a). Sun & Nie (2015) addressed the policies to develop green energy under oligopoly market structures and found that market power has significant impact on the efficiency of policies. Sun & Nie (2015) stressed that the subsidy should consider market structure to improve subsidy efficiency. To avoid cheat behaviors in subsidy, Yang et al. (2016) designed subsidy mechanism for renewable energy based on outputs under incomplete information and argued that the designed mechanism can avoid cheat behaviors to a certain degree. Yang et al. (2018) identified the projection competition between regions to launch green innovation with renewable energy. Taken the time cost into account, Yang et al. (2019) considered optimal subsidy time to develop renewable energy and concluded that the subsidy patterns heavily depend on the dynamic properties of projects in detail.

A typical example about cooperative innovation is CERN (European Organization for Nuclear Research), which was established in 1954 by 12 founding states and made significant achievements in physics, computer fields and so on. Now, CERN owns 23 members. (https://home.cern/ about/ who-we-are/our-governance/member-states) Thus, cooperative innovation is an important issue in both economics and society (Nie et al. 2019b), and the theory about cooperative innovation is developed in recent years. For example, Acemoglu & Wolitzky (2020) recently compared community enforcement with specialized enforcement to promote cooperative innovation and argued that the equilibrium depends on the properties of agents.

Bosch-Sijtsema & Postma (2009) developed the theory about cooperative innovation, including stimulating polies and governance mechanism. By compared cooperation with non-cooperation, Karbowski (2019) highlighted the effects of cooperative R&D on firms' performance and identified that profit-incentive firms prefer cooperative R&D and cooperative innovation promotes the outcomes of innovation. Rare literature about cooperative green innovation is launched in recent years. In practice, to cope with global climatic change, it is crucially necessary to launch cooperative green innovation.

CONCLUSIONS AND SUGGESTIONS

Financial inclusion is a vital organ in the development of any financial structure and helps the economy to grow. On one side, it is mandatory for the growth of any economy due to the increased availability of financial services and products to the majority of the population in the country. On the other side, due to improved financial inclusion, the consumption and production activities in the economy also increase which causes the energy demand to rise and consequently the CO_2 emissions in the economy rise. Perhaps, nothing is more important today for businesses and societies than the management of the global and local environmental changes that are degrading all aspects of life—a trend at risk of worsening for future generations. As major polluters, enterprises are expected to behave responsibly toward the natural environment. However, enterprises often do not pay enough attention to the environment and may even be environmentally irresponsible. Encouraging enterprises to actively accept environmental responsibility is the key to solving the problem of environmental pollution. Innovation is an important factor for environmental quality is it brings new technological innovation and it increases energy efficiency, which is beneficial for environmental quality improvement. The study investigated different factors associated with environmental quality. It was found that innovation positively affects carbon emission, while it enhances environmental quality when it reaches a certain level. Countries should focus to enhance innovation and green technologies, considering that global warming and environmental problems encounter. The findings indicate that trade openness is negatively associated with carbon emission, which evidences that trade is related to the advance method of production and stimulates environment. Countries should further encourage globalization and trade openness, which can transfer green technology and new knowledge, which are beneficial for environmental quality. Therefore, the policies related to climate change alleviation in most countries should widely concentrate to convert nonrenewable energy to renewable energy since it is environmentally favourable. Financial development in panel countries is still weak to provide funding to environment-friendly projects; however, financial development should give special focus to facilitate green projects in countries and provide incentives for the improvement of environmental quality. Financial institutions and banks should engage in those activities and projects, which recognize the importance of environmental problems. These investigations illustrate that financial development is positively associated with carbon emission; however, financial institutions can play an important role in establishing policies regarding environmental quality. The study on the impact of institutional quality on environment indicates that strong institutions boost environmental performance, while weak institutions are associated with environmental harm. The improvement of national laws and regulations are important to enhance environmental quality. The quality institutions may also encourage the spill over of technology through the inflow of foreign direct investment (FDI) because quality institutions control other related factors including service quality, civil rights, corruption, politics and accountability and play an important role in enhancing environmental governance to maintain resource utilization. It is suggested for the countries that strengthening institutions are the most important factors that enhance environmental quality because institutions quality is associated with other factors such as foreign direct investment, energy usage and financial development. The findings suggest the panel countries to focus on institutional quality factors as these factors are important in safeguarding environmental quality. This study is important for the countries to concentrate on these factors to achieve higher level of environmental quality as well as to enhance economic growth as well as it suggests to regulate innovative investment and to subsidize to improve cooperative green innovation. Future empirical studies can examine the nonlinear impact of financial inclusion on green growth and the environment. The future comparative country-wise empirical analysis will be more helpful in the context of economic and environmental implications.

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Article submitted to the Proceedings Book of the VIth. International Symposium–2022, *Theme: “Biosphere & Environmental Safety”*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

FREQUENCY DISTRIBUTION OF HEAVY METAL CONTENTS IN NATURAL, URBAN AND MINING LOCATIONS IN MONGOLIA

Ariunkhishig MUNKHSUKH, Hosam E. A. F. BAYOUMI HAMUDA

*Institute of Environmental Engineering and Natural Sciences, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Budapest, Hungary, ariunkhishig0888@gmail.com, *E-mail: Bayoumi.hosam@uni-obuda.hu, +36303900813*

As there are just a few researches on heavy metals in soil in Mongolia, the examination will be led to investigate the presence of any harmful metals in 22 samples with ICP-OES technique which is the most elemental analysis technique. Samples will be collected from mining area which is in the desert, urban area in the capital city and mountainous local city in Mongolia. The study will focus on determining the spread of heavy metal contents as well as its health risk assessment and contamination level. The results will be analyzed with Mongolian standard for toxic chemicals in soil. The modifications used to immobilize the pollutants may not be specialized for a certain metal, resulting in the release of a hazardous metal into the soil. Therefore, there will be a need for developing new methods that can effectively lead to removal of heavy metals from the contaminated soil. The dissertation will include: Introduction and aim, Literature survey, Materials and method, Result, Discussion, Recommendation and further tasks, Summary, Acknowledgement and References.

***Keywords**: distribution, heavy metal contents, natural, urban, mining locations, Mongolia*

INTRODUCTION

Because of the rapid rise of industry and agriculture and the disturbance of natural ecosystems caused by anthropogenic pressure connected to the human population increase, soil pollution with heavy metals poses a danger to the environment and food security. Pollution with heavy metals and human exposure are created by various anthropogenic activities such as mining, industrial production, and the usage of metal-containing chemicals in domestic and agricultural contexts. Also, there are different ways to pollute the cities and other locations with human beings even the people themselves can contaminate the local areas. Metal contamination is one of the leading problems in Mongolia. Furthermore, citizens living in polluted areas face healthy living shortages. It was found that the lack of right urban planning system, particularly in Ulaanbaatar (The capital of Mongolia), can increase the waste disposal materials, which may contribute to heavy metal contamination of soil. The hazards of polluted materials should be monitored frequently in various ecosystems such as hydrosphere, lithosphere, including the living systems too. This ecological investigation will provide helpful knowledge on how these hazard materials are frequently occurred in different habitats regarding to their fate and bioaccumulation and also, how these materials joined or transferred to the food web.

The primary heavy metals that pollute the topsoil in Ulaanbaatar are Zinc (Zn) and Chromium (Cr); which are originated from industrial waste, ger area chimneys, stove ash, waste, power plants, and fumes and ash from power plants, the operation of the market center. Exceeding the maximum allowable levels in the soil is harmful to the local environment and for living organisms. Ulaanbaatar has a high level of soil microbial contamination and a low overall level of heavy metal pollution in comparison with other Mongolian cities, but excessive pollution is observed in some areas for example, the ger locations. The leading causes of microbial contamination are ger areas pit latrines, open latrines, and household waste. To determine human health and environmental risks, it is required to analyze level of heavy concentrations in different investigated ecosystems.

PUBLIC HEALTH ASSESSMENT OF HEAVY METALS IN THE MONGOLIAN SOIL

The thesis work has investigated heavy metal contents in the capital city (Ulaanbaatar), mining field (Dundgovi), and one of the provinces (Arkhangai), while further study aimed to analyse the samples from 3 different major cities in Mongolia. All of the measured samples were collected from urban areas, and heavy metals in these areas affect the human body through respiration, consumption, and dermal ingestion. Few studies explain that one of the main factors polluting the biosphere is the influenced by human activities such as consumption of fuel, power station, power generation, household, pit latrines, etc. For example, lead, zinc, and copper are metals that come from traffic pollution, while nickel can be found in the environment, cadmium from industrial contamination, and chromium from the air. Accordingly, the determination of heavy metals would be the best scenario to consider public health as well as food safety. According to the Table 1, arsenic and lead were found very high in Ulaanbaatar city (capital city), while chromium and nickel elements were found in high amount in Erdenet. In Darkhan city, the arsenic content was lower than in other cities, while the content of other elements was higher. More specifically, arsenic content was the highest in all cities, while zinc was the lowest. Erdenet had a high content of heavy metals due to large-scale mining operations, while Darkhan may have had lower output than the other two cities due to less population and less transportation [2].

Table 21. Heavy metal concentration with their background values in the soil of three different cities in Mongolia (Source: [1])

City	Type of Indication	As	Cr	Pb	Ni	Zn
Ulaanbaatar	Concentration	28.04	16.56	43.11	21.26	106.11
	Background	14.17	13.04	37.91	14.74	114.10
Erdenet	Concentration	12.78	65.70	18.06	29.30	155.17
	Background	4.00	60.00	15.00	18.60	77.80
Darkhan	Concentration	3.33	31.90	20.90	19.49	67.26
	Background	3.33 [1]	38.20	46.66	12.73	52.30
	MPC	6.00	150.00	100.00	150.00	300.00

HEAVY METAL POLLUTION AROUND A COAL-MINING REGION

The study included heavy metals from Chinese coal mines: copper, lead, zinc, cadmium, chromium, arsenic, mercury and nickel. Nowadays, those metals which are main factors of plant growth and health are exceeding the limits which are affected by mining and natural alterations, affecting public health and soil quality. From the Table 2, it can be concluded that all 7 elements exceeded the standard [2].

HEAVY METALS IN SURFACE SOIL BASED ON SEMIVARIOGRAM

To provide more scientific knowledge about soil quality around the mining area, it is necessary to investigate and analyse the distribution and investigating the locations of heavy metals. Heavy metals from mining activities are enriched to specific levels, resulting in soil contamination. With the improvement of Information Technology, the study had access to do the investigation with geo-statistics in GIS while traditional investigations mainly focused on laboratory analyses. But these methods are both work effectively to examine heavy metal distribution. A spatial distribution plays key role in cleaning pollutants and preventing from upcoming errors. [3].

In Inner Mongolia, which is located in China has severe problem with heavy metal pollution because it has big source of mining. This study was focused on open-pit mining which collects a large collection of solid waste that has included heavy metal ions which might leak into soil through erosion and rainwater runoff. The coefficient of variation method indicated that zinc has small fluctuations while other elements (chromium, copper, manganese and nickel) had moderate fluctuations which mean the soil around the mining area got polluted by human activities. In this study, Maximum Difference Analysis has determined that copper and zinc contents are higher than the standard limitation in Inner Mongolia. A stepwise regression model was used in the study to provide more quantitative data. Overall, the statistical analysis can effectively summarize the distribution of metals but also supplements the traditional research techniques of soil properties. As a result, the heavy metal content in the center of the mining area was the highest in comparison with east and north side of the studied area. The effect of diffusion is also one of the considerations of heavy metal distribution. Because there is no river around the area, the distribution of heavy metal could change the content of the metals in soil [3].

Table 2. Heavy Metals content of the soil (Source: [2])

Statistical parameter of HMEs	Hg	Cd	As	Cu	Pb	Ni	Zn
Maximum	0.17	0.56	11.30	42.61	63.52	49.77	129.29
Minimum	0.01	0.03	4.21	9.82	19.66	13.24	31.32
Mean	0.03 ± 0.003	0.20 ± 0.016	8.99 ± 0.168	26.55 ± 0.753	27.62 ± 0.798	29.61 ± 0.644	66.68 ± 2.7
Median	0.02	0.18	9.16	26.09	26.38	29.83	64.50
Standard deviation	0.02	0.12	1.28	5.74	6.07	4.91	21.17
Variable Coefficient/%	66.67	60.00	14.24	21.61	21.99	16.57	31.75
Soil background value of Shandong Province, China	0.019	0.084	8.6	24.0	25.8	25.8	63.5

INFLUENCE OF DIFFERENT URBAN STRUCTURES ON METAL CONTAMINATION

Metals pose a threat to public health because they can have various adverse health effects. Metal toxicity is caused by the potential production of highly reactive species, such as reactive oxygen species (ROS) and other free radicals, which can cause DNA damage, protein depletion, and lipid peroxidation. Although some metals, such as Copper (Cu), Zinc (Zn), and Chromium (Cr), are necessary for human nutrition, an excess of them poses several health and environmental risks. Cr, for example, is classified as a human carcinogen by the International Agency for Research on Cancer (IARC) due to its potential mutagenic properties. Furthermore, Cr toxicity has a significant impact on plant biological processes. Some metals, such as Lead (Pb) and Aluminium (Al), have no known beneficial effects on living organisms. On the other hand, Pb is classified as possibly carcinogenic to humans by the IARC. Chronic exposure to Pb causes infertility, paralysis, mental retardation, brain and kidney damage, and other health problems. Al is known to cause a variety of human diseases, including Alzheimer's. As a result, metals rehabilitate pollutants in the environment and living organisms. Metals are produced by various anthropogenic and natural processes, such as weathering the Earth's crust, industrialization, and mining. However, heavy traffic is a significant source of metals in urban areas. Metals associated with dust are transported away from the sources of generation by wind and settle in urban areas. As a result, metal exposure risk in various metropolitan cities has become a significant concern for public health practitioners. Each town has a distinct urban structure and land use pattern, resulting in varying contaminant exposure levels for its residents. The arrangement and relationships of the arrays of services, goods, and residents create a distinct urban structure for each metropolitan city, which changes over time. The impact of urban design and land use distribution patterns on the environment is poorly understood [4].

SOIL POLLUTION

Soil is one of the most important factors in human life on earth, but it is often polluted by human activities. [6] Many human activities, such as waste disposal, industrial waste, military training, and farming reduce soil quality with high levels of toxicants [7]. There are various types of pollution, one of which is heavy metal pollution, caused by toxic levels of heavy metal pollutants [8]. Heavy metal pollution has received the attention of researchers worldwide, mainly due to its health effects on living beings [9]. Human biology is full of instances where heavy metal toxicity has led to mass deaths [10]. Heavy metals are toxic to living organisms at excessive concentrations, but some are essential for no plants' average healthy growth and reproduction at low but critical concentrations [8]. The heavy metals important in trace elements to plants include Co, Cu, Fe, Mo, and Zn, and for animals are Cr, Ni, and Sn. The heavy metals Cd, Hg, and Pb are not essential for plants or animals [9]. The objective of this study is to monitor and analyze the levels of heavy metal in the examined areas which required for measuring the rate of contamination and describe the way of controlling. In Mongolia, there are just a few researches dealing with the survey of heavy metals in soil in the mining area (Gobi desert), where the examination investigated the presence of 17 harmful metals (As, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Sb, Sn, W, V, Y, Zn, and Zr) in samples collected from five areas of three cities with Inductively Coupled Plasma Mass Spectrometry (ICP-OES) which is the most elemental analysis technique. Samples were collected from three different cities like: Ulaanbaatar (ger and garden areas), Arkhangai (mountain and river-side), and Dundgovi (mining area: Gobi desert).
This type of examination can be used to evaluate the health quality of the biosphere in the investigated areas. The present study is focused on the determination and the how these toxic elements are spread what are their effects on the quality of the investigated ecosystem areas. Depending on the results, I can particularly suggest the way to remove such contaminations from the ecosystems in the investigated areas. Under the conditions mentioned above, it must undertake health of local population and the protection rate in the ger area.

MATERIALS AND METHODS

Samples collection and locations

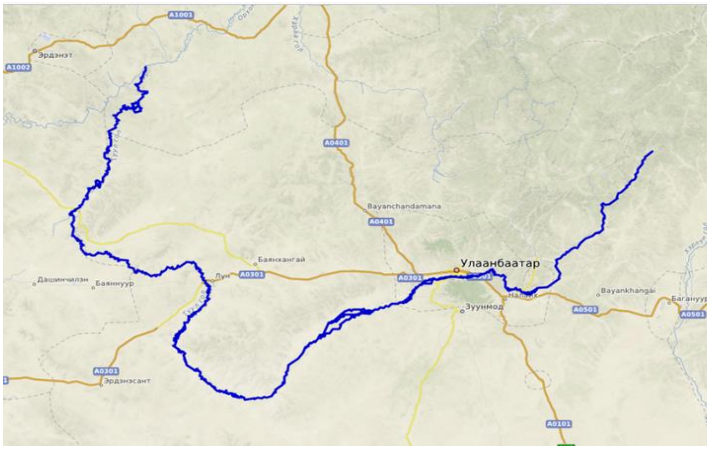


Figure 1. The position of Ulaanbaatar

In this geographical region, the characteristics classification of soil this region is included within the Khentii subrange inside the Khangai range, and darkish-brown (Kastanozems) and mountain darkish-brown soil (Mollic Cambisols) which cover most of the area. Two different soil samples were collected from Ulaanbaatar city (Figure 2): 1. Garden in an urban area and 2. Ger district
The population of Ulaanbaatar is about 1.5 million, with ger districts housing which occupy more than half of the houses (193,529) according to the statistics of 2019. A ger household consumes around 1 million tons of raw coal (as energy source) annually, which obtains from the coal mines of Baganuur and Nalaikh. In each year, about 200,000 tons of coal ash is disposed in unauthorized and unregulated locations such as public rubbish sites and ravines around the ger region due to a lack of control for coal

ash disposal in the ger area. Accordingly, coal ash has become one of the main sources of soil pollution in Ulaanbaatar's ger district. When compared to other geological materials, coal ash includes high levels of heavy metals because the concentration of heavy metals is enriched 4 to 10 times after burning and it has bad influencing on the public health in the investigated area. The toxic impacts of these heavy metals are easily conveyed by air and can negatively affect the population health throughout ingestion, inhalation, and skin contact. Furthermore, these heavy metals quickly pollute the ecosystem environment, including soil and water. Arkhangai aimag (Figure 2) is a province located slightly in the West of Mongolia. Agriculture, particularly animal husbandry, is the primary source of income. The soil samples were collected from mountainous and riverside areas. Last but not least, samples were also collected from the mining area (Figure 2) to investigate the frequent content of heavy metals in the soil samples. Erdenes Silver Resource LLC (the name of the company) is located in Dundgobi Aimag, the middle segment of the Gobi desert.

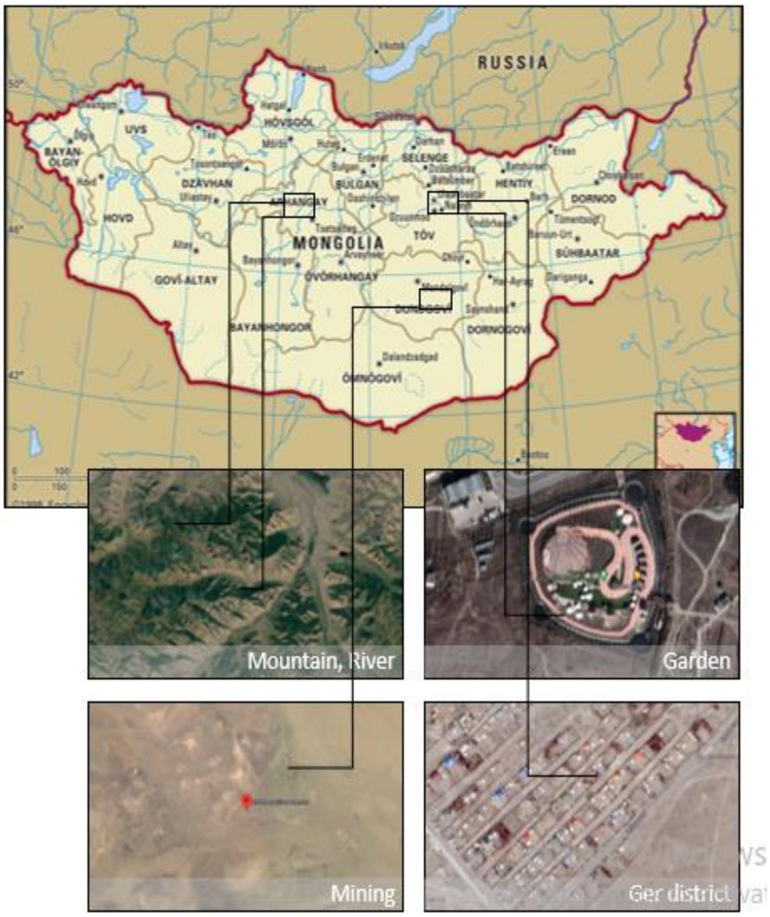


Figure 2. Collection points of the soil samples

The mining area

Open-pit mining is a surface mining technique that extracts minerals from an open pit. One of the most common methods used worldwide for mineral mining and does not require extractive methods is Open-pit mining. This surface mining technique is used when mineral or ore deposits are relatively close to the Earth's surface. The steps of an opencast mining operation are done as following: 1. Drilling 2. Planning 3. Blasting 4. Hauling 5. Crushing. These operations need to be carefully planned for proper mine planning and design to prevent extra loads such as operating costs, environmental footprints, etc. Erdenes Silver Resource LLC is committed to minimizing the negative impact of mining operations on the project area (Figure 3), avoiding and preventing any adverse environmental effects. The company follows the principle of ensuring and supporting the participation of local people in the implementation.

Figure 3. Mining area

Sampling

- Twenty-two soil samples were collected from:
- Ger district,
- Garden in an urban area,
- Mining area,
- River-side, and
- Mountainous area for three cities:
- Ulaanbaatar city
- Arkhangai province
- Dundgovi province
- The collection of soil samples was conducted through the following steps (Figure 4):
- Selecting sampling spot
- Removing the surface litter at the sampling spot
- Making "V" shaped cut to a depth of 15-20 cm in the sampling spot
- Collection of soils
- Mixing the soil samples thoroughly
- Removal of materials like stones, gravel, and roots
- The thoroughly mixed sample is quartered by dividing it into four equal parts.
- The remaining quarters are mixed after discarding two opposite quarters.
- Collecting the sample in a polyethylene bag
- Labelling the samples

Figure 4.. Collection of samples

Approximately 750-800 gr of surface soil (20cm depth) samples were obtained with a shovel from each area, and placed in plastic bags. The collected soil samples were transported to the laboratory of Khanlab LLC, Ulaanbaatar, Mongolia for further analysis using the sample-box cab.

Khanlab LLC

Khanlab LLC is a mineralogy and environmental analysis laboratory based in Mongolia. The company operates according to national standards, conducts mineral research and analysis by more than 100 methods and techniques of selective chemical and instrumental analysis, and accurately identifies more than 70 elements and compounds.

Applied Method

The aqua regia was used to extract the total heavy metal content of the soil samples according to Mongolian standard test method for soil. For each soil sample, the extraction was performed in triplicate. Inductively coupled plasma - optical emission spectrometry (ICP-OES) is a technical method using plasma and a spectrometer to detect the composition of elements in liquid-phase samples. Since 1974, the procedure has been commercially accessible. It has become frequently used in systematic research for more particular analytical goals due to its dependability, multi-element choices, and fast throughput. The technical procedure of the detection is shown in Figure (5). Figure (5) summarized the principle routine work with ICP –OES [W-1]

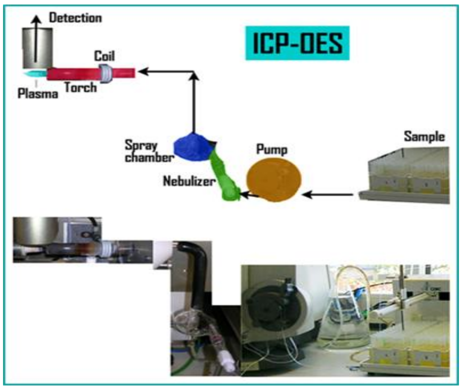


Figure 5. ICP-OES (Source: W-1)

STATISTICAL ANALYSIS

The values in the showing figures are the average of three replicates and the histograms show the standard deviations at all treatments. Linear registration was used to determine the relationship between the metal concentrations in different locations, and also R^2 was calculated for each metal.

RESULTS AND DISCUSSION

Comparison Between Heavy Metal Contents In Different Samples
The following Figures from 6 to 17 show comparisons between results of heavy metal content in different samples with standard limitations in Mongolia.

Evaluation of arsenic in different soil samples
Inorganic arsenic compounds are more hazardous than organic arsenic compounds. High doses of arsenic can be fatal, especially if taken in a short time. While long-term exposure to low quantities of arsenic has no immediate consequences, exposed persons can develop cancers of the skin, bladder, liver, lungs, and kidneys. Arsenic levels in drinking water can cause ulcers or discoloration of the skin on the feet, hands, and chest. Children are especially vulnerable to contamination because they put items in their mouths, ingest dirt, and spend more time outside. Inorganic arsenic is a carcinogenic chemical. The health risk caused by arsenic-contaminated soil is determined by the toxicity of Arsenic and the amount of arsenic to which humans are exposed through soil contact. According to research on the toxicity of arsenic and the possibility for individuals to be exposed to arsenic in soil, arsenic-contaminated soil may constitute a public health risk in some polluted locations. Arsenic poisoning can have a wide range of adverse health consequences
Figure 6 indicates that arsenic levels in all categories are more significant than the threshold, particularly in the ger district. Aside from the ger district, the mining result shows a larger quantity than the standard limits. The sample from the mountainous location has the lowest impact, although it is still higher than the standard.

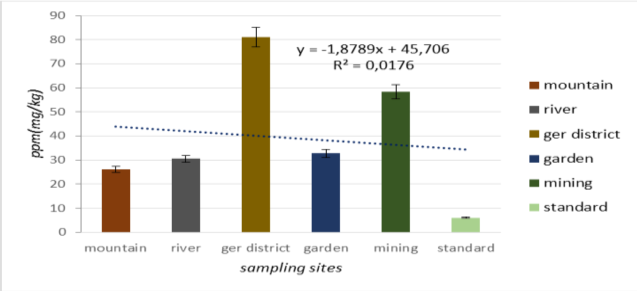


Figure 6. Evaluation of arsenic in different soil samples

The widespread use of arsenic in industrial and agrochemical applications has been identified as one of the few causes of groundwater and sediment arsenic contamination in the environment, with far less severe effects than natural causes. In the physical approach, the concentration of arsenic in the soil can be reduced by using biological meaning such as bioremediation or phytoremediation [13], by cultivating hyper-accumulating plant.

Determination of chromium in different soil samples

Chromium (Cr) contamination is a major environmental problem that negatively influences our environment and natural resources, particularly water and soil. Excessive exposure might increase accumulation levels in human and animal tissues, resulting in harmful consequences. Several studies have found that chromium is a hazardous element that interferes with plant metabolic functions, limiting crop development and production and lowering vegetable and grain quality. Chromium exposure can occur by inhalation (breathing it in), ingestion (eating or drinking it), or direct touch (getting it on your skin). Air, food, drink, and polluted soil and groundwater can all be sources of exposure. In all places, the level of chromium in soils from different areas is lower than the requirement.

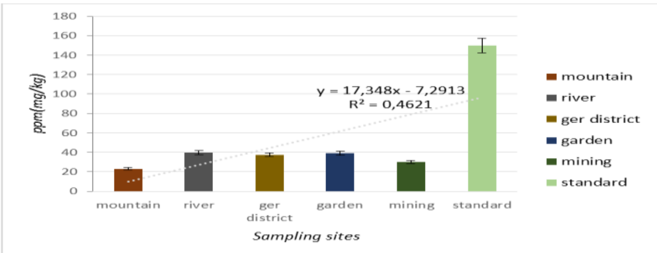


Figure 7. Determination of chromium in different soil samples

Measurement of copper in different soil samples

When copper (Cu) enters the soil, it forms strong bonds with organic substances and minerals. As a result, it does not move far after being released and seldom reaches groundwater. Copper may travel long distances in surface water, either suspended on sludge particles or free ions. Copper may disrupt soil activity by negatively influencing the action of microorganisms and earthworms. Because of this, organic matter decomposition may be significantly slowed. When farming soils become contaminated with copper, animals absorb levels that are harmful to their health. Copper poisoning mainly affects sheep since the effects of copper emerge in low quantities. Copper poisoning in plants can reduce iron absorption and limit development. Excess copper in the soil might hinder seed germination. Excessive use of copper-containing fungicides and industrial activities can result in high soil copper levels (such as mining). Copper also demonstrates that all results are less than the standard limitation in the Figure (8).

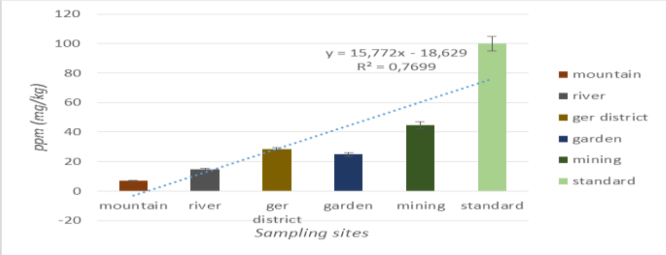


Figure 8. Measurement of copper in different soil samples

Detection of iron in different soil samples

Soil typically contains between 1% and 5% iron (Fe), but because most of this iron is inaccessible, determining an appropriate level for soil is challenging. According to some estimations, the ground should hold at least 0.001 g of iron per 100 g (or 10 mg/kg). The Figure (9) below illustrates no substantial variance in iron levels across different zones.

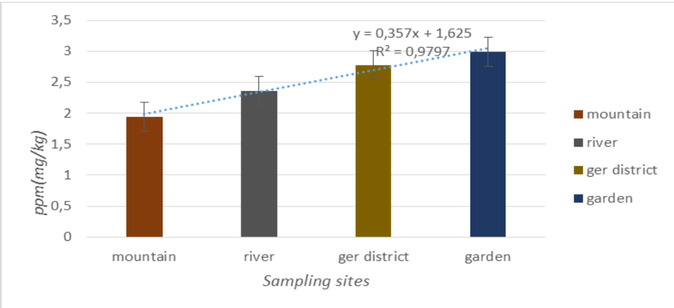


Figure 9. Detection of iron in different soil samples

Estimation of cobalt in different soil samples

Because cobalt (Co) is extensively distributed in the environment, individuals may be exposed to it by breathing air, drinking water, or eating cobalt-containing food. Skin contact with cobalt-containing soil or water may potentially increase exposure. Cobalt is seldom free in the environment, but when cobalt particles are not attached to soil or sediment particles, absorption by plants and animals is increased, and accumulating in plants and animals may occur. As indicated in the graph, the cobalt concentration in the Ger district is the highest compared to the others. However, overall data suggest that cobalt levels in various places are lower than the statutory limit (Figure 10).

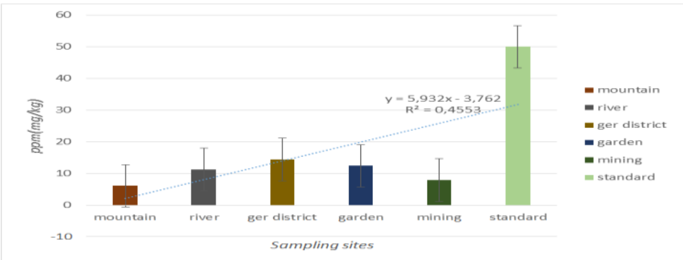


Figure 10. Estimation of cobalt in different soil samples

Content of manganese in different soil samples

Manganese (Mn) is an important element which has a role in normal physiological properties of humans and animals. Low concentration of Mn is important in the food and has nutritive value for humans. Meanwhile the excess of Mn concentration has a chronic effect to human health [11]. The higher concentration of Mn is harmful to the human life [12]. The high concentration of Mn can cause a syndrome called manganism [11]. Also, Mn is an important element for plant growth, but it is toxic at higher level. Various crops have different tolerant regarding to the toxicity of Mn. Soil acidity is response to form the Mn^{2+} ions into the soil solution. The following chemical reaction illustrates this process:

$$\text{Mne}^- + 4H^+ + 2e^- \rightarrow \text{Mn2}^+ + H_2O$$

(solid Mn, not available to plants) (soluble Mn, readily available for plant uptake)

Figure 11 summarizes the Mn content in all areas is higher than the standard limit while the sample from the ger district hit the peak.

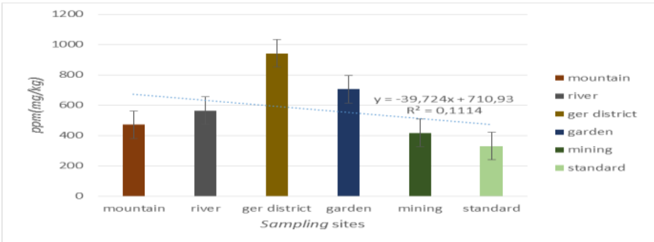


Figure 11. Content of manganese in different soil samples

Distribution of nickel in different soil samples

Nickel (Ni) is a potentially harmful element that pollutes land and water, jeopardizes food and water security, and impedes global sustainable development. Nickel pollution may be caused by industry, liquid and solid fuels, and municipal and industrial waste. Nickel exposure can result in several adverse health impacts, including allergies, cardiovascular and kidney illness, lung fibrosis, and lung and nasal cancer. The results in this basic Figure (Figure 12) do not differ much, and they are all below the limitations.

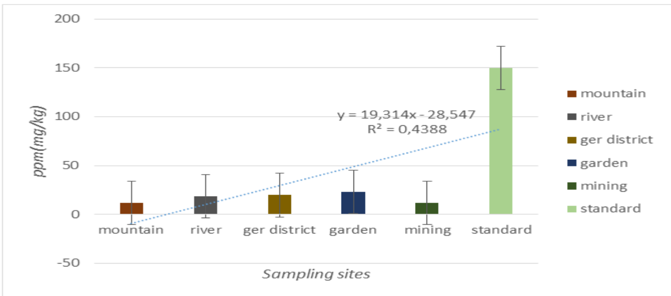


Figure 12. Distribution of nickel in different soil samples

Detection of lead in different soil samples

Lead (Pb) in soil is bound to the clay surfaces and particles of organic materials. The results showed that Pb content in samples collected from garden, mountain, and river-side is lowest, compared with its concentration in ger district which is highest and exceeds the standard limit. In addition, the Pb concentration in the mining region sample is the second highest after in the ger district (Figure 13).

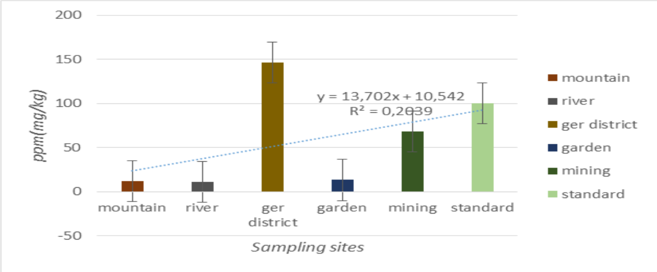


Figure 13. Detection of lead in different soil samples

Analytical measurement of vanadium in different soil samples

Vanadium (V) is a trace element that is abundant in the Earth's crust. Vanadium levels in bare rocks and minerals are naturally high, notably titaniferous magnetite. Anthropogenic sources of vanadium include the burning of fossil fuels and waste such as steel-industry slags. Vanadium contamination can disrupt ecological systems and cause animal poisoning and human sickness. The Figure below shows that the heavy metal distribution in different areas is below the standard limit. In contrast, rich metal content in the garden shows the highest result compared to others (Figure 14).

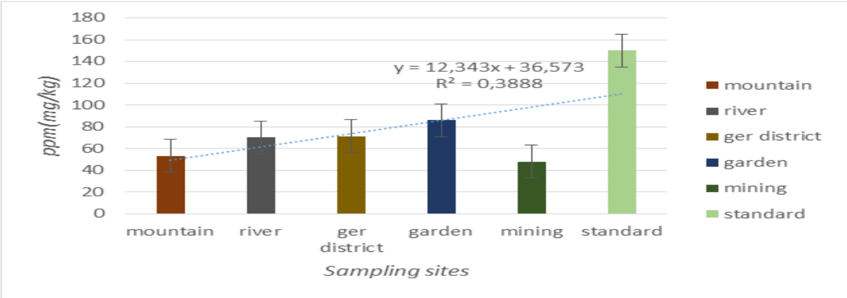


Figure 14. Analytical measurement of vanadium in different soil samples

Illustration of yttrium in different soil samples

Yttrium (Y) is rare in nature because it exists in tiny amounts. Yttrium is typically found exclusively in two types of ores. Because of its suitability for producing catalysers and polishing glass, the usage of Yttrium is still expanding. Because damps and vapours may be breathed with air, Yttrium is most harmful in the workplace. This can result in lung embolisms, especially if exposed for an extended period. When breathed, Yttrium increases the odds of developing lung cancer in humans. Finally, when it accumulates in the human body, it might endanger the liver. Yttrium is discharged into the environment, mainly by the petroleum industry. It can also enter the environment when home items are discarded. As Mongolian standard limitation of Yttrium has not been founded, the graph analyzed the yttrium content in 5 different samples. From the chart, Yttrium content in the garden soil sample was the highest compared to others.

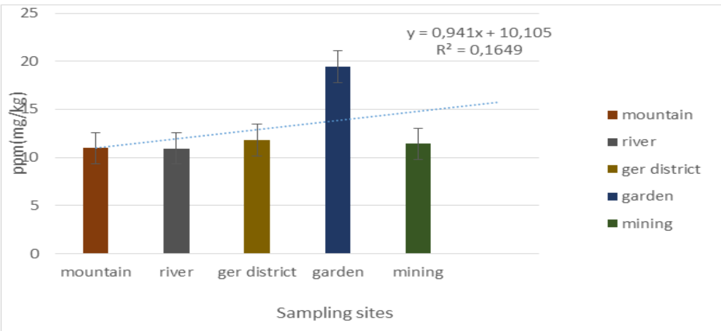
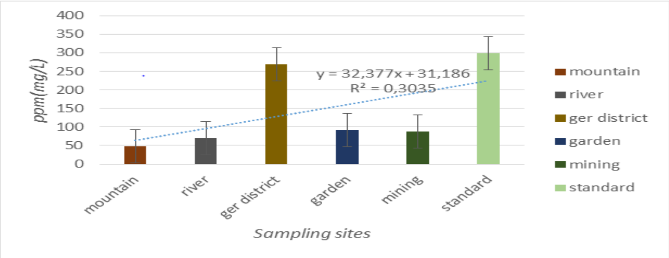


Figure 15. Illustration of yttrium in different soil samples

Examination of zinc in different soil samples

It is estimated that 17.3% of the global population is at risk of zinc (Zn) deficiency. Approximately half a million children under the age of five die each year from causes related to Zn malnutrition. As shown in the chart, Zinc content in the ger district was the highest compared to the rest; on the other hand, all results were below the standard limit (Figure 16).



Quantification of zirconium in different soil samples

There was no significant difference for the Zirconium (Zr), except the metal amount in a sample from the riverside was a bit higher than the others (Figure 17).

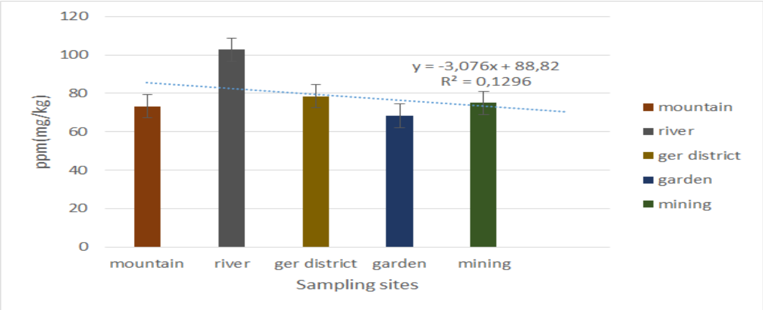


Figure 17. Quantification of Zirconium in different soil samples

Examinations of Cadmium, Molybdenum, Antimony, Tin, and Tungsten in different soil samples

Cadmium (Cd), Molybdenum (Mo), Antimony (Sb), Tin (Sn), and Tungsten (W) were also tested in five different samples, but the results were below what the ICP-OES could detect. The results of this research work are to some extend agree with the recent studies for example: metal ions act as essential raw materials for applied methods and valuable intermediates in element extraction. Recent studies concluded that pollution of heavy metals is a good risk to reduce the health of different environment [14]. Also, it was found that there is a little information about the effect of heavy metals from urban regions on the ecosystem in Mongolia [15]. Ulaanbaatar which is the capital of Mongolia is also acts as the center of socio-economical, and is characterized as the central city for industrial, and transport activity in Mongolia [15]. In Mongolia, several locations are highly located by high human density e.g., as in Ulaanbaatar and these locations have minimum industrial efficiency during the recent years, and has highly polluted with heavy metals that affect the urban life. During the present study, it was found that contamination of detected heavy metal indicated the rate of pollution in Mongolian soil which affects the human life-style. In Mongolian capital city, it was mentioned that the As pollution was high due to its origin from three power plants in the city as well as the traffic activity which increase the concentration of in Pb pollution [16]. The results of the present diplom work agree with the authors regarding to the contamination of the capital city with As and Pb. Batjargal et al. [16] mentioned that the level of the concentrations of As, Cd, Cr, Cu, Ni, Pb, and Zn in soils close to the major roads in Ulaanbaatar and the level of Pb concentration in the topsoil was slightly higher than the standard in case of samples collected from ger. These results are agreed with our results too.

Battsengel et al. [17] studied the distribution of heavy metals and their effects on the human health in ger region in the capital of Mongolia using the same method of extraction and method of detection. They mentioned that Mo and As were the most enriched elements compared with the other elements. But my results showed that the As was detected also in higher concentration but Mo was at low as the can not detected. Also, they mentioned that Zn and Pb have higher pollution indexes and more toxic element due to the ecological risk. I have obtained similar results.

CONCLUSION AND FURTHER TASK

Metal distribution in soil samples is one of the most important characterizations of soil quality as well as the environmental health too. Climate and meteorology, soil parent material, terrain, landscape, plant covering, human activities, and other factors influence soil formation and quality. Large-scale of mining operations result in land occupancy which can cause plant damage, soil layer damage, and other behaviors such as in air pollution, etc.

In Mongolia, there are just a few researches dealing with the survey of heavy metals in soil in the mining area (Gobi desert), where the examination investigated the presence of 17 harmful metals (As, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Sb, Sn, W, V, Y, Zn, and Zr) in samples collected from five areas of three cities with Inductively Coupled Plasma Mass Spectrometry (ICP-OES) which is the most elemental analysis technique. Samples were collected from three different cities like: Ulaanbaatar (ger and garden areas), Arkhangai (mounting and river-side), and Dundgovi (mining area: Gobi desert).

Depending on my investigation, I have to mention that he results of this study showed that the detection of the heavy metals were as following:

1. Concentration of Ar was higher in ger and mining than other habitats as well as the standard limit too.
2. Concentration of Cr was very low in all investigated ecosystems which similar to Cr, Co, and Ni.
3. Concentration of Fe was not found in mining, but its concentration was higher in garden and ger than in mountain and river-side.
4. Concentration of Mn was higher than the standard limit in all investigated habitats but the highest value of concentration was detected in ger followed by in garden and the lowest level was detected in mining.
5. Regarding to Zn and Pb, their concentrations were all lower than the standard limit given by the government in all locations except in case of ger area.
6. Concentration of V was detected in all examined locations in lower values than the standard limitation given by the government. The highest level of V was found in garden without any significant differences with its values in riverside and ger area.
7. Concentration of Y was found at highest concentration in garden soil and its concentration in other analyzed locations was not significant.
8. Concentration of Zr was found to be higher in river-side than in any other location.

The mine operation is estimated for a total of 5 years. The relevant professional organization and its laboratory will conduct environmental monitoring and analysis related to open-pit mining. An annual ecological action plan should be developed for the open pit project.

The current state of urban development and socio-economic growth, scientific and technological progress, recent changes, and the future shorten development policy issues based on urbanization trends; the medium and long term requires planning and implementation. Mongolia's long-term development policy - 2050 is detailed in the document.

The following significant steps are estimated to be taken:

- Implement a person-centered development policy, develop capable, ethical, and responsible citizens
- Ensure equal participation and support for businesses through government policies to increase employment
- The city has become a unified standard for citizens to study and work safely to create favourable living and travel conditions in the environment
- Introduce environmentally friendly, advanced techniques and technologies for air, soil, and environmental pollution
- Optimal planning for the city's future and the proper urban planning policy implementation is the basis of urban development and is scientifically based

- Reflects modern policies and solutions that have an accurate budget estimate to develop and implement planning
- Creating a diversified and intelligent public transport network, zones connecting the city with satellite cities

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[W-1] Website from internet: https://www.ru.nl/science/gi/facilities-activities/elemental-analysis/icp-oes/

ANALYSIS OF LICHEN BIODIVERSITY IN DIFFERENT AREAS OF HUNGARY

Viktória TÖRÖK, Rebeka SZALÓKI, Ádám MEDVECZKI, Hosam E.A.F. BAYOUMI HAMUDA

*Institute of Environmental Engineering and Natural Science Department, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Hungary, torok.viktoria94@gmail.com, *E-mail: Bayoumi.hosam@uni-obuda.hu, +36303900813*

In the present study, a comparison between air polluted and non-polluted areas was observed depending on the frequency and distribution of lichens. Comparing our test results, based on OKIR data, it was found that in the area of Tatabánya, and the most serious emission of harmful substances were sulfur oxides (SO_2) and nitrogen oxides (NO_x). It was found few or damaged samples, and even in the area of the new industrial park we did not find any samples at all. On the other hand, we found few, but healthy and abundant lichens in the vicinity of shopping centres and one of the industrial areas (sampling site "A"). Based on the retrieved data, we found that the emissions of SO_2 and NO_x have decreased somewhat over the past 6 years, but are still significant in the given area. In Budapest (e.g., the XXII district) the emission of harmful substances is almost a third of the values in Tatabánya in terms of SO_2, which is surprising given the presence of a significant amount of chemical industry. The emission of NO_x also remains well below the values in Tatabánya. On the other hand, based on the queried data, it was found that over the past 6 years, the emission of SO_2 has increased, while that of NO_x has decreased in the monitored area. We did not find an evaluable lichen sample within the investigated area. In the XIII district harmful substance emissions remain significantly lower compared to the previous test areas, in contrast to this, it was demonstrated that the second highest result in the emission of NO_x. The lichen samples are varied, in one location (sampling location "A") we found damaged and sparse colonies, but in the others we could find particularly rich and large colonies, mainly in the parks and areas along the Danube. In the XX district, the emission of SO_2 in the residential area of the district is extremely low, and that of NO_x is also significantly lower than the previously investigated ones. We observed healthy lichen colonies in the district. SO_2 emissions are not typical in the Várgestes area, and the amount of NO_x is negligible. At the sampling locations, it was found that the lichen colonies are extensive, healthy and grow abundantly. The most dominant lichen species of the investigated areas were: in Tatabánya area: Xanthoria parietina, Physcia ascendens, Hypogymnia physodes, Flavoparmelia caperata, where in Várgesztes area, it was found the following strains: Xanthoria parietina, Physcia ascendens. Buti n Budapest areas such as XIII district, Flavoparmelia caperata, Flavoparmelia caperata, Physcia ascendens, and only Flavoparmelia caperata was found in XX district and no lichens were detected in XXII district. Finally, it was concluded that in the industrial areas, Tatabánya and XXII district has a high level of pollution, which is not healthy for humans and other living beings. In addition, it can also have a negative impact on the ecosystem in terms of development and can also cause the buildings to corrode. The XIII district and XX district is characterized by significantly less air pollution data, and in addition, their environmental conditions can also have a positive effect on them. Thanks to the location next to the Danube, pollutants are cleared from the air in this area more quickly due to the wind. In addition, green zones are also common, where there is a chance for dirt to accumulate. On the other hand, the test sites "C", "D", and "E" are located near park areas and the Danube, where several factors ensure adequate air exchange and purification.

***Keywords**: lichen biodiversity, air pollution, distribution of lichens*

INTRODUCTION

More than 20,000 types of lichens are known worldwide, hundreds of which can also be found in Hungary. It is mainly a terrestrial species, but a few aquatic species are also known. Pioneering organisms, they can be found in extreme habitats (rocks, deserts, tundras), both on natural and man-made surfaces. Lichens are long-lived, resistant to drying out, but light-demanding plants. Lichen acid can also erode the substrate. Lichens are perennial, colonizing, tube-spored, cellular organisms. They are not simple organisms, but organisms formed from the coexistence (symbiosis) of fungi, fungi and algae, or cyanobacteria (blue-green algae).
All lichens contain at least one photobiont and one mycobiont partner, but there may be more than one photobiont partner. The non-fungal partner is called photobiont and contains chlorophyll; the fungal partner can also be called mycobiont. Scientists define them as biological indicators, or bioindicators since most of lichens are sensitive to the amount of pollutants mainly sulphur dioxide (SO_2) in the air, so they are also suitable for determining air quality.
The shape and protection of the lichens are given by the fungal filaments. These fungal threads are intertwined as a dense, intricate and resistant structure in the lower and upper bark layers. Seaweeds and algae can be observed in the photosynthesizing layer. The most common algae species found in domestic lichens are the following:

- Trebouxia
- Myrmecia
- Pleurococcus
- Coccomyxa
- Pseudochlorella
- Trentepohlia
- Phycopeltis
- Gloeocapsa
- Nostoc
- Scytonema.

Among the photobionts there are filamentous structures, but they consist of chains or clusters of more or less spherical cells. Thanks to the chlorophyll content, color hydrates are produced during photosynthesis with the help of light. Unlike photobionts, fungi cannot produce carbohydrates for themselves. Carbohydrates produced by photobionts in lichens are primarily used by photobionts, but also by mycobionts. The algal cells supply ready-made organic material to the fungal filaments, and they supply the host cells with salts dissolved in water and carbon dioxide, which the lichens absorb from their environment through their entire body surface.
The shape of rhizina shows great diversity. It can be simple, forked, and shaggy or have a slipper-like adhesive surface. The lichen-forming fungus is not viable to survive on its own, but the photobiont partner is. It is possible for them to survive on their own under laboratory conditions, but it is almost impossible to resynthesize them. It succeeded under the influence of stress (reduction of water and nutrient levels), which may indicate that the lichen communities were created to overcome different extremes.
The appearance of lichens shows great diversity. Their color is determined by the species of algae / seaweed that are also responsible for photosynthesis. Some lichens have special pigments. An example is usnic acid, which gives the characteristic yellow color and leads to many shades, from orange to red to brown. Lichens that do not have such special pigments are gray or gray-green when dry. These species then glow green or olive-green when wet (the photosynbiont layer emerges due to the cortex layer becoming more transparent). The color (usually the color considered in the dry state) plays a significant role in the definition of the variety.

LICHENS: CLASSIFICATION AND GROUPING

Lichens are usually classified according to fungi. The fungi are mainly hose fungi, but they can be basidium and algal fungi.

They can be divided into four classes according to Hortobágyi(1979):

- Class 1: Phycolichenes
- Class 2: Tuberous lichens:
  - Ascolichenes o Subclass:
    a. Pyrenocarpeae o Subdivision
    b. Discocarpeae (Gymnocarpeae)
- Class 3: Basidial lichens - Basidiolichenes
- Class 4: Semilichens - Deuterolichenes

Grouping lichens is not an easy task, so we can approach this problem from several perspectives. Based on their living space, we distinguish:

- • epiphytic species
- – bark dwellers – corticol
  - ▪ Lichen
  - ▪ Map lichen
- – branch dwellers - ramikol
- – leaf inhabitants – epiphyll
- terrestrial species
- – rock dwellers – saxicol
- – soil dwellers – terricol)

Another grouping method is grouping based on morphology.

1. Lichens with bark colonies:
   - ➢ They adhere firmly to the substrate with their entire lower surface.
   - ➢ Substrate can be: rock, tree bark, anthropogenic
   - ➢ Colonies can be: contiguous, fissured, granular, bordered, warty
2. Leafy lichens:
   - ➢ It is between the bark and beard lichen.
   - ➢ Sheet-like, flat, with rounded edges.
   - ➢ It is not completely fixed to the ground.
   - ➢ Substrate can be: rock, tree bark, soil.
3. Bushy lichens:
   - ➢ Small, bush-like colony.
   - ➢ Not always fixed to the ground.
   - ➢ Fluffy, ribbon-shaped, or thread-like colony
   - ➢ Branching, simple, erect, drooping

Lichens can be divided into three groups based on the closeness of the symbiosis of fungi and algae:

[1] Algal cells and fungal filaments live freely side by side o For example: Pedunculate lichen species

[2] Algal cells and fungal filaments are loosely involved o For example: Some of the bark lichens

[3] The hyphal threads that hold the algae together penetrate deep into the cells

LICHENS: THEIR IDENTIFICATION:

Lichen identification is possible in most cases in the field.

Certain species, on the other hand, require examination of their macroscopic and microscopic structure (reproductive structures, spores, cellular characteristics) and chemical properties.

Chemical reagents can be used on the lichen tissues, as a result of which it can be concluded about a color change, or its absence, but the chromatographic method is more accurate.

LICHENS: THEIR REPRODUCTION

Lichens are long-lived organisms. They grow extremely slowly, their diameter increases by one or two millimeters per year. Their reproduction (Figures 1 and 2) takes place in the way of algae, fungi and lichens.

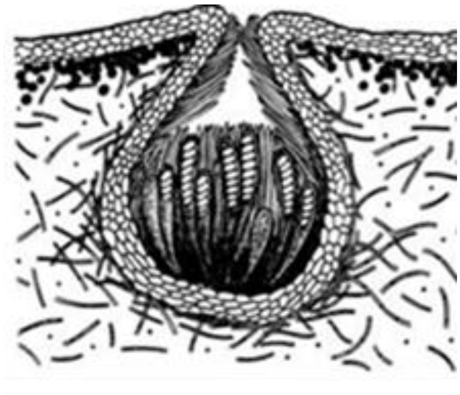

Figure 1. Perithecium longitudinal section

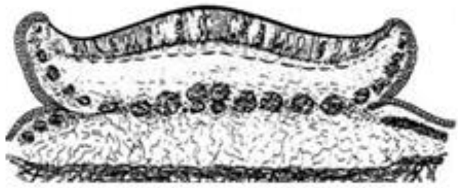

Figure 2. Longitudinal section of apothecary

- In the kelp mode: asexually with zoospores or division into two
- In a fungal way: Fungi can develop a fruiting body (for example, perithecium or apothecium, but the spore only sprouts when gonidia meet.
- With lichen reproduction: There are several types of vegetative reproduction.

It can be realized vegetatively in several ways:

- With colony parts: Thanks to the genetic identity, it can continue to reproduce from fragments broken off from the lichen body. Foliage and bark lichens can easily become brittle when dry.
- With soredia: Dust-like grains, soredia, which consist of photobiont cells surrounded by fungal filaments, appear on the colony body.
- With isidia: The colony body creates simple or branched outgrowths, isidia, which are a mixture of fungal and photobiont cells. The isidium contains everything necessary for the production of the new colony body, so it can reproduce by breaking off and dispersing.
- With pycnidia: With tiny spherical or pear-shaped pycnospores.

LICHENS: THEIR ECOLOGICAL IMPORTANCE

Their living space:

Lichens have successfully multiplied in many different habitats, especially in extreme places such as deserts, tundras, and stone surfaces. This can be attributed to several things. The first such factor, which helps their spread, is poikilohydricity, so they are resistant to drought, primarily they require light. It can be said that lichens are tolerant of various environmental factors. They are also pioneer organisms.

We call pioneers the organisms that appear first when the cause of destruction has ceased, or settle in areas where life has died out for some reason, be it natural or artificial. Their occurrence and distribution are primarily determined by the substrate and climatic factors, and whether there is an organism that would compete with the number of lichens.

Nitrogen use:
The Earth's atmosphere contains 80% nitrogen, which most organisms cannot use directly. Cyanobacteria are capable of this and know how to fix atmospheric nitrogen. As a result, after the nitrogen has been fixed, the nitrogen fixed by it will be available to other plants as well, with the death of the lichen colony or the excrement of herbivorous animals. In addition, some of the nitrogen can be leached from the lichen, where it can reach other epiphytic species or seep into the soil. Many studies have shown that nitrogen is essential for plants. Non-nitrogen-fixing lichens also contribute significantly to the nutrient cycle. Lichens can also absorb minerals through their plant bodies. In forests overgrown with dense lichens, epiphytic species can bind nutrients in fog and precipitation (e.g. ammonium nitrate).

Food for living things:
Some vertebrates also feed on lichens, especially deer and caribou in North America and Eurasia. In winter, these animals feed mainly on beard lichens, thanks to which they can survive the nutrient-poor period. It can also be used for animal feed (for example, reindeer husbandry). It is interesting that former species are also food for humanity served, for example manna moss. Some lichen colonies may serve as habitat for some invertebrates, which may serve as food for larger invertebrates or vertebrates. Lichen is also important from the point of view of the food chain.

Their positive effect on the soil:
Thanks to being a pioneer, it plays an important role in soil formation, referring here to rock compaction, soil binding and humus formation. Certain lichens are effective sand and soil binders that can help stabilize dunes and help prevent erosion. In dry, subarid areas, lichens and bryophytes can create biological soil crusts that maintain the soil's basic structure. Lichens can also settle on barren surfaces, such as road cuts, rock outcroppings, or volcanic ash and prepare the area for other plants. It captures moisture, wind-blown organic debris and contributes to organic deposits.

Their role in scientific life:
Lichens also "take on a role" in scientific life, since the drained juice of certain lichen species (Rocella, Lecanora and Variolaria species) is used to make litmus paper. Lichen acid has an antibacterial effect, i.e. it is effective against some bacteria, which is why it is the basis of several medicinal products. The best-known species used in medicine, Iceland lichen, is an excellent anti-inflammatory and cough suppressant. Their use has important ecological significance; they are also used as food, medicine, and clothing dye (e.g. Harris tweed).

EFFECT OF POLLUTION ON LICHENS

Lichens are excellent at concentrating nutrients from dilute sources and indiscriminately absorbing essential substances from the atmosphere, such as sulfur dioxide, fluoride or heavy metals. Pollutant sources that can have a harmful effect on lichens:
• Smelters: heavy metals, pollutants
• Car exhaust gases: nitrogen oxide
• Intensive animal husbandry: ammonia
• Agricultural chemicals: fertilizer, herbicide
• Oil contamination Pollutants can be microscopic particles, gases, or liquids. Microgranules of microscopic particles are absorbed by the colony body, which can embed in the thallus tissue and release harmful substances over a long period of time.

Sulfur dioxide:
The most intensively studied pollutant is the sulfur dioxide compound, which is a gas that dissolves easily in water and creates highly reactive acid ions. They are absorbed through the plant body and

interfere with photosynthesis. It inhibits the growth of lichens, the germination of spores and the activity of nitrogenase. Many lichen species are sensitive to air pollution, especially sulfur dioxide. In areas polluted with sulfur dioxide, the majority of lichens show an increased concentration of sulfur in the soil. Sulfur damages chlorophyll, which causes the photobiota to die and the fungal component as well, as it cannot survive on its own. By the way, lichens can also detect the hydrogen fluoride content of the air. In general, beard lichens are the least and bark lichens the most resistant to harmful effects. Thanks to this, the pollutant level can be monitored by noting the species and their condition in the given area. Sulfur dioxide has been a significant industrial pollutant for years. It can enter the atmosphere as a by-product of high-sulfur fuels, although their emissions have decreased thanks to various sulfur removal technologies, they are still significant. Lecanora conizaeoides is extremely tolerant to sulfur dioxide; it became widespread around industrial cities during the industrial revolution. Thanks to environmental protection measures, their number has decreased, already close to the times before the industrial revolution.

Oxidation:
There are few studies on the effects of oxidizing compounds on lichens, but several experimental studies have shown that ozone has adverse effects on lichens, which may vary among species. For example, in Southern California, sulfur dioxide emissions are low, but oxidizers are present in high concentrations in this area, as a result of which the number of lichen species found at the beginning of the 20th century has significantly decreased or disappeared

Metals:
Certain metals can have different effects on lichens. It is mainly observed around the plaques placed on the rocks. Metals containing copper, bronze or zinc are often used for plaques, which, if dissolved by precipitation, damage or destroy the lichen colonies living around it.

Determination of air quality based on SOx and NOx and their physiological effects
The Hungarian air quality index presents the composition and proportions of air pollution in various areas of Hungary with regard to the most important environmental pollutants. Different limit values apply to different pollutants depending on their health-damaging effects, the sources of which enter our environment mainly from the industrial and transport spheres.
The index takes into account the concentration values of the following pollutants and is given in $\mu g/m^3$:

- Benzene (C_6H_6);
- Carbon monoxide (CO)
- Nitrogen dioxide (NO_2);
- Ozone (O_3);
- Aerosol particles, fraction below 10 microns (PM_{10});
- Aerosol particles, fraction below 2.5 microns ($PM_{2.5}$);
- Sulfur dioxide (SO_2)

During our tests, we primarily dealt with nitrogen and sulfur oxides, which are the most determining points of air quality, along with carbon oxides. 2. Presentation of the most common NOx and Sox

Nitrogen dioxide:
Nitrogen dioxide (NO_2) is a reddish-brown gas with a pungent smell and an acidic chemical reaction.
Highly reactive, highly oxidizing and corrosive.
It is heavier than air and poorly soluble in water.
Molecular weight: 46.01
Its sources: NO_2 is usually not released directly into the air, but is formed during atmospheric reactions of nitrogen oxide (NO) and other nitrogen oxides (NOx) with other substances or is produced during the combustion of N-containing compounds. Volcanic activity from nature, lightning and significant amount is released into the atmosphere through its nitrifying bacteria. NO2 comes mainly from the burning of fossil fuels (coal, natural gas, crude oil), especially diesel fuel used in vehicles. Cars account for a very high percentage of NO_2 emitted in cities. Burning

natural gas, especially in the winter, also produces NO and NO_2. Industrial sources: nitric acid production, welding, petroleum refining, metal manufacturing processes, use of explosives, and the food industry.
Physiological effects: Nitrogen oxides are toxic to both animals and humans. The mechanism of action of NO_2 is twofold. On the one hand, in connection with the wet respiratory mucosa, saltpeter- or it turns into nitric acid and locally damages the tissue. On the other hand, it is absorbed into the bloodstream, where it oxidizes the hemoglobin molecule into methemoglobin, so it is unable to transport oxygen to the organs. Symptoms of acute poisoning: conjunctival and mucous membrane irritation, coughing, vomiting stimulus, headache, and dizziness.
The symptoms resolve within 1-2 hours, and after several hours of symptom-free period, emphysema and pneumonia develop. Acute poisoning does not occur in free atmospheric conditions.
Symptoms of a prolonged effect: NO_2 reduces the lung's resistance to infections, aggravates asthmatic diseases, can lead to frequent respiratory diseases and, over time, to the weakening of lung function and changes in the blood count.
Groups at particular risk: Young children and the elderly, asthmatics (especially children), people with diseases of the circulatory system and respiratory organs. Health limit value: 100 μg/m3 1-hour, 85 $\mu g/m^3$ 24-hour and 40 $\mu g/m^3$ annual average
Danger level: II. Extremely dangerous Effect on the ecosystem: NO_2 has a toxic effect on plants; over a concentration arround 120 $\mu g/m^3$ and it reduces their development even in a short time. If NO_2 and O_3 (ozone) are present at the same time, the effect is enhanced. Together with sulfur dioxide, it is involved in causing acid rain. Lichens show the presence of NO_2 as a bio-indicator, because they cannot develop in its presence or only with difficulty. Effect on buildings: NO_2 has an acidic chemical effect in the presence of moisture, which is why it strongly corrodes metals and building materials. Effect on visibility: NO_2 forms secondary particles, nitrates, which can form a dark yellowish haze, impairing visibility.[2]

Sulfur dioxide
Sulfur dioxide (SO_2): SO_2 is a colourless, water-soluble gas with a typically pungent smell. It combines with water to form sulfuric acid or sulfuric acid.
Molecular weight: 64.07
Sources: SO_2 mostly comes from the burning of sulfur-containing fuels, a significant part of which is the energy industry, and it also comes from the oxidation of coal and oil-containing compounds. SO_2 can also escape from other industrial technologies, such as fertilizer production, aluminum industry and steel production. It can also be released into the air from natural sources during geothermal processes (volcanism).
Physiological effects: Adsorbed to the moist respiratory mucosa, it has an irritating effect due to its acidic chemistry. Once in the bloodstream, it converts hemoglobin into sulfhemoglobin, thus inhibiting oxygen uptake. In clean air, the blood count is restored. During its acute effect, it irritates the mucous membranes of the nose, throat and lungs, and can cause coughing, phlegm formation and asthma attacks. These do not occur at free atmospheric concentrations. In chronic cases, SO_2 respiratory diseases e.g. can cause bronchitis. Most vulnerable groups: Children and the elderly, people with respiratory diseases, especially asthma. Health limit value: 250 μg/m3 in a 1-hour period, 24-hour average 125 $\mu g/m^3$, annual average: 50 $\mu g/m^3$ Danger level: III. Dangerous Its effects on the ecosystem: SO_2 forms sulfuric acid and sulfuric acid with the humidity of the air, which harms the living world. It is the main component of acid rain, which destroys trees and can destroy entire forests.
Lichens show the presence of SO_2 as a bioindicator, because they cannot develop in its presence, or only with difficulty. Effect on visibility: SO_2 turns into sulfate in secondary form, which can cause fog, worsening visibility. It is the main component of reducing type smog (mainly occurring in winter). EU trends and regulations:

Nitrogen oxides (NOx):
One of the main reasons for exceeding the nitrogen dioxide (NO_2) limit value is nitrogen oxide (NOx) emissions from diesel cars and light trucks, energy and the metallurgical industry. The new

EU-wide testing procedure adopted in 2017, which reflects the emissions of these vehicles under real driving conditions, and the 2016 Commission proposal for a revised type-approval system (10) will go a long way towards making progress in this area. . 9 Amended Commission Regulations 2017/1151/EU. OJ L 175, 7.7.2017, p. 1. 10 COM(2016) 31 final.[3]

Sulphur oxides (Sox):

1979: The Geneva Convention on long-range transboundary air pollution aimed to reduce the emission of acidic substances. Since the signing of the convention, sulfur emissions have decreased significantly in Europe, but due to the increase in road traffic, the level of nitrogen oxide emissions has not changed or increased as a result of modernization.

1985: Most of the member states of the European Union accepted the protocol related to the Geneva Convention on the reduction of sulfur emissions. The protocol aimed to reduce sulfur dioxide emissions by 30% by 1993 compared to the 1980 level. The group of countries that signed the document became known as the 30% club. The objective was met by all of the signatory countries, as well as many states that did not join the agreement.

1987: The Montreal Protocol set targets and deadlines for the reduction of emissions of gases dangerous to the ozone layer.

198:- In a directive, the European Union obliged power plants, as well as the energy, iron, chemical and wood industries, as well as the waste processing sector, to reduce their sulfur dioxide and nitrogen oxide emissions. Restrictions were also introduced in the areas of waste incineration, transport, and heat and energy production.

1992: At the Earth Summit held in Rio de Janeiro, Brazil, the European Union also signed the UN Framework Convention on Climate Change. This is where the principle of "sustainable development" was formulated. This means improving the quality of life in a way that does not harm the environment, future generations, or residents of rich or developing countries.

1994: The second protocol on sulfur emissions was signed by many European countries. Since signing, all EU member states have achieved the goal of reducing emissions by 35% compared to 1990 levels. During the next decade, sulfur dioxide emissions are expected to decrease further.

1996: The Car/Oil program began, proposing stricter emission standards for passenger cars.

1997: In the agreement signed in Kyoto, Japan, the European Union promised to reduce sulfur dioxide emissions by 50% and ammonia emissions by 30% by 2010 compared to the 1990 level.

According to the experts, the targets for sulfur dioxide are achievable, on the other hand, the level of nitrogen oxide emissions is extremely worrying, and little has been done so far to solve the problem of ammonia emissions.

2001: Clean air for Europe started! (CAFE) program, which aims to eliminate air pollution harmful to human health and the environment.

2005: The European Commission announced an air cleanliness strategy in order to reduce air pollution. Among its goals, the Commission wants to reduce the number of premature deaths caused by diseases related to air pollution by almost 40% in the twenty years until 2020.

Another goal of the strategy is to reduce the area of forests and other ecological systems damaged by atmospheric pollutants. The strategy pays special attention to fine particles and ground-level ozone pollution, as they represent the most serious threat to human health.

Macro and micro habitats

Large habitats, such as rainforests, can be divided into smaller, so-called micro-habitats. For example, in rainforests, other types of lichens can settle on the leaves of flowers or on the bark of trees. According to this, other lichen species need different growth conditions. Lichens can live not only in exotic, but also in urban environments, but their numbers decrease more and more as pollution increases.

The decrease in the diversity of lichens when approaching cities is influenced by factors other than distance. In protected places, various lichens can survive even in hostile environments. Such protected places can be created by trees, shrubs, and walls. The highly polar sulfur dioxide molecules are deposited on all kinds of surfaces, so the shrubs can absorb them and provide cleaner air for the lichens, thus creating micro-habitats. Valleys can provide protection against wind-blown pollutants, and an alkaline substrate can protect the lichen against acidic pollutants (in combat zones, desert zone).

LICHENS: THEIR ROLE AS BIOINDICATORS:

Although lichens are tolerant of most environmental factors, air pollution is a critical factor for them. They are particularly sensitive to the content of sulfur dioxide in the air, on the other hand, they have a narrow tolerance. For this reason, the quality of the air is characterized very precisely. The idea of using lichens in biomonitoring first arose in 1859 and was developed in 1866 by the Finnish lichenologist W. Nylander to study lichens near Paris. Based on the lichens, the air pollution of an area can be assessed using lichen maps. (Figure 3)

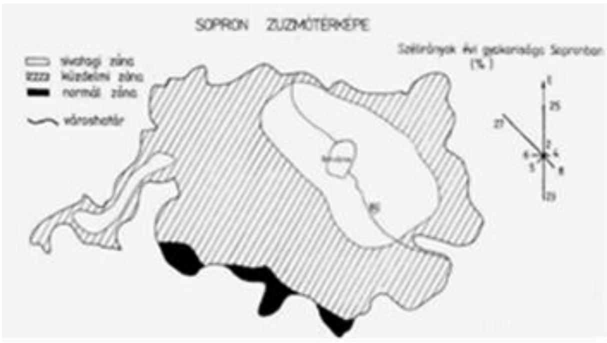

Figure 3. Air pollution in Sopron based on lichen map

Based on this, we can distinguish three zones.

- Desert zone: no lichens can be found within this zone due to the level of air pollution
- Struggle zone: the amount of lichens is sparse and scattered
- Normal zone: the air quality is suitable for lichens Based on the different levels of air pollution. Different species appear that can tolerate different levels of SO_2 concentration.

MATERIALS AND METHODS

In our research, we documented the lichen species found in the different observation areas with photographs, identified and characterized them in a table using the Képes lichen guide. In choosing our research area, we tried to choose areas with as diverse an environmental impact as possible, such as: industrial areas, residential areas in the center and outskirts of the capital, or in the countryside. (XXII. district of Budapest, Tatabánya, XX. district of Budapest, XIII. district of Budapest, Várgesztes) For each study area, we determined which type of lichen is dominant in the given area, which we compare at the end of the study. From the website of the National Environmental Protection Information System (OKIR), we queried the air pollution data for specific areas for sulfur oxides and nitrogen oxides, which can affect the lichen population. Since lichens have a very slow growth time and pH-lowering factors also affect their development, we reviewed the data from 2016 to 2020 inclusive.

RESULTS

Examination of lichens in the XXII. in the vicinity of district industrial areas

In the southwestern part of Budapest, the XXII. In the district's industrial areas (Figure 4), there are many companies involved in the chemical industry and other economic activities, such as SONEAS chemical and pharmaceutical raw material manufacturer, Agro Chemie Kft., Brenntag Hungaria

Kft., Green-Ex Trans, Reyclan, ESD Work Hungary, Geo Build Kft. Hatarai Érd, the Danube. The lichen survey monitored the lichen population up to the M6 motorway, but probably due to its similar conditions, the other part of the M6 motorway also has similar air quality data.

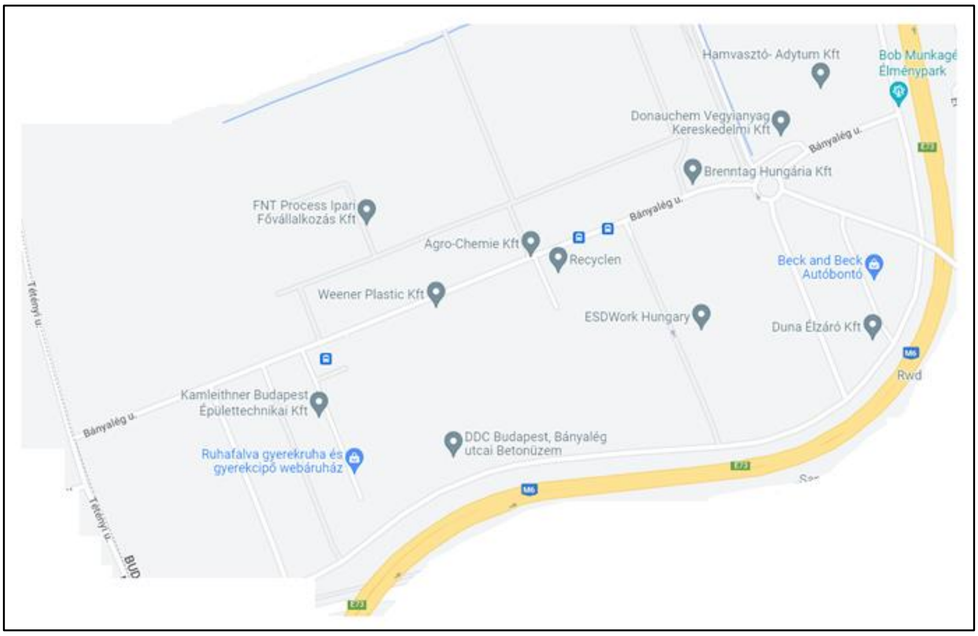

Figure 4. Map of XXII. district

In the area of the map (Figure 5), we did not encounter lichens at a height of 30-250 cm in negligible quantities, or only in open (open areas more active in air movement) located above 5 m (typically on acacia, oak and birch), which could not be found due to access obstacles were documented and were not identified. However, based on my experience with lichens, they typically looked like xanthoria parietina and pertusaria albescens from a distance. The following figure is XXII. district shows the emissions of various sulfur oxides and nitrogen oxides based on OKIR data between 2016-2020 (Figures 6 and 7):

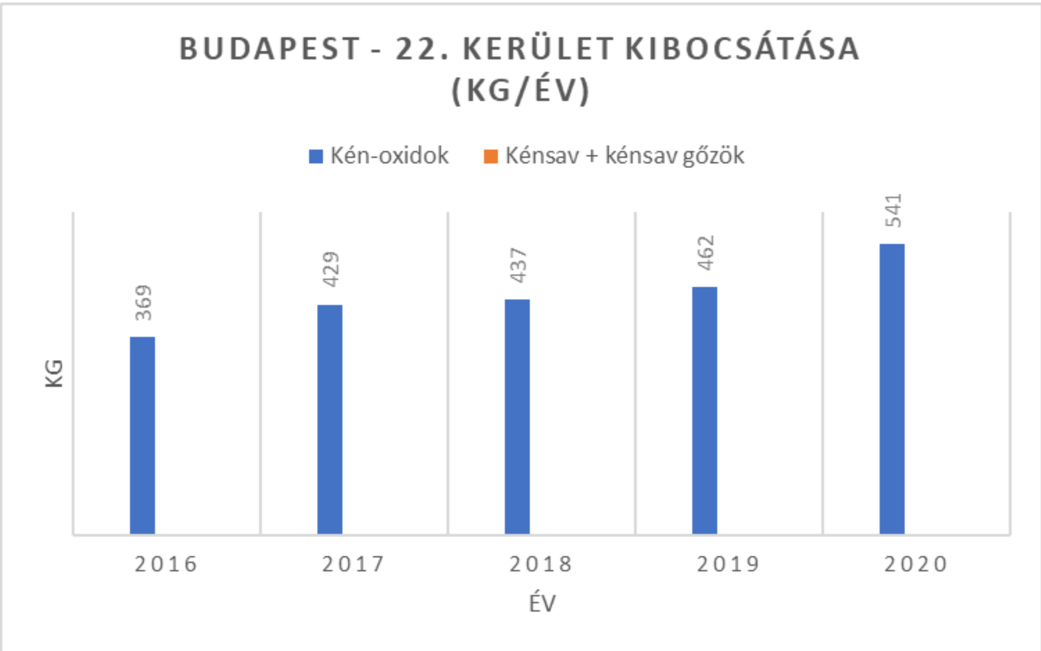

Figure 6. The XXII. district average annual (2016-2020) sulfur oxide emissions

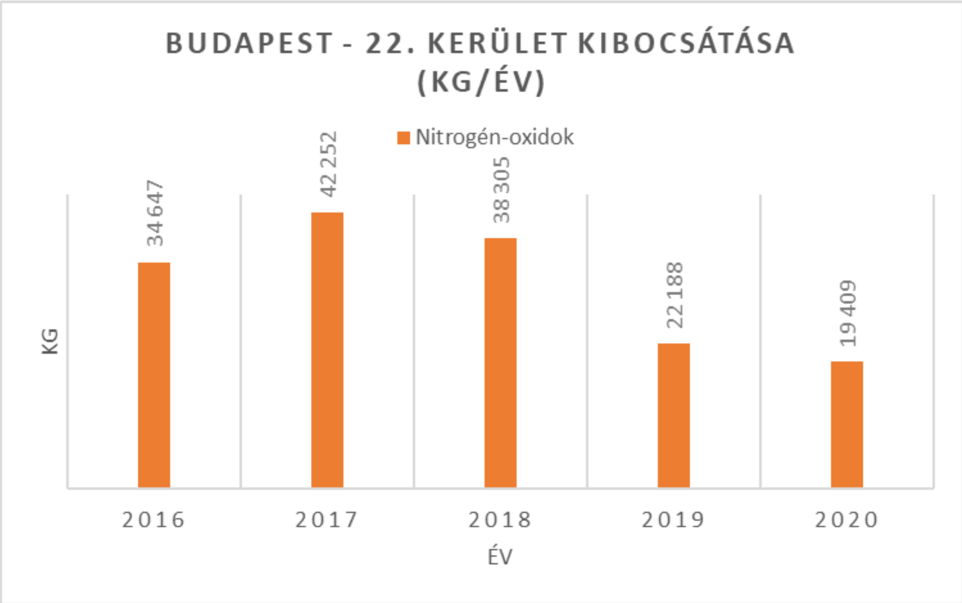

Figure 7 The XXII. district average annual (2016-2020) nitrogen oxide emissions

Examination of lichens around the industrial areas of Tatabánya

One of the important stops of our investigation was Tatabánya (Figure 9) and its industrial area. Tatabánya is located in the southern part of Komárom-Esztergom county in the Tatai ditch, which stretches between Vértes and Gerecse. It is bordered by the Vértes and Gercse rivers to the north, east and south, and the Kisalföld to the west. The largest water catchment in the region flows through the settlement, which is the Által River and the Galla stream. It is located 55 kilometers from Budapest, and its average height above sea level is 199 meters. It is considered a traffic hub at the county, regional and national level and is located almost halfway between Budapest and Győr. In terms of vehicular traffic, the M1 highway connecting Budapest and Vienna, the main road No. 1, and the Budapest-Hegyeshalom-Rajka railway pass through here. In addition to these, Tatabánya is of course connected to the surrounding settlements by high-traffic roads and, in terms of public transport, by other railway lines and bus routes.

The life of the city was determined by coal mining from 1894 until the regime change in 1989, which brought economic changes. The former coal, bauxite, stone mining, cement and aluminum production, as well as the state-owned construction industry activity gradually ceased or receded into the background. Their place was gradually taken over by the Industrial Park established in Tatabánya, which now operates in the following areas with 27 large companies:

• Machine industry
• Automotive industry
• Electronics
• Logistics, shipping
• Packaging technology and plastics industry
• Healthcare industry

In Tatabánya, the factories of the multinational companies are basically located in the area of the Industrial Park, which was established on the border of Tatabánya from the Környe side, but one or two larger companies have also settled on the site of the old mine buildings. Thus, we can say that two pollution zones with industrial activities have formed in Tatabánya. The companies located here are active in the following areas on the site of the buildings connected to the older mining industry:

- Machine industry
- Chemical industry
- Logistics
- Quarrying

- Sawmill

I completed my examination in the area of Tatabánya on 18.03.2022. The weather was cool, with temperatures around 5-10 °C. Location "A" (Figure 8) is located in the older industrial part of Tatabánya, near the production hall of a chemical multinational company, on Fatelepi út. Here, the huge traffic contributes to the pollution of the factory, as both a lot of trucks arrive at the factory and the neighboring logistics company handles a lot of traffic on an average day. Also, there is a sawmill and a quarry nearby, so the concentration of airborne dust is very high in the area. There are very few trees in the area due to industrial activities.

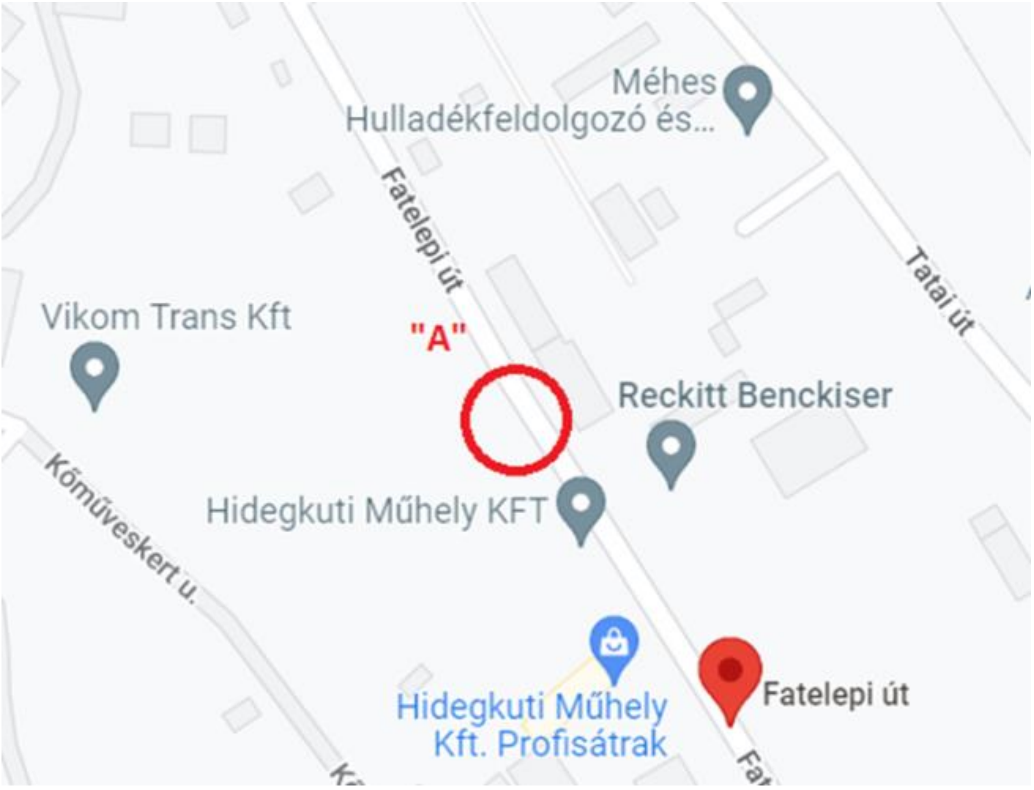

Figure 8. Sampling site "A" in front of Fatelepi 15

There are very few trees in the area due to industrial activities. I managed to find a total of 3 examinable trees in the area. (Figure 9)

	
Xanthoria parietina (Yellow wall lichen) • Colony: Lobos • Battery color: Golden yellow • Fruiting body: apothecium, orange-red	*Physcia adscendens* • The colony has a warty, vesicular, uneven surface, and the back is whitish • Colony: Lobos

• Socket: Tree bark • Size: Large, 10-12 cm	• Body color: ash gray • Size: Small, 2-5 cm
	
Xanthoria parietina (Sárga falizuzmó) • Colony: Lobos • Battery color: Golden yellow • Fruiting body: apothecium, orange-red • Size: Large, 5-10 cm • Socket: Tree bark • Other: The colony has a warty, vesicular, uneven surface, and the back is whitish	*Physcia adscendens* • Colony: Lobos • Body color: ash gray • Size: Small, 2-3 cm
	
Xanthoria parietina • Colony: Lobos • Battery color: Golden yellow • Fruiting body: apothecium, orange-red • Size: Large, 12-17 cm • Socket: Tree bark • Other: The colony has a warty, vesicular, uneven surface, and the back is whitish	*Physcia adscendens* • Colony: Lobos • Body color: ash gray • Size: Small, 1-2 cm

Figure 9. Collection and identification of lichen samples taken at Tatabánya (Fatelepi 15)

Based on the sampling, it can be said that Xanthoria parietina (Yellow wall moss) and Physcia adscendens are the dominant species at sampling location "A". Our next sampling site (Figure 10) was the Ifjúság grove, located not far from the "A" site, which is close to the Tatabánya thermal power plant and a busy road passes by it. The Park does not occupy a large area; there was no lichen to be found on most of the trees. (Figure 11)

Figure 10. "B" sampling location, the Youth Park, "Liget"

 

Physcia adscendens

- Colony: Lobos, Body color: ash gray, Size: Small, 3-4 cm

 

Flavoparmelia caperata

- Colony: Lobos;
- Colony color: Grey-green, possibly yellowish;
- Size: Small, 0.5-1cm;
- Base: Tree bark Other: its back is black

	
*Xanthoria parietina (*Yellow wall lichen*)* • Colony: Lobos • Battery color: Golden yellow • Fruiting body: apothecium, orange-red • Size: Small, about 0.5 cm • Socket: Tree bark • Other: The colony has a warty, vesicular, uneven surface, and the back is whitish	*Physcia adscendens* • Colony: Lobos • Body color: ash gray • Size: Small, 0.5 cm • Sporadic in several places on the trunk

Figure 11. The collection and identification of my lichen samples taken at Tatabánya (Youth Park (Liget))

Based on the sampling, it can be said that *Xanthoria parietina* (Yellow wall moss) and Physcia adscendens are the dominant species at the "B" sampling site, similarly to the "A" test site. Our next location (Figure 12) is about two kilometers from here, at a traffic junction. There is a 4-lane main road here with a lot of traffic, as well as a bus interchange and a gas station.

Figure 12. "C" sampling location, Károlyi Mihály utca

	

Xanthoria parietina • Colony: Lobos • Battery color: Golden yellow • Fruiting body: apothecium, orange-red • Size: Small, about 2-3 cm • Socket: Tree bark • Other: The colony has a warty, vesicular, uneven surface, and the back is whitish	*Physcia adscendens* • Colony: Lobos • Body color: ash gray • Size: Small, 0.5 cm • Sporadic in several places on the trunk
	
Xanthoria parietina • Colony: Lobos • Battery color: Golden yellow • Fruiting body: apothecium, orange-red • Size: Large, approx. 12 cm • Socket: Tree bark • Other: The colony has a warty, vesicular, uneven surface, and the back is whitish	*Physcia adscendens* • Colony: Lobos • Body color: ash gray • Size: very small, about 0.3 cm • Sporadic in several places on the trunk
	
Xanthoria parietina • Colony: Lobos • Battery color: Golden yellow • Fruiting body: apothecium, orange-red • Size: Small, about 0.5 cm • Socket: Tree bark	*Physcia adscendens* • Colony: Lobos • Colony color: ash gray, dark gray • Size: continuous layer • Trunk in several places

• Other: The colony has a warty, vesicular, uneven surface, and the back is whitish	

Figure 13. Collection and identification of my lichen samples taken at Tatabánya (Károlyi Mihály utca)

As in the previous two study sites, the same two species were dominant here. Our next test location was Bánhida in Tatabánya (Figure 14). It is a residential area, but there is a 2-lane road with heavy traffic next to my sampling location. (Figure 15)

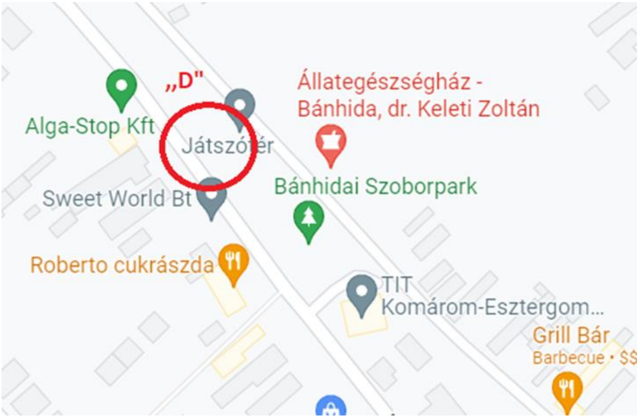

Figure 14. "D" sampling site, Bánhida sculpture park

<table>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Xanthoria parietina (Yellow wall lichen)
• Colony: Lobos
• Battery color: Golden yellow
• Fruiting body: apothecium, orange-red
• Size: Large, about 4 cm
• Socket: Tree bark
• Other: The colony has a warty, vesicular, uneven surface, and the back is whitish</td></tr>
</table>

	
Hypogymnia physodes (Swollen plate lichen) • Leafy lichen. • Color: grey. • Size: small, 0.5 cm and smaller • Its surface is matte, it has wrinkled lobes, the edges of the colonies are wrinkled. • Found on tree bark.	*Flavoparmelia caperata* • Colony: Lobos • Colony color: Grey-green, possibly yellowish • Size: Small, 0.5-1cm • Socket: Tree bark • Other: His back is black
	
Hypogymnia physodes (Swollen plate lichen) • Leafy lichen • Color: grey • Size: small, 0.5-1 cm • Its surface is matte, it has wrinkled lobes, the edges of the colonies are wrinkled. • Found on tree bark.	*Flavoparmelia caperata* • Colony: Lobos • Colony color: Grey-green, possibly yellowish • Size: Large, 4 cm • Socket: Tree bark • Other: His back is black

Figure 15. Collection and identification of lichen samples taken at Tatabánya (Bánhida)

Based on the sampling, it can be said that Hypogymnia physodes and Flavoparmelia caperata are the dominant species at sampling site "D". The location "E" is also a busy hub, there are grocery stores here, and a construction site is currently underway. The M1 ramp is also not far from it.

Figure 16. "E" sampling site on Győri út

	
Xanthoria parietina (Yellow wall lichen) • Colony: Lobos • Battery color: Golden yellow • Fruiting body: apothecium, orange-red • Size: Large, 15-20 cm • Socket: Tree bark • Other: The colony has a warty, vesicular, uneven surface, and the back is whitish	*Physcia adscende* • Colony: Lobos • Body color: ash gray • Size: Small, 1-2 cm

	
Xanthoria parietina (Yellow wall lichen) • Colony: Lobos • Battery color: Golden yellow • Fruiting body: apothecium, orange-red • Size: Large, 15-20 cm • Socket: Tree bark • Other: The colony has a warty, vesicular, uneven surface, and the back is whitish	*Physcia adscende* • Colony: Lobos • Body color: ash gray • Size: Small, about 1 cm scattered
	
Xanthoria parietina (Yellow wall lichen) • Colony: Lobos • Battery color: Golden yellow • Fruiting body: apothecium, orange-red • Size: Large, 5-10 centimeter colonies form vertically running strips that almost touch each other • Socket: Tree bark • Other: The colony has a warty, vesicular, uneven surface, and the back is whitish	*Physcia adscende* • Colony: Lobos • Body color: ash gray • Size: Small, 2-5 cm

Figure 17. The collection and identification of my lichen samples taken at Tatabánya (Győri út)

Yellow wall lichen was the most dominant species at this sampling site. Our last sampling location in Tatabánya took place in the area of the new industrial park, where there are very few trees. No lichens were found in the examined area (Figure 18).

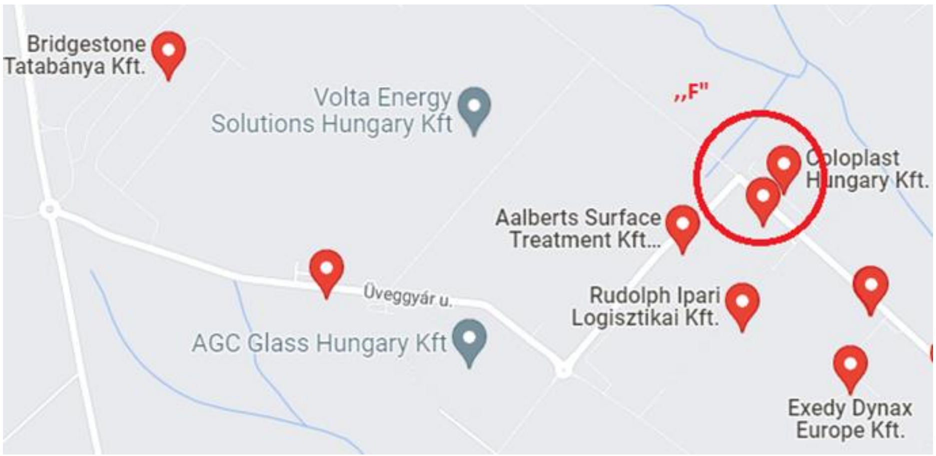

Figure 18. Sampling location "F" in the area of the industrial park

Table 2 summarizes how the number of trees with and without lichen developed on the trees examined in the area I chose: The Table shows how many testable samples we found among the trees in the selected area:

Table 2. Number of trees examined in Tatabánya, with and without lichens

Location	Area	Number of trees with lichens	Number of trees without lichens	Diameter	Type and number
Tatabánya	A	3	1	2-17 cm	Yellow and grey
	B	3	5	0,5-4 cm	Grey and yellow
	C	3	2	0-12cm	Grey and yellowish green
	D	3	4	0,5-4cm	Yellowish grey and grey
	E	3	0	1-20cm	Yellow and grey
	F	0	2	-	-

The following Figures show Tatabánya's emissions of various sulfur oxides and nitrogen oxides based on OKIR data between 2016-2020 (Figure 19, Figure 20), respectively.

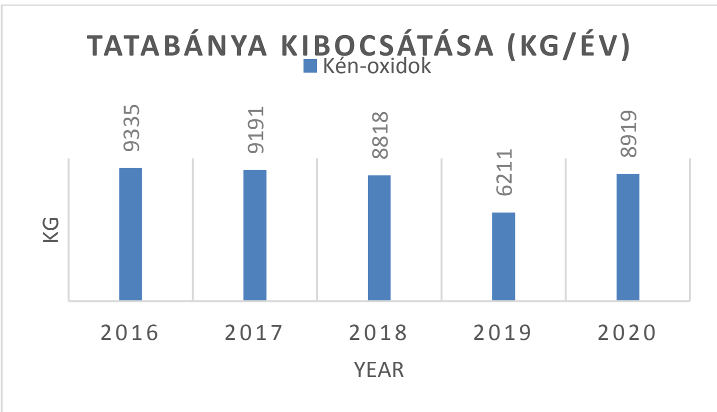

Figure 19. Average annual (2016-2020) sulfur dioxide emissions in Tatabánya

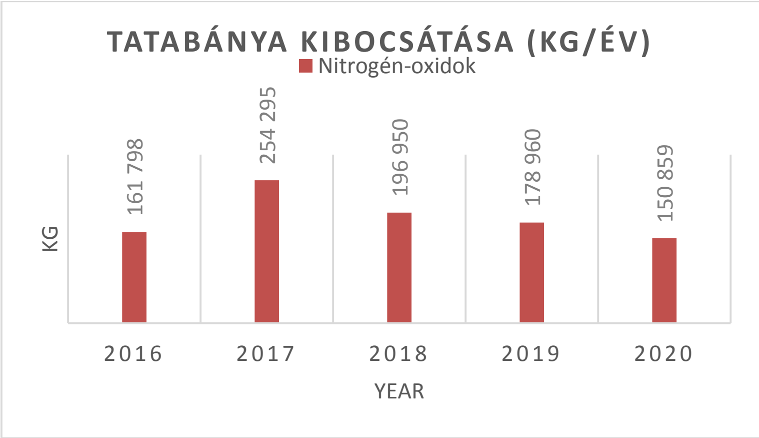

Figure 20. Average annual (2016-2020) sulfur dioxide emissions in Tatabánya

Examination of lichens in Budapest, XIII. district kindergartens Our examination in the XIII. We completed it in the area of district kindergartens on 11.03.2022 and 16.03.2022 (Figure 21) which shows the locations of the collections in the afternoon hours between 13.00 and 17.00. The weather was cool, with temperatures around 10-15 °C.

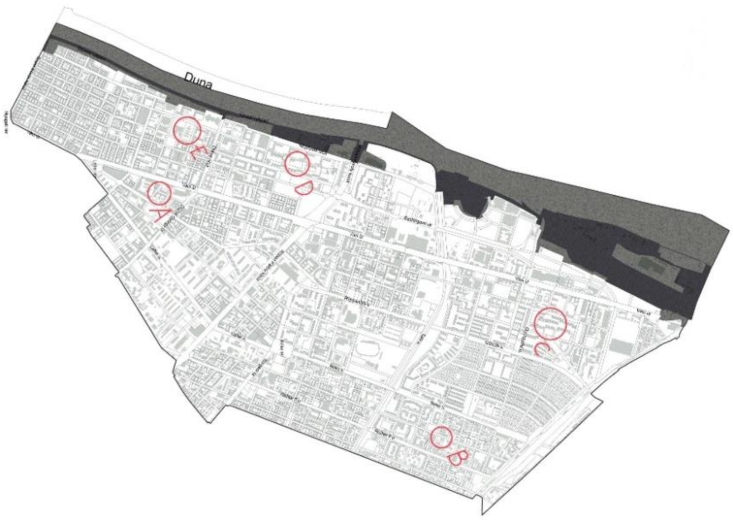

Figure 21. Map of the Budapest, XIII. district. Samples collection

The XIII. district is located on the Pest side of Budapest, next to the Danube. In the 20th century, it was considered one of Hungary's most important machinery industry centers, but after the change of regime, industrial activity took a backseat, and trade took over the leading role. The busiest roads in the district are: Váci út, Béke utca, Lehel utca, Újpest-rakpart, Róbert Károly körút, Dózsa György út and Szent István körút. The heavy traffic in this area results in significant noise and air pollution. It is one of the fastest developing districts of the capital. Construction is currently underway in several parts of the district, which creates a lot of airborne dust in the area. In the district, more and more emphasis is being placed on the development of groves and green areas and the construction of parks. The first test sites are located in the vicinity of location "A", Angyalföldi út and Lőportár utca (Figure 22).

Flavoparmelia caperata
• Colony: Leafy lichen. • Colony color: yellowish, greyish, greenish. • Size: larger, about 8-10 cm. • Fruiting body: Apothecium (yellowish, greyish) • Socket: Tree bark • Other: The lichen colony is damaged. Its surface is matte, its apothecia are slightly protruding and yellowish in color.

Flavoparmelia caperata (Yellow plate lichen)
• Colony: Leafy lichen. • Colony color is yellowish, greyish, greenish. • Size: smaller, about 1-2 cm. • Fruiting body: Apothecium (grey) • Socket: Tree bark • Other: The surface is matte, the apothecia are slightly protruding, wrinkled and yellowish in color. Damaged lichen colonies.

Flavoparmelia caperata (Yellow plate lichen)

• Colony: Leafy lichen. • Colony color: Yellowish, greyish. • Size: The colony is approximately 5-6 cm in diameter. • Fruiting body: Apothecium (orange) • Socket: Tree bark • Other: The surface is matte, the lobes are wrinkled and fragmented.

Physcia caesia
• Leafy lichen. • Its color is whitish, grey. • Size: small, 0.5 cm • Its surface is matte, it has wrinkled lobes, the edges of the colonies are wrinkled. • Found on tree bark.

Figure 22. The XIII. district: ollection and identification of collected lichen samples from the XIII. district (Angyalföldi út and Lőportár út)

Based on the samples, the most dominant species around area "A" is *Flavoparmelia caperata* (Yellow plate lichen). The location of the next investigation location is "B", this area around Jász utca and Rokolya utca.

Hypogymnia physodes (Swollen plate lichen)
• Leafy lichen. • Color: grey. • Size: small, 0.5 cm (many small ones scattered over a large area) • Its surface is matte, it has wrinkled lobes, the edges of the colonies are wrinkled. • Found on tree bark.

<table>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Hypogymnia physodes (Swollen plate lichen)
• Leafy lichen. • Color: grey. • Size: small, 0.5 cm (many small sizes scattered over a large area) • Its surface is matte, it has wrinkled lobes, the edges of the colonies are wrinkled. • Found on tree bark.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Flavoparmelia caperata (Yellow plate lichen)
• Leafy lichen. • Its color is yellowish, grey. • The diameter of the colony is approximately 3-4 cm. • Its surface is matte, its lobes are ruffled. • Found on tree bark</td><td>Hypogymnia physodes (Swollen plate lichen)
• Leafy lichen. • Color: grey. • Size: difficult to determine, covers a large area of the tree trunk • Its surface is matte, it has wrinkled lobes, the edges of the colonies are wrinkled. • Found on tree bark.</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Hypogymnia physodes (Swollen plate lichen)</td></tr>
</table>

• Leafy lichen. • Color: grey. • Size: small, 0.5 cm (many small sizes scattered over a large area) • Its surface is matte, it has wrinkled lobes, the edges of the colonies are wrinkled. • Found on tree bark.	
	
Hypogymnia physodes (Swollen plate lichen) • Leafy lichen. • Color: grey. • Size: Undeterminable, dense, scattered over a large surface • Its surface is matte, it has wrinkled lobes, the edges of the colonies are wrinkled. • Found on tree bark.	

Figure 23. The XIII. collection and identification of lichen samples from the district (around Jász utca and Rokolya utca)

Based on the pictures, it can be observed that the most dominant species around area "B" is *Hypogymnia physodes* (Swollen plate lichen). The location of next investigation and location is "C", located at the Gyöngyösi promenade and its surroundings

	
Xanthoria parietina (Yellow wall lichen) • Colony: Lobos • Colon color: golden yellow • Fruiting body: apothecium • Size: small, 2-3 cm • Base: tree bark • Other: Colony uneven with warts and blisters	*Phaeophyscia orbicularis* • Colony: Lobos • Battery color: Dark gray • Fruiting body: Apothecium • Size: Small, 0.5 cm • Socket: Tree bark • Other: The surface is matte, it has wrinkled lobes, the edges of the colonies are wrinkled.


Hypogymnia physodes (Swollen plate lichen)
• Colony: Lobos • Body color: Ash gray • Size: Small, 2-3 cm • Socket: Tree bark • Other: The colony consists of frills overlapping each other at the edges and curling up like a lip at the ends.


Hypogymnia physodes (Swollen plate lichen)
• Colony: Lobos • Body color: Ash gray • Size: Small, 0.5 cm (Dense, covers a large surface on the bark of the tree) • Socket: Tree bark • Other: The colony consists of frills overlapping each other at the edges and curling up like a lip at the ends.


Physcia adscendens
• Colony: Lobos • Body color: ash gray • Size: Large, 10-15 cm • Other: Light-colored eyelashes can be seen on the edges of slender frills. The end of the frills bulges out in the shape of a helmet.

<table>
<tr><td></td><td></td></tr>
<tr><td>Xanthoria parietina (Yellow wall lichen) • Colony: Lobos • Battery color: Golden yellow • Fruiting body: apothecium, orange-red • Size: Large 5-6 cm • Socket: Tree bark • Other: The colony has a warty, vesicular, uneven surface, and the back is whitish</td><td>Physcia adscendens
• Colony: Lobos • Body color: ash gray • Size: Small, 0.5-1 cm • Other: Light-colored eyelashes can be seen on the edges of slender frills. The end of the frills bulges out in the shape of a helmet.</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Physcia adscendens
• Colony: Lobos • Body color: ash gray • Size: Small, 0.5-1 cm (They are located densely on the bark of the tree, covering a large surface) • Other: Light-colored eyelashes can be seen on the edges of slender frills. The end of the frills bulges out in the shape of a helmet.</td></tr>
</table>

<table>
<tr><td></td><td></td></tr>
<tr><td>Physcia adscendens
• Colony: Lobos • Body color: ash gray • Size: Large, 10-15 cm • Other: Light-colored eyelashes can be seen on the edges of slender frills. The end of the frills bulges out in the shape of a helmet.</td><td>Flavoparmelia caperata (Yellow plate lichen)
• Colony: Lobos • Colony color: Yellowish, greyish • Size: Small, 1 cm • Socket: Tree bark • Other: The surface is matte, it has wrinkled lobes, the edges of the colonies are wrinkled.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Physcia adscendens
• Colony: Lobos • Body color: ash gray • Size: Small, 2-3 cm • Other: Light-colored eyelashes can be seen on the edges of slender frills. The end of the frills bulges out in the shape of a helmet.</td><td>Flavoparmelia caperata (Yellow plate lichen)
• Colony: Lobos • Colony color: Yellowish, greyish • Size: Small, 2-3 cm • Fruiting body: Apothecium, yellow • Socket: Tree bark • Other: The surface is matte, it has wrinkled lobes, the edges of the colonies are wrinkled.</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Xanthoria parietina (Yellow wall lichen)</td></tr>
</table>

• Colony: Lobos • Battery color: Golden yellow • Size: 4-5 cm • Fruiting body: Apothecium, orange • Socket: Tree bark • Other: The surface is matte, it has wrinkled lobes, the edges of the colonies are wrinkled.	
	
Hypogymnia physodes (Swollen plate lichen) • Colony: Lobos • Body color: Ash gray • Size: Can't be determined (Dense, covers a large area on the bark of the tree) • Socket: Tree bark • Other: The colony consists of frills that overlap each other at the edges and bend up like a lip at the ends	

Figure 24. The collection and identification of the lichen samples from the XIII. district (Gyöngyösi sétány).

Based on the pictures, it can be observed that the most dominant species around area "C" is *Physcia adscendens*. The location of the next investigation is the location "D", Vizafogó promenade and its surroundings.

	
Hypogymnia physodes (Duzzadt tányérzuzmó) • Hypogymnia physodes (Swollen plate lichen) • Colony: Lobos • Body color: Ash gray • Size: Small, 0.5 cm (Rarely, scattered on the bark of the tree) • Socket: Tree bark • Other: The colony consists of frills overlapping each other at the edges and curling up like a lip at the ends.	

Hypogymnia physodes (Swollen plate lichen)
• Colony: Lobos • Body color: Ash gray • Size: Small, 0.5 cm (Rarely, scattered on the bark of the tree) • Socket: Tree bark • Other: The colony consists of frills overlapping each other at the edges and curling up like a lip at the ends.

Hypogymnia physodes (Swollen plate lichen)
• Colony: Lobos • Body color: Ash gray • Size: Small, 0.5 cm (Rarely, scattered on the bark of the tree) • Socket: Tree bark • Other: The colony consists of frills that overlap each other at the edges and bend up like a lip at the ends

Flavoparmelia caperata (Yellow plate lichen)
• Colony: Lobos • Colony color: Yellowish, greyish • Size: Small, 4-5 cm • Fruiting body: Apothecium, yellow • Socket: Tree

Physcia adscendens
• Colony: Lobos • Body color: ash gray • Size: It is difficult to determine, it is densely located on a large surface on the trunk of the tree. • Other: Light-colored eyelashes can be seen on

<table>
<tr><td>bark Other: The surface is matte, it has wrinkled lobes, the edges of the colonies are wrinkled.</td><td>the edges of slender frills. The end of the frills bulges out in the shape of a helmet.</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Hypogymnia physodes (Swollen plate lichen)
• Colony: Lobos • Body color: Ash gray • Size: Small, 1 cm (Rarely, scattered on the bark of the tree) • Socket: Tree bark • Other: The colony consists of frills overlapping each other at the edges and curling up like a lip at the ends.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Flavoparmelia caperata (Yellow plate lichen)
• Colony: Lobos • Colony color: Yellowish, greyish • Size: Small, 4-5 cm • Fruiting body: Apothecium, yellow • Socket: Tree bark Other: The surface is matte, it has wrinkled lobes, the edges of the colonies are wrinkled.</td><td>Physcia adscendens
• Colony: Lobos • Body color: ash gray • Size: It is difficult to determine, it is densely located on a large surface on the trunk of the tree. • Other: Light-colored eyelashes can be seen on the edges of slender frills. The end of the frills bulges out in the shape of a helmet.</td></tr>
</table>

Figure 25. The collection and identification of lichen samples from the XIII. district (Vizafogó sétány).

The most dominant lichen species around area "D" is *Physcia adscendens*. The location of my next investigation is the location "E", it is located at the Karpát and the vicinity of Vág utca (Figure 26).

<table>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Flavoparmelia caperata (Yellow plate lichen)
• Colony: Lobos • Colony color: Yellowish, greenish • Size: Small, 0.5-1 cm (Scattered on a small surface) • Fruiting body: Apothecium, yellow • Socket: Tree bark Other: The surface is matte, it has wrinkled lobes, the edges of the colonies are wrinkled.</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Hypogymnia physodes (Swollen plate lichen)
• Colony: Lobos • Body color: Ash gray • Size: Small, 0.5 cm (Rarely, scattered on the bark of the tree) • Socket: Tree bark • Other: The colony consists of frills overlapping each other at the edges and curling up like a lip at the ends.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Hypogymnia physodes (Swollen plate lichen)</td><td>Flavoparmelia caperata (Yellow plate lichen)</td></tr>
</table>

• Colony: Lobos • Body color: Ash gray • Size: Small, 0.5 cm • Base: Fabric material on tree bark • Other: The colony consists of frills overlapping each other at the edges and curling up like a lip at the ends.	• Colony: Lobos • Colony color: Yellowish, greenish • Size: Small, 0.5 cm (Scattered on a small surface, damaged) • Socket: Tree bark Other: The surface is matte, it has wrinkled lobes, the edges of the colonies are wrinkled.
	
Flavoparmelia caperata (Yellow plate lichen) • Colony: Lobos • Colony color: Yellowish, greyish • Size: Small, 4-5 cm • Fruiting body: Apothecium, yellow • Socket: Tree bark Other: The surface is matte, it has wrinkled lobes, the edges of the colonies are wrinkled.	*Phaeophyscia orbicularis* • Colony: Lobos • Battery color: Dark gray • Fruiting body: Apothecium • Size: Small, 4-5 cm Base: Tree bark • Other: The surface is matte, it has wrinkled lobes, the edges of the colonies are wrinkled.
	
Flavoparmelia caperata (Yellow plate lichen) • Colony: Lobos • Colony color: Yellowish, greyish • Size: Small, 4-5 cm • Fruiting body: Apothecium, yellow • Socket: Tree bark Other: The surface is matte, it has wrinkled lobes, the edges of the colonies are wrinkled.	Swollen • Colony: Lobos • Battery color: Dark gray • Fruiting body: Apothecium • Size: Difficult to determine, covers a large surface, approx. 100 cm • Socket: Tree bark • Other: The surface is matte, it has wrinkled lobes, the edges of the colonies are wrinkled.

	
Flavoparmelia caperata (Yellow plate lichen) • Colony: Lobos • Colony color: Yellowish, greyish • Size: Small, 2-3 cm • Socket: Tree bark Other: The surface is matte, it has wrinkled lobes, the edges of the colonies are wrinkled.	*Phaeophyscia orbicularis* • Colony: Lobos • Battery color: Dark gray • Fruiting body: Apothecium • Size: Small, 2-3 cm (Several smaller ones are scattered on the tree trunk) • Socket: Tree bark • Other: The surface is matte, it has wrinkled lobes, the edges of the colonies are wrinkled
	
Physcia adscendens • Colony: Lobos • Body color: ash gray • Size: It is difficult to determine, it is densely located on a large surface on the trunk of the tree, about 1 m in size. • Other: Light-colored eyelashes can be seen on the edges of slender frills. The end of the frills bulges out in the shape of a helmet.	*Flavoparmelia caperata* (Yellow plate lichen) • Colony: Lobos • Colony color: Yellowish, greyish • Size: Small, 2-3 cm • Fruiting body: Apothecium, yellow • Socket: Tree bark • Other: The surface is matte, it has wrinkled lobes, the edges of the colonies are wrinkled.

<table>
<tr><td></td><td></td></tr>
<tr><td>Physcia adscendens
• Colony: Lobos • Body color: ash gray • Size: It is difficult to determine, it is densely located on a large surface on the trunk of the tree, about 1.5 m in size. • Other: Light-colored eyelashes can be seen on the edges of slender frills. The end of the frills bulges out in the shape of a helmet.</td><td>Xanthoria parietina (Yellow wall lichen)
• Colony: Lobos • Battery color: Yellow • Size: Small, 2-3 cm • Fruiting body: Apothecium, yellow • Socket: Tree bark • Other: The surface is matte, it has wrinkled lobes, the edges of the colonies are wrinkled.</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Phaeophyscia orbicularis
• Colony: Lobos
• Battery color: Dark gray
• Fruiting body: Apothecium
• Size: Large, covers most of the tree trunk, about 1.5 in height.
• Socket: Tree bark
• Other: The surface is matte, it has wrinkled lobes, the edges of the colonies are wrinkled.</td></tr>
</table>

 

Hypogymnia physodes (Swollen plate lichen)
• Colony: Lobos • Body color: Ash gray • Size: Large, covering the trunk of the tree at a height of about 1.5 m. • Socket: Tree bark • Other: The colony consists of frills overlapping each other at the edges and curling up like a lip at the ends.

Figure 26. The collection and identification of lichen samples from the XIII. district (Kárpát utca and Vág utca)

The most dominant species from the investigated area "E" is *Physcia adscendens*, which can be found on the largest surface.
The following Table 3 shows how many testable samples we found among the trees in the selected area.

Table 3. The number of trees examined in the XIII. district, with and without lichen

Location	Area	Number of trees with lichens	Number of trees without lichens	Diameter	Type and number
Budapest XIII. kerület	A	4	3	0.5-10 cm	Yellowish-grey, grey
	B	5	2	0.5 -4 cm	Yellowish-grey, grey
	C	10	3	0.5-150 cm	Yellowish-grey, grey, yellow
	D	8	2	0.5- 20/30 cm	Yellowish-grey, grey
	E	10	4	0.5-160 cm	Yellowish-grey, grey, yellow

The following Fgures 27 and 28 are showing the emissions of various sulfur oxides and nitrogen oxides from XIII. district based on OKIR data between 2016-2020.

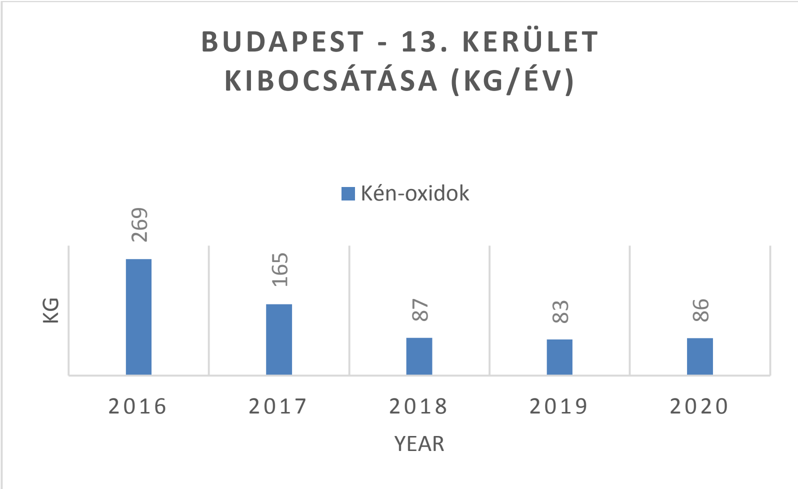

Figure 27. The XIII. district average annual (2016-2020) sulfur oxide emissions

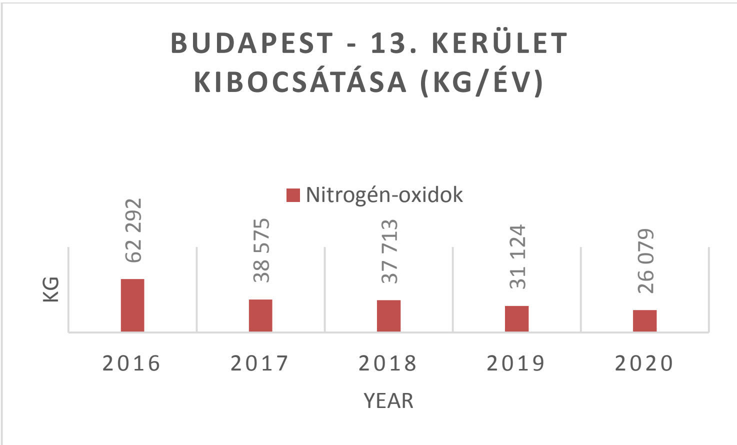

Figure 28. Average annual (2016-2020) nitrogen oxide emissions in XIII. District

EXAMINATION OF LICHENS IN THE XX. DISTRICT RESIDENTIAL AREA

Pesterzsébet, Budapest XX. district (Figure 29), touching the banks of the Soroksári-Danube, it is located in South Pest. Its area is 2.3% of the total area of the capital, which makes it the seventeenth place among Budapest's 23 districts. The district consists predominantly of residential properties, its industry is negligible. An important institution of the district is the Jahn Ferenc Dél-Pest Hospital, which was handed over in 1980. In the northwest, along the Határ road, the IX. bordering the district, in the northeast, it is separated from the XIX. from the district, Soroksár separated from the district from the south, the XXIII. district, while on the western edge is the Ráckevei (or Soroksári)-Danube, on the other side of which is Csepel, the XXI. district is located. The Gubacsi Bridge (or Csepel Passage) spanning the river connects the town with Csepel Island.

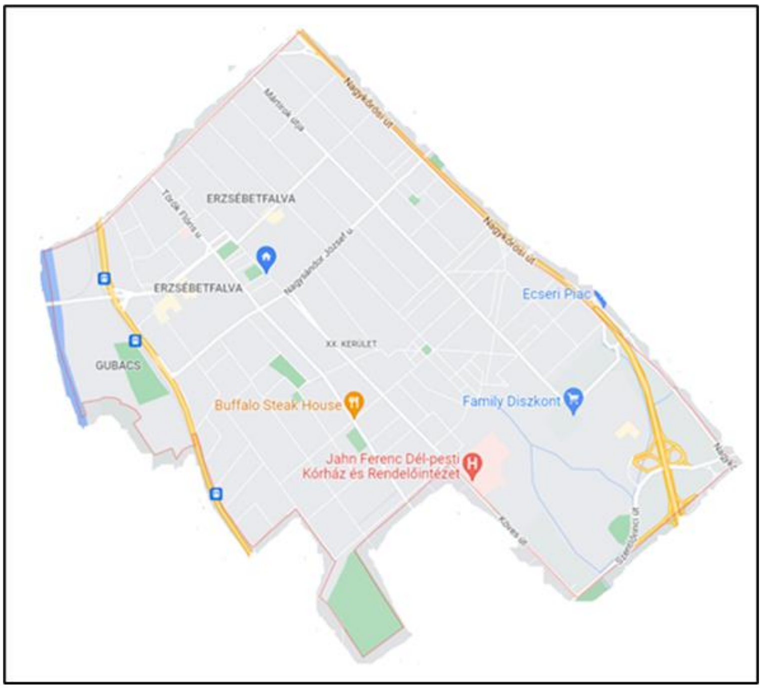

Figure 29. Map of collection sites in Budapest XX. district

Traffic in the district is relatively quiet, because a significant part of the roads with heavy traffic run along the edge of the district (Soroksári út on the west side, the entrance section of the M5 highway on the east, Határ út on the north). From the south, the fastest approach by rail is HÉV H6 and the Budapest–Kunszentmiklós–Tass–Kelebia railway line. Both railways have stops near the city centre. The study of lichens is the whole of the 20th century. District-wide. The main environmental impacts are caused by traffic.

	

Pertusaria albescens
A family of bark beetles • Colony color: greenish white. grayish white. • Fruiting body: apothecium, rare. • Base: tree bark. • Habitat: wooded, light-rich forest. • Frequency: common. Other: its colony is surrounded by a white precolony, on which characteristic small, white spot corals can be seen.

	*Flavoparmelia caperata* A Family of Deciduous Plants • Colony color: yellowish green, greyish green. • Fruiting body: apothecium, rare. • Substrate: tree bark, rock. • Habitat: wooded, light-rich forest, rare orchard. • Frequency: common. • Other: declining due to increasing air pollution.
	*Flavoparmelia caperata* (Yellow plate lichen) • Colony color: greenish gray. • Fruiting body: apothecium, yellowish-brown, red-brown. • Base: tree bark. • Habitat: also in human environment. • Frequency: moderately common. • Other: a species of lichen resistant to air contamination (toxitolerant).
	*Xanthoria parietina* Deciduous • Colony color: golden yellow, orange. • Fruiting body: apothecium, orange-red. • Substrate: tree bark, rock. • Habitat: open, rich in light, also in a human environment. • Frequency: common. • Other: colony with warty, vesicular, uneven surface, thread whitish.

Figure 30. The collection and identification of lichen samples from in the XX. district

The most dominant lichen species around District XX is *Flavoparmelia caperata* (Yellow plate lichen), which can be found on the largest surface. The following Figures 31 and 32 show the emissions of various sulfur oxides and nitrogen oxides based on OKIR data between 2016 and 2020.

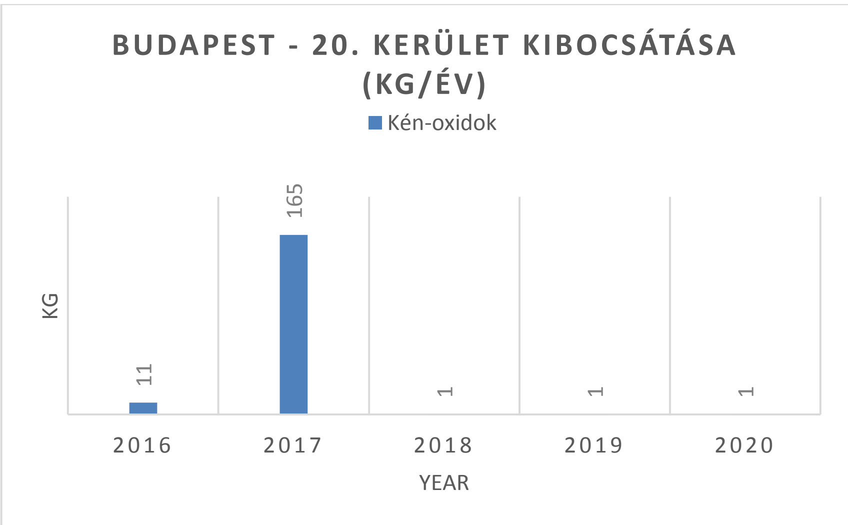

Figure 31. The XX. district average annual (2016-2020) sulfur oxide emissions

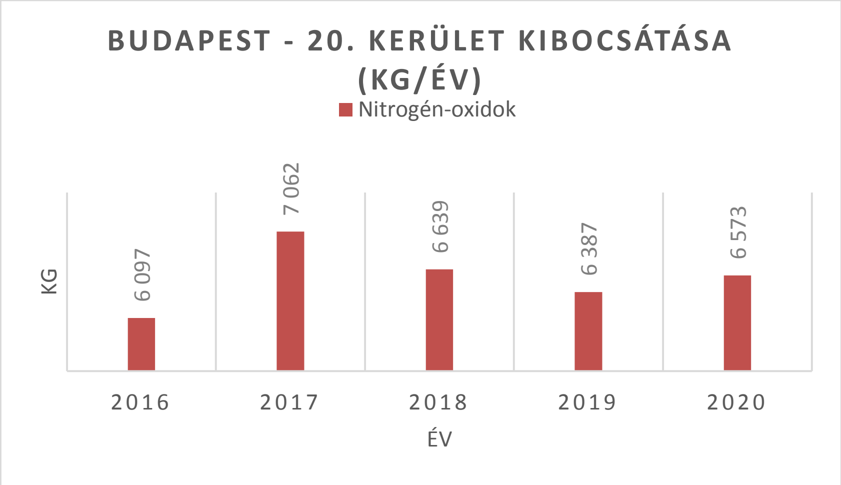

Figure 32 The XX. district average annual (2016-2020) nitrogen oxide emissions

EXAMINATION OF LICHENS IN VÁRGESZTES

Characterization of Várgesztes

Territorially, the settlement of Várgesztes belongs to the geographical large landscape of the Transdanubia Mountains, within it the Vértes-Velencei Mountains to the central landscape, the Vértes Mountains to the small landscape group and the Vértes Peripheral Region to the small landscape. It is located on the edge of Komárom-Esztergom County, in the northwestern part of the Vértes Mountains, in a valley, 17 kms from Tatabánya. It can be approached by a single road, a sack village. There is very little vehicular traffic, and there are no industrial areas in the vicinity (Figure 33).

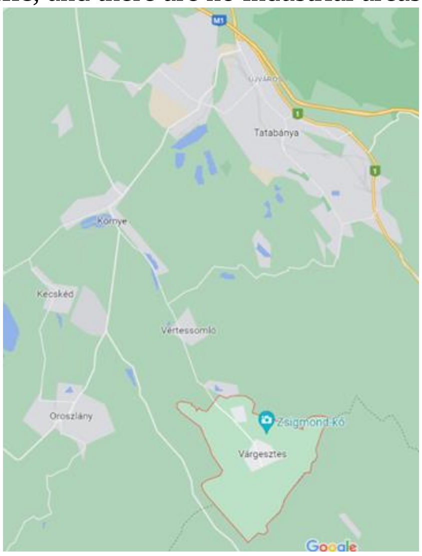

Figure 33. Location of Várgestes compared to the surrounding settlements

Topography: The structure of the Vértes is sásslar and slightly more segmented than that of neighboring Gerecs to the north and Bakony to the south. On average, there are valleys with a length of 4 km projected onto an area of 1 km^2. The trench basins in Várgestes and Vérteskosma are tectonic trench basins covered with Tertiary sediments between tuffaceous cherts, which follow fault lines in a southwest-northeast direction. From a landscape ecological point of view, vertical separation can be said about forest communities. The Atlantic influence is in effect, thanks to which it is a rainier area, the average annual rainfall exceeds 700 mm. In the northern part, approximately a few hundred millimeters more precipitation falls than in the southern parts.

Climate: The climate of Várgestes can be said to be very specific. The surrounding elevations, which exceed 400 m, are characterized by a moderate cool, wet, mild winter climate. However, in the pool where the village is located, the average annual temperature is 9°C, 16°C in the summer semester, with an average July temperature of 19.5-20°C. The low temperature is partly due to the fact that the North Vértes can be classified as one of the more gloomy landscapes of our country. The annual average of cloud cover is nearly 60%, and can reach up to 45% in summer. The Gestes basin is particularly characterized by damp weather with fog formation. The number of foggy days can be up to 30-40 days per year. For example, in December, the pool is shrouded in fog for an average of 6-8 days. Due to the average cloud cover, the number of sunny hours can only be 1900-2000 hours. The summer is moderately hot; there are 5-20 so-called hot days out of 60 summer days. This can be considered low in national terms.
There is no strong summer warming in the pool. The frosty period covers a large part of the year, since the first autumn frost sets in already in mid-October and frosty days are frequent until the end of April. These days make roughly 100 days. Thanks to the effect of the pool, the winter is not extreme, but moderately cold, with an average temperature of 2°C. The number of winter days is more than 35. On average, we can talk about 35-45 days with snow, when the thickness of the snow is 7-9 cm, in rare cases a maximum of 80 centimeters.
Blows of snow are common. It is interesting that, leaving the Gesztes basin, it can be 1-2°C cooler than the Somlói bridge, despite this, the snow melts in the basin up to 2-3 weeks later than on the plain in front of it.
The prevailing wind direction in the area is north-west, which is reinforced by the Móri and Tatai moats. The wind speed is around 3-3.5 m/s.
The distribution of the annual 700 mm of precipitation is as follows:
• Maximum: June is the wettest, with an average of 65-85 mm of rain
• Second maximum: November, 60-80 mm is typical
• Minimum: March is the poorest in terms of precipitation, characterized by 30-40 mm Although in terms of the number of rainy days, the area is above the national average with its 140-170 rainy days, and the landscape is subject to high precipitation uncertainty. A single rain can be followed by a longer dry period or even a year.

Hydrogeography There are few watercourses in Vértes, the reason for which is that the dolomite has an extremely good water storage capacity, and the water permeability of the loose soil and crumbly, gravelly rocks found here is also very high. The consequence of this is that precipitation can seep deeply in a fairly short time. So it is not surprising that the Gesztesi stream also appears in a wet area, but its water yield is very small.
The water quality of the water in the Gesztes basin has improved significantly since the canal system was established in 1993. Flora-Fauna Due to the segmentation of Vértes, we can observe a rich fauna and flora in this area. We can meet many protected animal species, such as the bald eagle or the peregrine falcon, the alpine and the mourning hawk. Among the plants, we can see sand female petals or even black and maidenhair primrose, bear's ear primrose.
Although Várgesztes is marked on the vegetation maps at the boundary of the cherry-oak and chert-oak areas, there are also pines, beeches and acacias here. Unfortunately, the size of the forest has shrunk significantly in recent times due to human activity and forestry reasons, thus having a significant impact on the lichens that live here. Várgestes can therefore be said to be a very favorable habitat for various lichens.
There is a difference in level between the different locations and the water supply of the areas also varies.We took the samples on the afternoon of March 26. Sampling site "A" is located in a dead-end street at 6 Erdősor utca. Vehicle traffic can only be experienced in the morning and evening hours. (Figures 34 and 35).

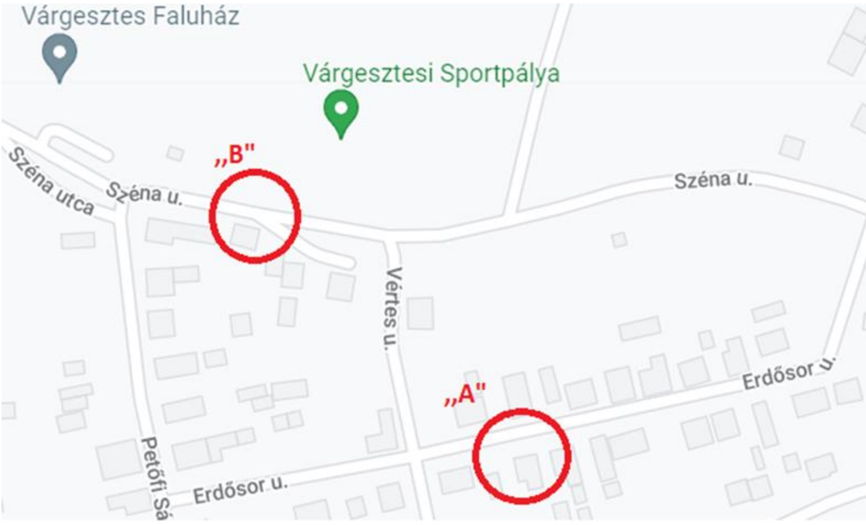

Figure 34. Sampling sites "A" and "B" in Várgesztes

	
Xanthoria parietina (Yellow wall lichen) • Colony: Lobos • Battery color: Golden yellow • Fruiting body: apothecium, orange-red • Size: Large 5-6 cm • Socket: Tree bark • Other: The colony has a warty, vesicular, uneven surface, and the back is whitish	*Physcia adscendens* • Colony: Lobos • Body color: ash gray • Size: Small, 0.5-1 cm
	
Xanthoria parietina (Yellow wall lichen) • Colony: Lobos • Battery color: Golden yellow • Fruiting body: apothecium, orange-red • Size: approx. 5 cm • Socket: Tree bark • Other: The colony has a warty, vesicular, uneven surface, and the back is whitish	*Physcia adscendens* • Colony: Lobos • Body color: ash gray • Size: Small, 0.5-2 cm scattered in several places on the trunk

	
Xanthoria parietina (Yellow wall lichen) • Colony: Lobos • Battery color: Golden yellow • Fruiting body: apothecium, orange-red • Size: 4-5 cm • Socket: Tree bark • Other: The colony has a warty, vesicular, uneven surface, and the back is whitish	*Physcia adscendens* • Colony: Lobos • Body color: ash gray • Size: approx. 0.5 cm
	
Xanthoria parietina (Yellow wall lichen) • Colony: Lobos • Battery color: Golden yellow • Fruiting body: apothecium, orange-red • Size: 5-7 cm, several large colonies on the trunk and branches • Socket: Tree bark • Other: The colony has a warty, vesicular, uneven surface, and the back is whitish	*Physcia adscendens* • Colony: Lobos • Body color: ash gray • Size: Small, 0.3-0.5 cm
	
Xanthoria parietina (Yellow wall lichen) • Colony: Lobos • Battery color: Golden yellow • Fruiting body: apothecium, orange-red • Size: 7-10 cm, mainly on the branches • Socket: Tree bark • Other: The colony has a warty, vesicular, uneven surface, and the back is whitish	*Physcia adscendens* • Colony: Lobos • Body color: ash gray • Size: 3-4 cm

Figure 35. Collection and identification of lichen samples taken in Várgesztes (Erdősor utca)

Based on the samples, *Xanthoria parietina* (Yellow wall moss) and *Physcia adscendens* are the most dominant in area "A". The other sampling location "B" is the sports field in the village center. In addition, there is the village hall, kindergarten and a cemetery, so there is little traffic here. I was able to document the following lichens on the sports field:

	
Xanthoria parietina (Yellow wall lichen) • Colony: Lobos • Battery color: Golden yellow • Fruiting body: apothecium, orange-red • Size: Stripes running vertically on the trunk • Socket: Tree bark • Other: The colony has a warty, vesicular, uneven surface, and the back is whitish	*Physcia adscendens* • Colony: Lobos • Body color: ash gray • Size: Small, 0.5-1 cm
	
Flavoparmelia caperata • Colony: Lobos • Colony color: Grey-green, possibly yellowish • Size: 3-4 cm • Socket: Tree bark • Other: His back is black	*Physcia adscendens* • Colony: Lobos • Body color: ash gray • Size: Scattered on the trunk
	
Flavoparmelia caperata • Colony: Lobos • Colony color: Grey-green, possibly yellowish • Size: 2-5 cm • Socket: Tree bark • Other: His back is black	*Physcia adscendens* • Colony: Lobos • Body color: ash gray • Size: 0.5 – 2 cm colonies touching each other on the trunk

Figure 36. The collection and identification of my lichen samples taken at Várgestztes (Sports Field)

Based on the samples collection, *Physcia adscendens* is the most dominant in area "B". The following Table shows how many samples were found on the trees in the selected area (Table 4).

Table 4. Number of trees examined in Várgeszte, with and without lichen

Location	Area	Number of trees with lichens	Number of trees without lichens	Diameter	Type and number
Várgesztes	A	5	0	0,3-7 cm	Yellow-grey Grey Yellow-green
	B	3	0	0,5-5 cm	Yellowish-grey Grey Yellow-green

At the sampling locations, we found that the lichen colonies are extensive, healthy and grow abundantly. In the following table, we have summarized the typically dominant lichen species of the investigated areas (Table 5):

Table 5. Summary of dominant lichen species in the investigated areas

Area	Location	dominant Lichen
Tatabánya	**A**	***Xanthoria parietina*** ***Physcia ascendens***
	B	*Xanthoria parietina* *Physcia ascendens*
	C	*Xanthoria parietina* *Physcia ascendens*
	D	*Hypogymnia physodes* *Flavoparmelia caperata*
	E	*Xanthoria parietina*
	F	-
XXII. kerület		-
XIII. kerület	A	*Flavoparmelia caperata*
	B	*Hypogymnia physodes*
	C	*Physcia ascendens*
	D	*Physcia ascendens*
	E	*Physcia ascendens*
XX. kerület		*Flavoparmelia caperata*
Várgesztes	A	*Xanthoria parietina* *Physcia ascendens*
	B	*Physcia ascendens*

CONCLUSION AND SUGGESTION

Based on our investigation, we conclude that in the industrial areas of Tatabánya and XXII. district in Budapest have a high level of pollution, which is not healthy for humans and other living beings. As we explained in the literature section, the high content of nitrogen dioxide and sulfur dioxide in the air can damage the mucous membrane, cause respiratory diseases and even lead to an asthma attack, and when it gets into the bloodstream, it can inhibit oxygen delivery. In addition, it can also have a negative impact on the ecosystem in terms of development and can also cause the buildings to corrode. The XIII. district and XX. district is characterized by significantly less air pollution data, and in addition, their environmental conditions can also have a positive effect on them. Thanks to the location next to the Danube, pollutants are cleared from the air in this area more quickly due to the wind. In addition, green areas are also common, where there is a chance for dirt to accumulate. For example, XIII. In the sampling area of district "A", we can see damaged lichens in several places, which can be caused by the fact that, in addition to being located near busy roads, there is little wooded area around it, so there is nothing to catch dirt coming from the direction of traffic. On the other hand, the test sites "C", "D", and "E" are located near park areas and the Danube, where several factors ensure adequate air exchange and purification. Várgesztes, like small rural settlements, has the most ideal properties in all respects compared to the other areas we examined, which can also be seen in the lichen samples. Nitrogen dioxide is produced by the burning of fossil fuels and natural gas, or by the use of vehicles, mainly diesel fuel. We can even contribute to reducing them by replacing the heating with more environmentally friendly solutions, such as heat pumps, ground probe heat pumps, or electric heaters. And during transport, we can give preference to public transport or electric vehicles. In the literature review, we also touched on the positive effects of the green environment, trees, shrubs and bushes, with the help of which microclimates are recommended, especially in residential areas, workplaces and educational institutions.

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Article submitted to the Proceedings Book of the VIth. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

EFFICACY OF DISPOSAL WASTEWATER SLUDGE AS "CLEAN" FERTILIZER

Hosam E.A.F. BAYOUMI HAMUDA[1], Fatma H. EL-FALLAH[2], Márta BERECZ[1], András SZEDER[1], András MÉNESI[1], Júlia KASZÁS[1]

*[1]Institute of Environmental Engineering and Natural Sciences, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Budapest, Hungary, *E-mail: Bayoumi.hosam@uni-obuda.hu, +36303900813 [2]Botany Department, Faculty of Science, Ajdabiya University, Ajdabiya, Libya*

Extensive areas of irrigated soils are unproductive, due to the accumulation of salts in the soil profile occupied by root systems. It is estimated that about 15% of the total land area of the world has been degraded by salinization and soil erosion, which are among the major causes of desertification. The expected increase in the world's population (~10 billion by 2050) needs food productivity to step up within a few decades. Organic fertilization is highly sustainable when compared to other options to date when taken into consideration as a solution to the highlighted issues. It is possible to use biological soil properties for evaluating the effects of organic matter application on soil characteristics. Different approaches have been suggested to solve these issues of soil destruction. This study focuses on selected organic materials (e.g., different agro-industrial by products, and composts) as effective tools to improve different soil properties of soils. However, further experimental investigations are needed to validate this approach in a wider range of soils, also combining waste recycling with other sustainable agronomic practices. The same amendments could likely be considered for soil remediation in the affected areas due to their high organic matter content. In fact, organic matter has several beneficial effects on agricultural fields, such as the slow release of nutrients, soil structure improvement, and the protection of soils against erosion. Selected studies were focusing on the effects of application of various organic matters (i.e., different organic waste materials, mixture of green waste compost) to two soils. In particular, such effects can be referred to chemical, biological, and physical soil properties. The observed results offer powerful evidence on the potential of organic fertilizers in improving soil properties. Such results showed the improving soil structure, increasing different enzyme activities and soil organic carbon, total nitrogen and extractable phosphorus and increasing soluble and Exchangeable-K^+. Urease activity was increased by more than 150% in the mixed treatment, compared to the control. The incorporation of organic manure into the soil significantly increased soil phosphatase activity and soil respiration rate. 15 $g \cdot kg^{-1}$ of compost significantly improved soil physical-chemical properties, especially C and N contents. Enzyme activities were substantially promoted in presence of both amendments. However, there is no clarity whether organic matter, composts of organic wastes are as plant-friendly as the manure-based composts are believed to be. It is also not clear as to whether the action of green compost as a fertilizer depends on the species of plants being fertilized by it. This raises questions whether green organic composts are beneficial (or harmful) at all application rates or if there is a duality in their action which is a function of their level of application. The study reveals that, in general, organic matter composts of all are highly potent fertilizers.

***Keywords**: wastewater sludge, clean fertilizers, chemical, biological, physical soil properties*

INTRODUCTION

Fertilizers are organic or inorganic materials of natural or synthetic origin that are added to soil to supply one or more nutrients essential for the plant growth. Organic manure or organic fertilizers are fertilizers derived from animal or plant matter (e.g. compost, manure etc). Manure is any organic substance that is added to the soil to increase its fertility, soil quality and for enhancing plant growth

As a result of the linear economy, growing of global population, decreasing of resources especially the agricultural lands due to the climatic changes and increasing resource consumption, humanity is seriously challenged by the generation of waste in large quantities from various sectors. Organic waste (OW), animal waste (AW), and municipal solid waste (MSW) represent the major groups of waste generated by these sectors. Options of applying such organic waste streams as feedstock for producing clean fertilizers instead of chemical fertilizers. The respective integrated concepts have received significant attention in recent years as a sustainable alternative to agrochemicals and fertilizers applied to soils for increasing soil productivity and reducing soil pollutions.

In addition, agricultural activities have contributed to lowering the organic matter content. All the above has led to these soils losing a large part of their natural fertility [1].

Many agricultural soils have become loaded with nutrients, pesticides, and heavy metals as a result of intensive use of agrochemicals and fertilizers, changes in agronomic practices (also including the intensive use of soil) and to recycling of wastes [2]. Rehabilitation of a soil under intensive cultivation may be promoted by set-aside practice (as stated by Agricultural European Policy) which favours detoxification and microbiological activation of arable soil layers because of an increase of organic substrates [3]. However, long-term adverse effects, such as the mobilization and solubilization of adsorbed chemical compounds caused by the interaction between chemicophysical and biological processes, may occur.

The organic matter is responsible for adsorption–desorption mechanisms regulating the long-term fate of soil contaminants [4]. Soil organic matter can be divided into two major pools based on relative susceptibility to biological decomposition: 1. easily or readily, metabolised pool and 2. more resistant pool of humic substances [5].

Options are sought and required, to produce food and feed with other methods than traditional cultivation of agricultural land, and natural collection. Landless food systems are called for, e.g. in a paper aiming at securing the availability of food in Africa in 2100 by more circular and sustainable food chains (Rahmann et al. 2019)[6].

Studies should be initiated to design bioreactors utilising locally available sources of nutrients and organic matter, to make the bioreactors more sustainable and develop organic farming systems in a context of landless farming [7].

MATERIALS AND METHODS

Soil characterization, sampling and amendment

The soil samples were collected from the top 20 cm of chernozem meadow from the non-cultivated or treated sampling area from Szeged, Hungary. The soil samples were divided into two sub-samples: control soil and soil amended with disposal wastewater sludge (DWS) originated from the plant of wastewater treatment in Hódmezővásárhely, Hungary at 15, 30, 45 and 60% (w/w) rates. Table 1 represents some physico-chemical properties of used soil and DWS samples. Fifteen weeks after soil amendment in greenhouse. The following evaluations were carried out to study the effects of disposal wastewater sludge on soil biological activities.

Table 1. The physicochemical properties of used soil and municipal wastewater sludge samples

Parameters	Virgin sample of chernozem meadow soil	Municipal wastewater sludge
Clay and slit content (Li), %	51.7	n.d.
Soil plasticity (K_A)	53.07	n.d.
$pH_{(KCl)}$	6.02	7.8
Dry matter content, %	n.d.	42.9
Organic carbon content, %	2.87	20.4
Humus content, %	3.55	n.d.
Salt content, (%)	0.081	n.d.
$CaCO_3$, (%)	2	n.d.
Total N, mg/kg	334.7	43311

NO_3-N, mg/kg	39	n.d.
NH_4-N, mg/kg	4.5	n.d.
Mg, mg/kg	257	11860
Na, mg/kg	53	1441
AL-P_2O_5, mg/kg	378	20104
AL-K_2O, mg/kg	428	2908
Zn, mg/kg	1.1	1068
Cu, mg/kg	2.4	182.3
Mn, mg/kg	61	351.2
Fe, mg/kg	1094	13610
Cd, mg/kg	1.02	4.168
Pb, mg/kg	0.96	540.7

n.d.: Not determined, AL: Ammonium lactate soluble P and K

PHYSICO-CHEMICAL PROPERTIES

Determination of soil pH and moisture content: Soil pH was measured in 1 M KCl suspensions (1:2.5 w/v) with a glass electrode. Soil moisture was measured gravimetrically from drying soil sub-samples in hot air oven to constant weight at 105°C. The percentage of water holding capacity (WHC, %) was measured with known amount of soil and the volume of water relationship, to give a condition of 45% of the maximum WHC following the protocol proposed by MISHRA [12].

Determination of soluble nutrient element content: According to the Hungarian Standard MSZ 20135/1999 [13], the method describes the procedure of determination of Na^{+}, K^{+}, Ca^{2+} and Mg^{2+} in soil using the atomic spectroscopic techniques.

Determination of total soluble heavy metal content: According to the Hungarian Standard MSZ 21470-50/1998 [14], the standard describes the procedure for determination of Fe^{2+}, Mn^{2+} and Zn^{2+} content in soil by atomic spectroscopic methods after HNO_3/H_2O_2 extraction/digestion in microwave.

EVALUATION OF SOIL MINERALIZATION OF ORGANIC C, N, P AND S

Because the soil sub-samples had been stored at 4°C, soil sub-samples were pre-incubated as previously described to allow the microbial activity to restore and stabilize. Total organic carbon (TOC) content was determined by oxidation with potassium dichromate ($K_2Cr_2O_7$) in a concentrated sulphuric (H_2SO_4) medium and excess dichromate evaluated using Mohr's salt [$(NH_4)_2Fe(SO_4)_2$] according to WALKLEY & BLACK [15] and YEOMANS & BREMNER [16].
Organic carbon mineralization (C_{min}) was evaluated by measurement of soil CO_2 respiration. The C_{min} was expressed as mg CO_2-C released per kg soil weight and incubation time.

Determination of N mineralization and nitrification rates: Total N content in soil was determined by Kjeldahl digestion–distillation procedure [17]. Potential net N mineralization and net nitrification rates were determined by aerobic incubation of the soils. Nitrogen mineralization (Available N: AN), which includes NH_4^{+}–N and NO_3^{-}–N, was determined in 20 g of soil, which were extracted with 100 ml 2 M KCl for 1 h and filtered through Whatman quantitative filter paper. The soil clear filtrate was analyzed for NH_4^{+}–N at 660 nm and for NO_3^{-}–N at 540 nm using alkaline phenol according to CATALDO el al. [18] and DORICH & NELSON [19], respectively. The organic N mineralization rate was estimated by the sum of ammonification and nitrification rates. The C/N ration was computed by dividing the OC concentration by the TNC. The TOC, TNC, and AN records are presented on a soil dry weight basis. The net ammonification and nitrification rate was calculated as the difference of N-NH_4^{+} and N-NO_3^{-} contents before and after incubation.

Phosphorus and sulphur mineralization was determined according to methods for P extraction and analysis in soils as detailed by OLSEN and SOMMERS [20]. Sub-soil samples were extracted in dilute NH_4F-HCl at the beginning and end of incubation period and the extracted P was estimated colorimetrically using the ammonium molybdate-stannous chloride blue colour method. Mineralized inorganic P was extracted with 0.5 M $NaHCO_3$ and was analysed by the ammonium molybdate–ascorbic acid method described in biomass P measurement.
Available extractable S was measured after the extraction with 0.01 M $CaCl_2$ and analysed according to SUBBA RAO [21]. The SO_4-S extracts were measured by converting them to barium sulfate by the addition $BaCl_2.2H_2O$ crystals; and the turbidity was measured at 340 nm on a UV-VIS spectrophotometer. Available S in soil sub-sample is expressed as SO_4-S in mg/kg.

Basal soil respiration
To determine the soil respiration rates, 50 g of soil samples were placed in hermetically sealed glass bottle, moistened at 45% and incubated in the dark at 28°C for 10 days. The amount of OC released as CO_2 and absorbed in vials containing 50 ml of 0.5 M NaOH placed inside bottle. The CO_2 emitted was measured as the Na_2CO_3 formed by titration with 0.1 M HCl.

SOIL MICROBIAL ACTIVITIES

Microbial characterization: Quantitative enumerations of mesophilic culturable populations of aerobic heterotrophs bacteria, filamentous fungi and actinobacteria were expressed by colony forming units (CFU) per gram dry soil. The populations were measured in 10 g of sieved soil was added to 90 ml of sterile saline solution (0.85%) in a 250-ml flask, and the suspension was shaken at 150 rpm for 30 min.
Ten-fold serial dilutions were made and 1 ml of 10^{-4}, 10^{-5}, 10^{-6} and 10^{-7} dilution was used to inoculate Petri dishes of different cultural media. Plates were incubated at 28°C for 2, 7 days for bacterial and fungal cultivation, respectively. Bacteria were determined on nutrient agar medium supplemented by filter-sterilized cycloheximide (100 µg/ml final concentrations) after autoclaving to prevent fungal growth. Fungal population was estimated on Rose Bengal-Streptomycin Agar [22] and modified potato dextrose agar (MPDA) supplemented with streptomycin (30 µg/ml) to inhibit bacterial growth according to ALEF & NANNIPIERI [23].
Actinobacteria were counted on Starch Casein Agar medium of KÜSTER & WILLIAMS (1964) [24] supplemented by cycloheximide (100 µg/ml) and modified by addition of nystatin and nalidixic acid which were used as antifungal and antimicrobial agent respectively in plates (WILLIAMS & DAVIES 1965) [25]. The plates were inverted and incubated for 7 days at 28°C. The results are reported as $\log_{10}$ of bacterial, fungal or actinobacteria CFU/g of dry soil.

Determination of soil microbial biomass: The most common technique used to estimate microbial biomass C, N, P and S were measured by the chloroform fumigation-extraction method. The MBC (C_{mic}), MBN (N_{mic}), MBP (P_{mic}) and MBS (S_{mic}) were measured by ethanol-free chloroform fumigation–extraction method. Briefly, 30 g soil for each sample was fumigated with ethanol-free chloroform for 24 h at 28°C after one week incubation at 45% WHC. Simultaneously, another unfumigated set was prepared and incubated under the similar conditions. After complete removal of $CHCl_3$, organic C and N from fumigated and non-fumigated soil sub-samples were extracted with 0.5 M K_2SO_4 with a soil:extractant ratio of 1:5 (w/v), inorganic P was extracted with 0.5 M $NaHCO_3$ (pH 8.5) with a soil:extractant ratio of 1:20 (w/v). Phosphate was measured by photospectrometry at 882 nm as described by JÖERGENSON et al. [26]. Also, S was extracted with 0.01 M $CaCl_2$ for 30 min on a rotating shaker [21]. MBC was calculated as: MBC = E_C/k_{EC}, where E_C = (organic C extracted from fumigated soils) − (organic C extracted from non-fumigated soils) and k_{EC} = 0.38 [27]. MBN was calculated as: MBN = E_N/k_{EN}, where E_N = (total N extracted from fumigated soils) − (total N extracted from non-fumigated soils) and k_{EN} = 0.54 [28]. MBP was calculated as: MBP = E_P/k_{EP}, where E_P = (total P extracted from fumigated soils) − (total P extracted from non-fumigated soils) and k_{EP} = 0.40 [29]. MBS was calculated as: MBS = E_S/k_{ES}, where E_S = (total S extracted from fumigated soils) − (total S extracted from non-fumigated soils) and k_{ES} = 0.35 [30]

Detection of phosphate-solubilizing microorganisms: One ml of homogenous soil sub-sample suspension of low dilution (10^5, 10^6 and 10^7) was plated on the surface of the agar plate containing a medium described by PIKOVSKAYA [31] and according to the procedure of GOLDSTEIN [32]. After incubation for 5 days at 28°C, colonies surrounding with clear zones were counted. Colonies showing solubilisation zones over 0.5 mm in diameter were counted.

Detection of cellulose-decomposing microorganisms: Microbial populations utilize cellulose as C source were detected by spread plate technique with 1 ml of soil suspension of low dilution (10^5, 10^6 and 10^7) on carboxymethylcellulose (CMC) medium according to HENDRICKS et al. [33]. Plates were incubated at 28°C for 2 and 5 days. The CMC plates were flooded with Gram's iodine which formed a bluish-black complex with cellulose but not with hydrolysed cellulose, giving a sharp and distinct zone around the cellulase-producing microbial colonies within 3 to 5 minutes. According to KASANA et al. [34] this is more rapid and efficient method than Congo red. The clear zone formed by isolates is used as indicator for cellulase activity.

DETERMINATION OF ENZYMATIC POTENTIAL ACTIVITIES

Hydrolysis of FDA was evaluated according to the methods of SCHNÜRER & ROSSWALL [35]. The enzyme potential activity is expressed as mg fluorescein /kg dry soil/h. ***Dehydrogenase*** was determined according to GARCÍA et al. [36]. ***Urease*** and N-α-benzoyl-l-argininamide (BAA) hydrolysing ***protease*** were determined following the method of NANNIPIERI et al. [37]. Urease and protease activities are expressed as mg NH_4/kg dry soil/h. ***Acid phosphatase*** was determined by spectrophotometry at 398 nm [38]. The enzyme activity is expressed as mg PNP/kg dry soil/h. ***β-glucosidase*** was determined using p-nitrophenyl-β-D-glucopyranoside as substrate. The amount of PNP was determined in a spectrophotometer at 398 nm [38]. ***Aryl-sulphatase activity*** was measured colorimetrically according to at 420 nm [39] and is expressed as mg PNP/kg dry soil/h.

RESULTS AND DISCUSSION

The application of bio-disposal wastewater sludge to soil can increase OM, pH of acidic soils [40], and soil microbial [43] and enzymatic activities [42] in the soil. The present investigations confirm the recent results mentioned above. The importance of the reuse of sewage sludge in agriculture is derived from its high nutrient content that can improve the soil characteristics crop production.

Changes in physicochemical properties

Our results clarified that disposal wastewater sludge enhanced the OM and biological characteristics e.g., the OC content and soil respiration were found to be higher in the treated soil sub-samples in comparison with the biodynamically properties of the control virgin soil. Table 2 shows that the application of DWS to the control chernozem meadow soil sample provided a good environmental medium for plant growth by increasing the pH and moisture content over the virgin control samples. The increases in soil moisture content will reduce the amount of water used in irrigation and the pH ranged between 6.19 and 6.71 creating a favourable medium for promoting plant growth.

Table 2. Application of disposal wastewater sludge changes the pH and moisture content of chernozem meadow virgin unfertilized soil samples.

Soil system	Various DWS rates (%)	$pH_{(KCl)}$	Moisture content (%)
Control untreated soil	0	6.02	**100**
Soil amended with DWS rates	15	6.19	**118.1**
	30	6.37	**132.76**
	45	6.50	**152.5**
	60	**6.71**	**165.4**

Our results are in an agreement with PRASANNA et al. [45] who pointed out those organic amendments are benefit for plant growth by increasing soil moisture holding capacity, improving soil texture, and providing plant nutrients such as N and P. Plant available macronutrients were affected by organic fertilizer application as the significantly higher of Na, K, Ca and Mg contents were found in soil under sludge treatment (Figures 1 - 4). The addition of disposal wastewater sludge to soil acts as nutrient reservoir. These nutrients released to the soil medium throughout the mineralization. The results showed higher nutrient contents of Na and K (Figure 1), Ca and Mg (Figure 2) and essential elements such as Fe as in Figure 3 and Mn and Zn (Figure 4) in DWS treated soil sub-samples in comparison with untreated control soil. The higher content of C, N, P and S indicates that OM can maintain the nutrients supply into DWS amended soil better than the control soil.

In general, soil treated with DWS had better soil properties than untreated soil sub-sample. The DWS amended soil had OC, total N, available P and S content higher concentration than in the control soil sample. Organic fertilizer is also known as a slow release nutrient source, so the nutrients can be effectively used for plant uptake, preventing nutrient losses from soil. Our results indicated that the significantly higher of Fe, Mn and Zn, in the investigated soil samples may also due to the higher content and type of DWS use. Our results are agreed with the findings of Singh et al. [46].

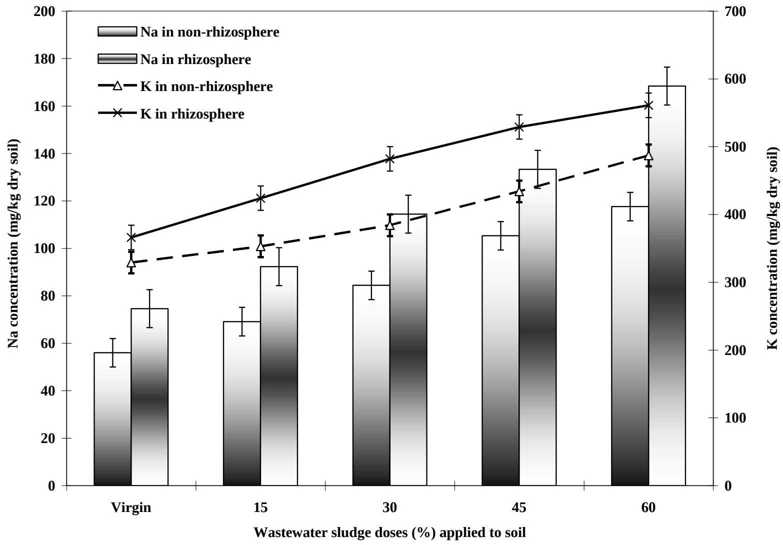

Figure 1. Effect of wastewater sludge on Na and K in bluk and rhizosphere soils

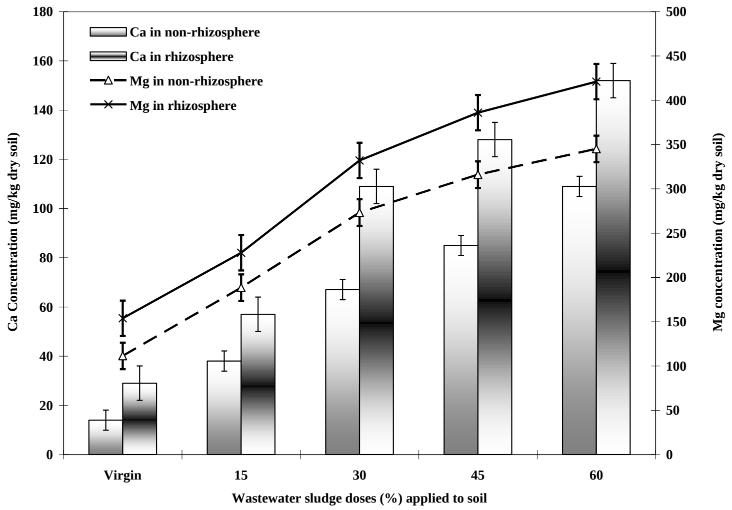

Figure 2. Effect of wastewater sludge on Ca and Mg in bluk and rhizosphere soils

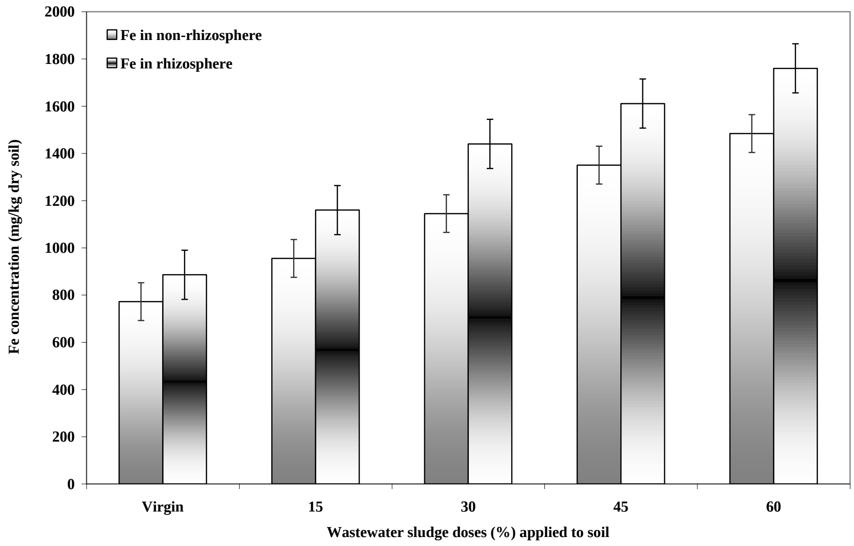

Figure 3. Effect of wastewater sludge on Fe in bluk and rhizosphere soils

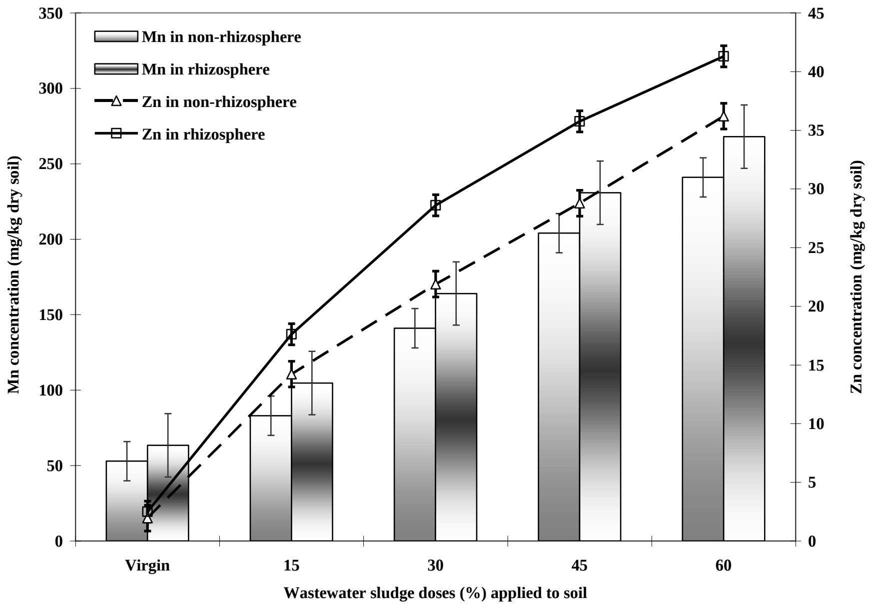

Figure 4. Effect of wastewater sludge on Mn and Zn in bluk and rhizosphere soils

Relationship between the microbial content and soil fertility

Microbiomes play a major role on decomposition of several organic compounds frequently used in agriculture, which directly affect the synthesis and decomposition of SOM [47].

In general, our results showed that higher microbial activity and potential activities of FDA and dehydrogenase occurred in soil samples amended with wastewater sludge (Figures 5 - 8), these indicating the impacts on the content and activity of soil microbiomes, which results in high nutrient recycling in the agroecosystem. The main microbial enzymes involved in the mineralization of SOM are cellulases, proteases, ureases and phosphatases [48].

Cellulase decomposers hydrolysed cellulose compounds present in fresh plant residues that are continuously deposited above soil [49]. Also, our results demonstrated that the quantitative counting of cellulose-decomposers in DWS amended soil was higher than those present in control soil samples (Figure 7).

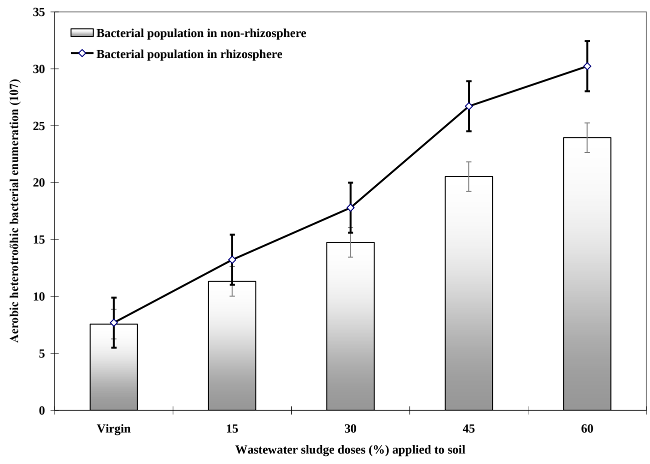

Figure 5. Effect of wastewater sludge on bacterial population in bluk and rhizosphere soils

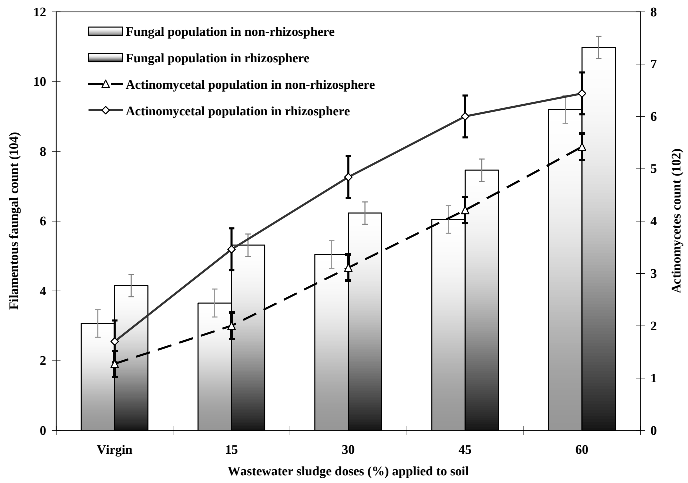

Figure 6. Effect of wastewater sludge on fungal and actinomycetes (actinobacteria) populations in bluk and rhizosphere soils

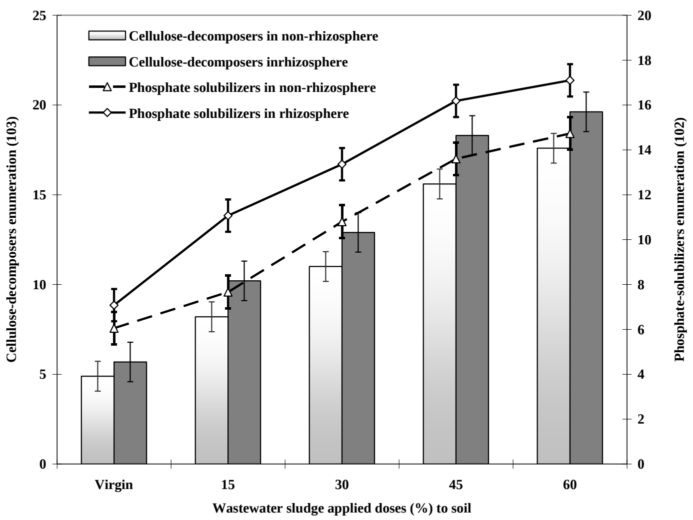

Figure 7. Effect of wastewater sludge on cellulose-decomposers and phosphate solubilizing microbes populations in bluk and rhizosphere soils

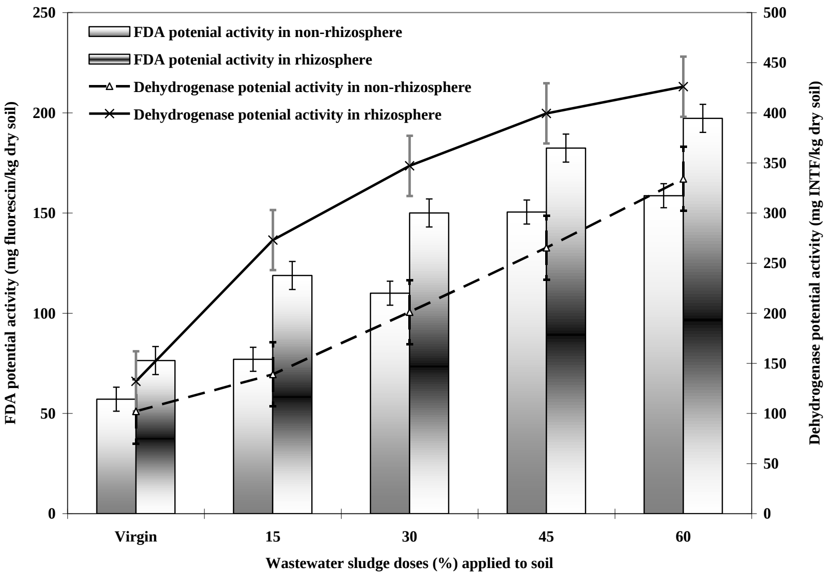

Figure 8. Effect of wastewater sludge on the potential activities of FDA and dehydrogenase in bluk and rhizosphere soils

Our results are agreed with SHENTU et al. [50] that soil biota is a significant component of soil quality as microbiomes play a vital role in soil ecosystem functioning related to soil fertility and primary production through OM decomposition and nutrient recycling.

Changes in microbial biomass C, N, P and S

Usually, larger differences were observed in the soil of higher DWS rates, for soil MBC and enzyme activities. Higher microbial activity was observed in the treated soil systems (Figures 9 - 10) than control soil samples. Dehydrogenase activity is directly linked with living cells associated with microbial oxido-reduction processes [51], which are important for OM degradation and transformation. Since, dehydrogenase activity is not active as extracellular enzymes in soil, it is considered to be a good indicator of overall microbial activity [36, 52].

Physiological and biochemical methods for estimating soil microbial biomass are usually calibrated against other methods and parameters. The estimation of microbial biomass can provide useful information on the changes in soil biological properties [53].

The strongest and most widely used calibration equations for quantifying microbial biomass are based on soil samples with a very wide range of biomass values [27, 54].

The potential activity of β-glucosidase in DWS managed treated soil was higher than the control soil. MOESKOPS et al. [55] reported significant correlation of β-glucosidase activity and SOC content with significantly higher β-glucosidase activity in organically managed soils. It has been shown that microbial activity and biomass is higher in fields with wastewater sludge amendments than fields with conventional fertilizers [56].

Furthermore, the microbial biomass reflects the contribution of soil microorganisms as both a source and a sink of C in soil ecosystem [57].

Soil microbial biomass, both source and sink of available nutrients plays a critical role in nutrient transformation.

As a consequence, our results are agreed that the microbiological properties, such as soil enzymatic activities have been suggested as potential indicators of soil quality because of their essential role in soil biology, ease of measurement and rapid response to changes in soil management [58].

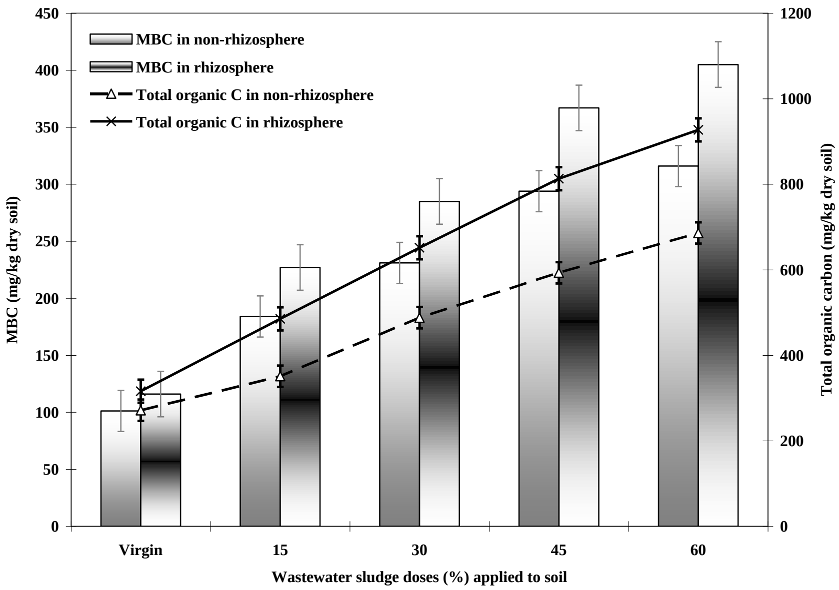

Figure 9. Effect of wastewater sludge on the MBC and TOC in bluk and rhizosphere soils

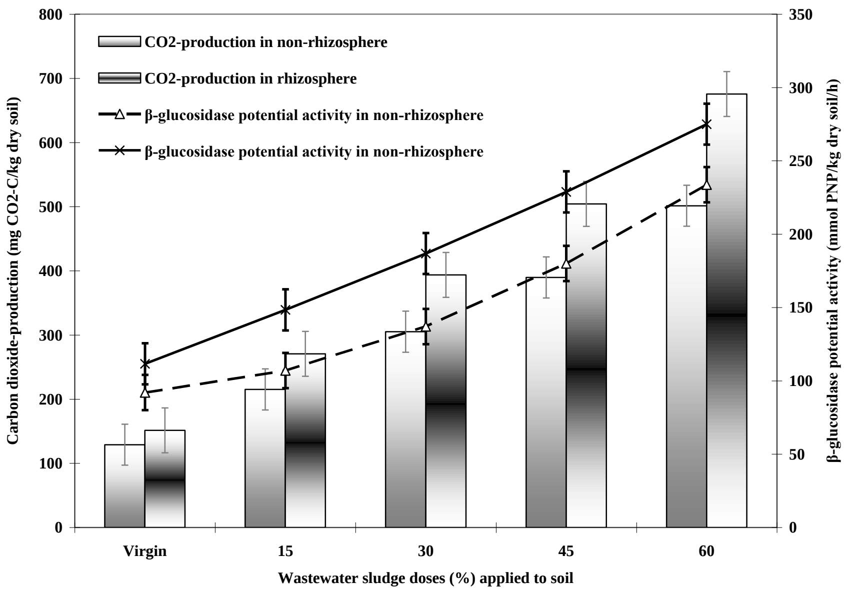

Figure 10. Effect of wastewater sludge on the CO_2 and β-glucosidase activity in bluk and rhizosphere soils

Our results showed that the application of wastewater treatment increases the MBN, TNC and the potential activites of urease and protease, and these stimulation effects were increased by increasing the application dose of DWS (Figures 11 and 12) in comparison with virgin soil samples.

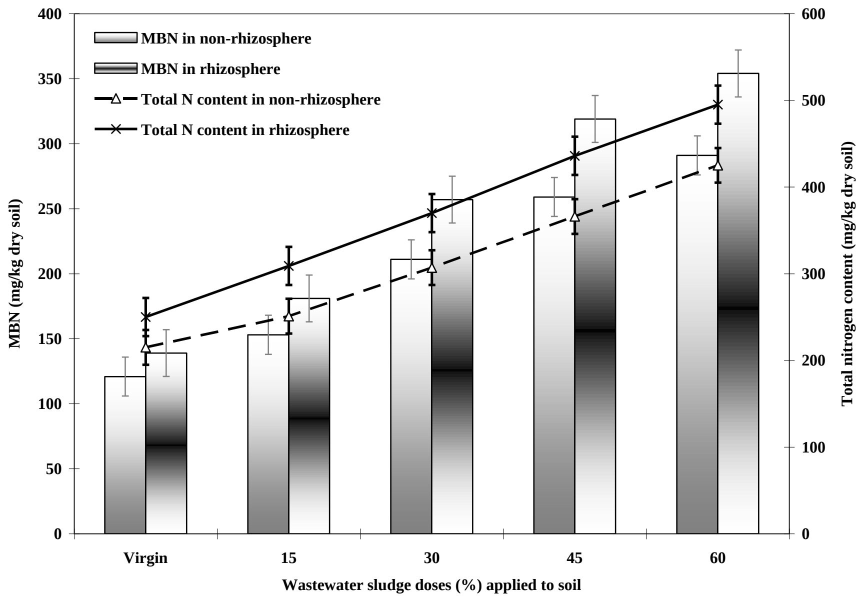

Figure 11. Effect of wastewater sludge on the MBN and TNC in bluk and rhizosphere soils

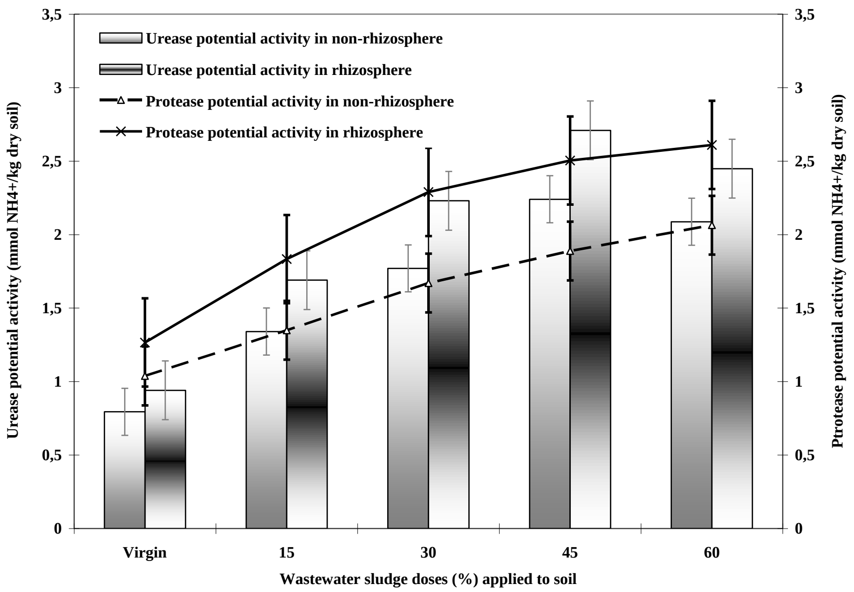

Figure 12. Effect of wastewater sludge on the potential activities of urease and protease in bluk and rhizosphere soils

Our results are in an agreement with the recent studies [59, 60], that soil is a highly complex biological system which is subject to dynamic changes under the effect of biotic and abiotic factors. The use of microbiological and biochemical properties of soil for the estimation of changes taking place in soil environment as a result of e.g., application DWS is fully justified. Nitrogen fertilization is the most important management strategy for the improvement of agricultural crops.

Urea is the most widely used source of organic N fertilizer in the world, which is easily hydrolysed to NH_4^+ and CO_2 by urease enzyme [61].

Organic N also affects directly the distribution and action of proteolytic enzymes in soils [62].

Figures 13 and 14 illustrate the effects of DWS on the MBP, TP, PO_4-P and potential activity of phosphatase under different treatments. It is clears that the addition of DWS increases the P content in treated soil more the control soil. The stimulation of the P content was influenced by the application dose, too.

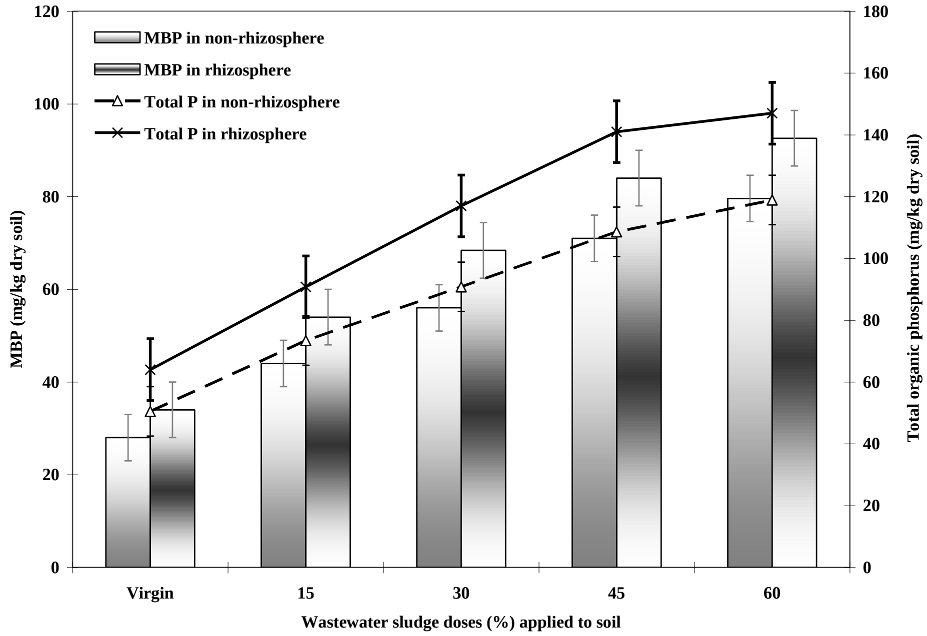

Figure 13. Effect of wastewater sludge on MBP and TP in bluk and rhizosphere soils

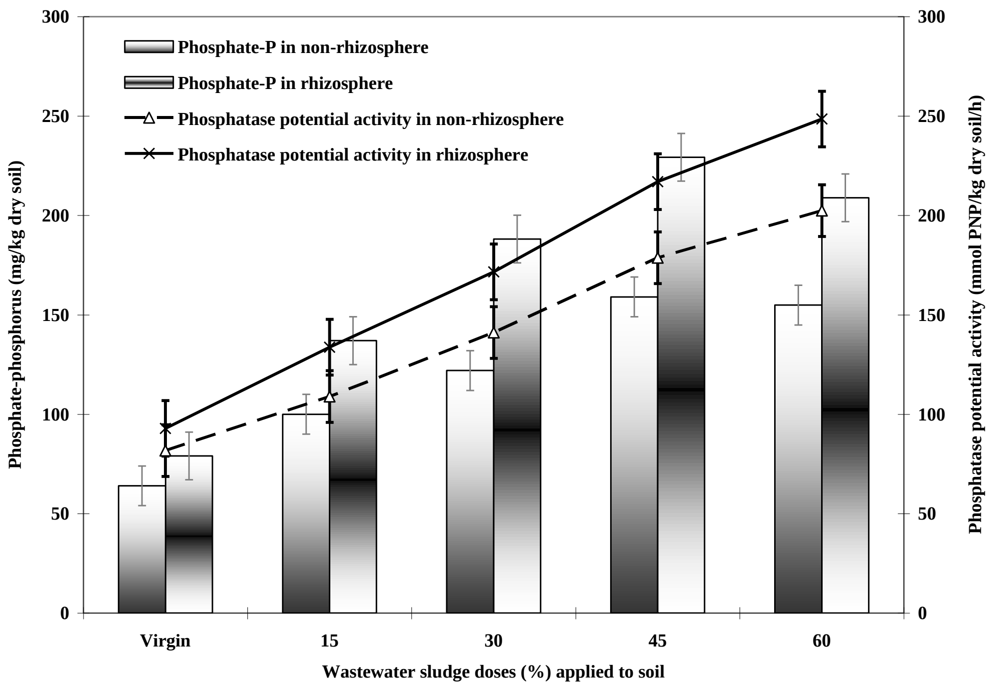

Figure 14. Effect of wastewater sludge on P and phosphatase activity in bluk and rhizosphere soils

Figure 15 demonstrates the effects of DWS on MBS and total S in treated soil samples. It was observed that by increasing the rate of applications, the investigated parameters increased

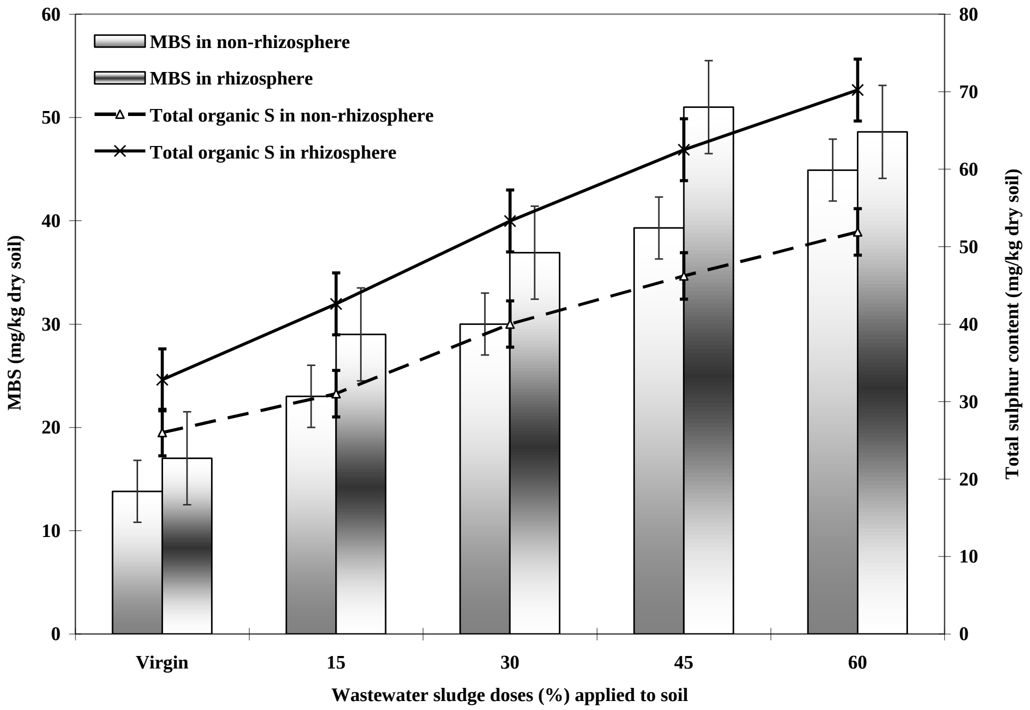

Figure 15. Effect of wastewater sludge on MBS and TS in bluk and rhizosphere soils

It is well established that the bulk of the S present in surface soils occurs mainly in organic forms and that it becomes available for plant uptake only if it is mineralised to inorganic sulphate by soil microorganisms. Microbial S values showed direct relationships with both microbial C and with total soil organic S. This result is in agreed with Banerjee and Chapman [30].

The results indicated that the enzymatic activities tended to be higher in soil treated with composted DWS than in samples without application of organic amendment. Although, our conclusion is in agreement with Vepsäläinen [63] in which soil enzyme activities are commonly correlated with each other, it is advisable in soil quality studies to measure a pattern of several enzyme activities simultaneously. Also, we are agreed with Roldán et al. [64] that soil enzyme activity can be used as an indicator of soil quality for assessing the sustainability of agricultural ecosystems.

Net N mineralization and nitrification

The concentration of NO_3-N in control soil amended with DWS was significantly affected by the interaction of DWS application rate. On the other hand, the control untreated soil produced the lowest concentration of soil NO_3-N, which was, however, not significantly different from that produced by the application of 15% of DWS (Figure 16).

Soil NO_3-N concentrations measured at the end of the experiment, which can be considered residual concentrations, increased as DWS rates increased.

In this study, the increase in DWS rates produced increases in soil NO_3-N concentration in soil amended with different rates of DWS.

Based on the results obtained, it seems that a control soil samples of the region studied, as a consequence of degradation processes originated mainly by the lack of vegetation cover and low organic matter content, can be considered as “poor” from a biological and biochemical point of view. Other parts of the study area (amended soil samples) may with time go the same way. It would, therefore, be of interest to study the regeneration of this type of soil to avoid desertification and to determine how regeneration affects the microbiological activity of these soils.

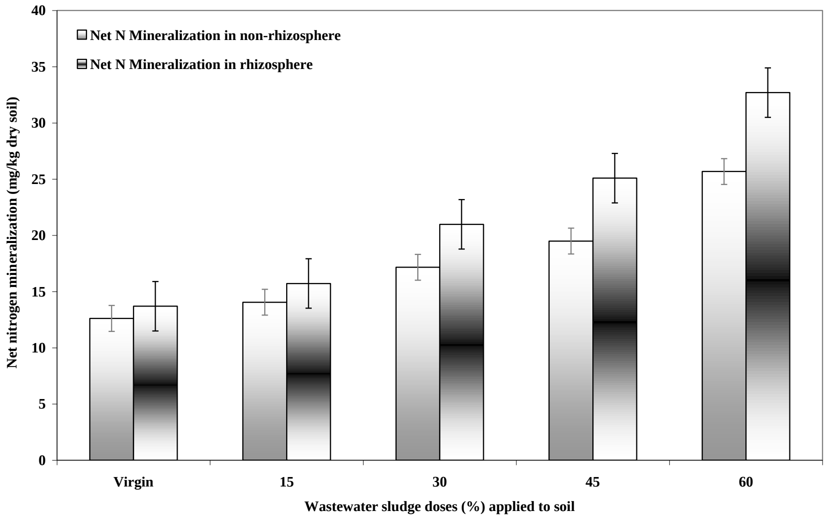

Figure 16. Effect of wastewater sludge on net N mineralization in bluk and rhizosphere soils

Organic manure (vermicompost, farmyard manure, etc.) is becoming an important component of environmentally sound agriculture. Recently, the use of organic materials as fertilizers for crop production has received attention for sustainable crop productivity (Arif et al., 2014)[65]. Organic manure act not only as a source of nutrients and organic matter, but also increase size, biodiversity and activity of the microbial population in soil, influence structure, nutrients get turnover and many other changes related to physical, chemical and biological parameters of the soil (Albiach et al., 2000)[66]. Nutrients contained in organic manure are released slowly and are stored for a longer time in the soil, thereby ensuring a longer residual effect and persistence of nutrient availability. Residual nature of organic sources makes them more value based for the whole system compared to individual crops (Arora and Maini, 2011)[67]. The judicious applications of organic manures not only improve the productivity but also make cultivation of crops more sustainable (Tiwari et al., 2002)[68].
Soil contains approximately 2344 Gt (1 gigaton = 1 billion tonnes) of OC globally and is the largest terrestrial pool of OC. Small changes in the soil OC stock could result in significant impacts on the atmospheric C concentration. The fluxes of SOC vary in response to a host of potential environmental and anthropogenic driving factors. Scientists worldwide are contemplating questions such as: What is the average net change in SOC due to environmental conditions or management practices? How can SOC sequestration be enhanced to achieve some mitigation of atmospheric CO_2? and Will this secure soil quality? These questions are far reaching, because maintaining and improving the world’s soil resource is imperative to providing sufficient food and fibre to a growing population. Additional challenges are expected through climate change and its potential to increase food shortages. This further research work should highlight knowledge of the amount of C stored in soils globally, and the potential for C sequestration in soil. It also discusses successful methods and models used to determine and estimate C pools and fluxes. This knowledge and technology underpins decisions to protect the soil resource.
Finally, and according to the findings obtained, the authors are strongly recognize the following that organic wastes such as sewage sludge and compost increase the input of carbon and nutrients to the agricultural land. However, sewage sludge-applied heavy metals, and organic pollutants adversely affect soil biochemical properties. The addition of sewage sludge decreased soil pH if it is highly acidic and increased soil salinity if it contains hlgh amounts of Na, K, Ca, Mg, etc to a greater extent than the addition of compost. Both sewage sludge and compost increased significantly the values of the cumulative C mineralized, dissolved organic C, humic and fulvic acid C, microbial biomass C, and metabolic quotient (qCO_2), especially with increasing application rate. Compared to compost, the addition of sewage sludge caused higher increases in the values of these parameters. The values of dissolved organic C, fulvic acid C, microbial biomass C, metabolic quotient, and C/N ratio tended to decrease with time. The soil treated with sewage sludge showed a significant increase in the mobile fractions of Zn, Cd, Cu, and Ni and a significant decrease in the mobile fraction of Pb compared to

control. The high application rate of compost resulted in the lowest mobility of Cu, Ni, and Pb. The results suggest that biochemical properties of calcareous soil can be enhanced by both organic wastes. But, the high salinity and extractability of heavy metals, due to the addition of sewage sludge, may limit the application of sewage sludge.

The application of chemical fertilizer can increase the yield of agriculture but excessive fertilizer application has become one of the important sources of agricultural non-point source pollution and how to control non-point source pollution is a thorny problem for developing countries in agricultural transformation and sustainable development. In the past 40 years, However, excessive fertilization has led to large-scale agricultural non-point source pollution, and agricultural non-point source pollution has surpassed the developed countries in both breadth and depth. As a sustainable development model, agricultural green development can improve the economic efficiency of existing resources and actively improve the current environmental efficiency without harming future resources.

CONCLUSION

A substantial increase in the quantities of soil microbial biomasses and enzymatic activities take place in the mineralization of OM present in the disposal wastewater sludge applied to the soil samples; however, there was a recovery of soil microbial biomass and enzymatic activities followed the use of soil organic fertilization practices. The biochemical indices selected in the present research can provide a reliable and useful indication of soil biological quality of soil fertility after application of disposal wastewater sludge. A greenhouse pot experiment is described for studying the changes in soil biodynamics after the application of disposal wastewater sludge. The result demonstrated that disposal wastewater sludge have a great potential to enhance soil OM, nutrient availability, microbial activity, microbial biomass and enzyme production. Soil biochemical and biological indicators of soil quality were generally higher in disposal wastewater sludge systems compared to control untreated soil system. High of soil enzymatic activities and microbial biomass C as affected by OM input in disposal wastewater sludge systems emphasize the important role of element recycling processes supported by an abundant and active soil biological community. The present research work highlights that a portion of C, N, P and S were increased in soil amended with higher rates of disposal wastewater sludge. Microbial interactions in the disposal wastewater sludge treated soil are the determinants of soil fertility and environmental health, our understanding of these interactions therefore has implications for sustainable soil management. However, the subject of agroecosystem is very complex and need more research to understand the interaction between the plant, the rhizospheric environment, and nutrient bioavailability.

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EFFECTS OF DIFFERENT PESTICIDES ON THE ACTIVITY OF SOME ENZYMES IN THE RHIZOSPHERE OF BROWN FOREST SOIL

Ádám GYARMATI, Hosam E.A.F. BAYOUMI HAMUDA

*[1]Tomori Pál College, Budapest, Hungary, [2]Institute of Environmental Engineering and Natural Sciences, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Hungary, E-mail: gyarmati.adam@uni-obuda.hu, *e-mail: Bayoumi.hosam@uni-obuda.hu, +36303900813*

Pesticides (herbicides, fungicides, zoocides, etc.) include all substances that reduce the harmful effects, or destroy pests that damage agricultural products or endanger humans in some way. Soil microbiotas produce countless enzymes, some of which can be induced or inhibited by certain chemical substances. Pesticides are made up of active ingredients, carriers and auxiliary substances. During their development, it is necessary to ensure that the active substance, which is the carrier of the biological activity, breaks down into biologically ineffective decomposition products after exerting the desired effect and does not have a harmful effect on the activity of the enzymes. In the present study, the pesticides used are: two herbicides (Ro-neet 6E, vernolat), two fungicides (fundazol 50 WP, Dithane M-45) and two zoocides (rogor L-40, phosphotion). Doses used during the study: (control; 1/2X, X (active ingredient: dose used in field) and 2X) of the active ingredient of each plant protection agent. After four weeks, the treated samples were analyzed in a controlled environment at 28°C and 45% soil moisture. The results showed the effect of different pesticides on the experiment, based on which it can be concluded that the order of toxicity was as follows: Dithane M-45 > vernolate > fundazol 50 WP > phosphotion > Ro-neet 6E > rogor L-40. The use of a double dose reduced the enzyme activity compared to the control. The use of the lowest concentration of pesticides showed a stimulating effect on the activity of the enzymes. Finally, it can be concluded that the used pesticides influenced the biological parameters of the examined brown forest soil in several ways, and these effects change the quality of the soil from different aspects. The plant protection agents used during the test must be chosen in such a way that they do not have a harmful effect on the biological functions of the soil. By analyzing the research, substances that have a positive or neutral effect on the biological functions of the soil can be used in agricultural practice.

***Keywords**: pesticides, activity of enzymes, rhizosphere, brown forest soil*

INTRODUCTION

Microbial properties like microbial diversity and biomass are useful for predicting changes in the soil functioning and for providing an integrated and relevant vision of soil quality. Little information is currently available for preventing the loss of microbial diversity and activity through the use of sustainable farming practices from the first cultivation year. Plants are able to select their own microbiome based on their specific root exudates or some other strategies such as root physical structure and mineral nutrients preference. The primary function of herbicides is to protect agricultural crops from infestation with weeds and to prevent arable soil from being overgrown by plant cover indigenous to the ecosystem. The chemicals known as pesticides are generally named synthetic organic compounds with broad molecular configurations having as a common property the ability of selectivity killing or inhibiting the growth of plants. All pesticides, including herbicides, play an important role in the environment by modifying the enzymatic activity of soils (Furczak and Gostkowska, [1], Nowak, [2] Strzelec, 3]).

Thus a higher enzyme activity indicates a greater intensity of mineralization of the organic matter (Benitez et al., [4], and Rossell et al., [5]). Soil microbiomes are very important for agroecosystem function and sustainability due to their contributions to nutrient cycling and to soil structure maintenance [6,7].

Bayoumi [8] studied the sensitivity of three strains of R. leguminosarum bv. viceae comparing with strains of R. leguminosarum bv. phaseoli, R. leguminosarum bv. trifolii, and R. loti to 8 herbicides. Among them, Paraquat was the most toxic one. Bayoumi et al. [9] reported that Acetochlor was the least inhibitor on tested Rhizobium strains. Bayoumi & Kecskés [10-13] in pot experiments established that microsymbionts were more sensitive to Trifluralin than macrosymbionts, whereas are sensitive to Paraquat, which reduced the size, number and dry weight of root-nodules, phytobiomass, height, and total N-content / plant. Eberbach & Douglas [14] found Paraquat and Trifluralin affected the nodulation potential of Rhizobium-legume.

Quantitative and representative recovery of microorganisms from environmental samples is essential in understanding ecosystem function. Microbial communities play essential roles in the earth’s ecology. A powerful concept in modern biology is that of the ecosystem. Soil enzymes are present in important cycles, such as C (invertase), N (urease and protease), and P (phosphatase) cycles. Soil enzyme activities are used as indices of microbial activity and react quickly to environment change. Hydrolytic enzymes activities (phosphatase, β-glucosidase), oxidoreductase activities (dehydrogenase) and indole acetic acid production, were used as measures of soil perturbation. The hypothesis in this study is to estimate the effects of applied herbicides on some soil enzymes.

MATERIALS AND METHODS

Soil Samples

In this research work, the soil was collected from the garden of Rejto Sandor Faculty of Light industry and Environmental Engineering, Óbuda University. The garden is located to the west of the faculty building and the soil is Ramann’s brown forest soil, which was not been exposed to any chemical or other agricultural treatments before. Using a garden shovel and plastic bag, around four kilograms of soil were taken from the topsoil, particularly from the depth of 0-25 cm. The collected soil was transferred to the laboratory and air dried for some weeks to remove excess moisture.

Plant residues, stones, and other debris or big particles were taken off by hand. A ≤ 2mm standard stainless-steel sieve was used for five minutes to homogenize the soil. Later, it was sent to Institute of Soil Science Centre for Agricultural Research, to measure some physicochemical characteristics of the soil. The results are shown in Table 1.

Table 1. Physicochemical characteristics of the tested soil

Tested parameters	Measurement units	Values
pH_{KCl}	-	7.13
EC	µS/cm	32.34
$CaCO_3$	m/m %	3.34
H	m/m %	1930
Total Nitrogen Content	mg/kg	18.76
NH_4-N	mg/kg	73.69
AL-P_2O_5	mg/kg	51.7
AL-K_2O	mg/kg	169
Al-Na	mg/kg	37.2
KCl-Mg	mg/kg	146
KCl-S	mg/kg	14.1

Pesticides used in the study

Six pesticides were applied to the brown forest soil of the wheat rhizosphere soil to investigate their side-effects on some biological caharacteristics of the tested soil. Pesticides were as mentioned below:

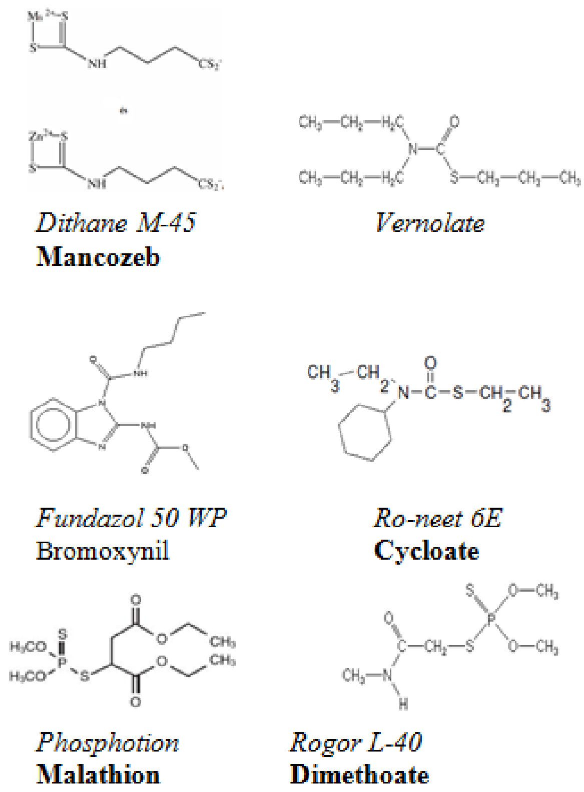

Figure 1. The pesticides used in the studa

According to the above plan, pesticides were each applied with three doses (1/2 X, X and 2X) doses as in Table 2 to the soil cultivated or non-cultivated (control) with wheat seeds (to study the effect of pesticides on the rhizospheric enzymatic activities) , and each cup was planted with seven wheat (common wheat: *Triticum aestivum* L.) seed. The seed was grown at 25±2℃ for 28 days. The exact amount of water was given to the plants every two days to maintain the soil moisture at approximately 45%.

Table 2. The pesticides recommended applied rates

Pesticides	Field recommended applied dose (X)
Dithane M-45	1.2-1.5 l/ha
Vernolate	4 kg/ha
fundazol 50 WP	0.5-1 kg/ha
Ro-neet 6E	**4-6 l/ha**
Phosphotion	1.2-1.5 l/ha
Rogor L-40	**2 l/ha**

INVESTIGATION OF ENZYMATIC ACTIVITIES IN SOILS

β-glucosidase activity

The potential activity of β-glucosidase was calculated as following: Two ml of 0.1 M maleate buffer (pH 6.5) and 0.5 ml of 50 mM *p*-nitrophenyl- **β** -D-glucopyranoside (PNG) were added to 0.5 g of soil sample. The rest of the method was the same as for phosphatase activity (Masciandaro, Garcia [15]). The PNP absorbance was measured at 400 nm. **β** -glucosidase activity is expressed as μmol of PNP per gram dry soil and incubation time (hours).

Phosphatase activity

The potential activity of phosphatase was done as following: Two ml of 0.1 M maleate buffer (pH 6.5) and 0.5 ml of 0.115 M *p*-nitrophenyl phosphate (PNP) were added to 0.5 g of soil sample and incubated at 37°C for 90 min. The reaction was stopped by cooling to 2°C for 15 min., then 0.5 ml of 0.5 M CaCl2 and 2 ml of 0.5 M NaOH were added and the mixture was centrifuged to 4000 rpm for 5 min. The reaction product was filtrated and the filtrate (*p*-nitrophenol) was analyzed calorimetrically at 398 nm (Tabatabai and Bermner, [16]). Controls were made in the same way, although the substrate was added before the CaCl2 and NaOH. The PNP absorbance was measured at 398 nm. Phosphatase activity is expressed as μmol of PNP per gram dry soil and incubation time (hour).

Aryl-sulfatase activity

The potential activity of aryl-sulfatase (μmol nitrophenol/g dry soil/h) was determined according to Tabatabai & Bremner [17]). The activity was measured by absorption of p-phenol at 400 nm after incubation with PNP sulphate.

STATISTICAL ANALYSIS

As stated before, three duplicates in triplicate were used in the research work, which is placed in a randomized block design. To calculate the statistically significant differences between treatments, a correlation based on a single classification was implemented. The standard deviation in each value was calculated at $P < 0.05$.

RESULTS AND DISCUSSION

In vivo pot experiment which carried out randomly in three replicates using brown forest soil with 45% moisture content as well as cultivated with the seeds of wheat and after 28 days at 25±2℃ and the around 10-12 hours photoperiod, the following Figures from 1 to 6 show the effects of six pesticides on the three enzymatic activities (Phosphatase activity (expressed as μmol p-nitrofenol (PNP)/g dry soil/h, β-glucosidase activity (expressed as μmol p-nitrofenol/g dry soil/h), Aryl-sulphatase activity (expressed as μmol PNP/g dry soil/h) in the rhizosphere of wheat seedlings in comparison with non-cultivated soil as control. The pesticides applied doses were half and double recomeded rapplication rate of each pesticide in comparion with the reconneded dose for agricultural lands. The measurements of potential enzymatic activities of the mentioned enzymes were done using the spectrophotometrical method.

Figure 1 shows the effect of Cycloate on the three mentioned enzymes method. Comparing with the enzymatic activities of the three enzymes in non-cultivated soil, it was found that Cycloate can promote the three enzymes at half and normal recommended doses while the dould dose reduced the potential activities of the three enzymes but higher than the activites of the enzymes in control soils.

Figure 2 illustrates the differences between the potential enzymatic activivtes in rhizosphere of wheat seedlings and those in the non-cultivated soil samples. It wa found that Vernolate has similar effects as Cycloate did. Vernolate can promote rhe half and recommended doses but able to reduce the potential activities of the three enzymes also, it is clear that the reduction of the potential acivities of the enzymes not reach the harmful effect but similar relatively to the control samples.

Figure 3 domenestrates the stimulation effects of the half and double dodes of Benomyl on the three enzymes in similar way the above mentioned pesticides

Figure 4 represents the mode of action of the investigated pesticide Mancozeb on the potential acivities of phosphatase, aryl-suphatase and beta-glucosidase in cultivated and non-cultivated soil samples. It was found that Mancozeb also, carried out the similar mode of actions as done ba Cycloate, Vernolate and Benomyl but stimulate the potential activity of beta-glucosidase more than any other pesticids. Mancozeb is highly stimulating aryl-sulphatase even at double dose.

Figure 5 labells the clear stimulation of Dimethoate to the potential activity of aryl-sulphatase higher than the control even at double dose

Figure 6 shows the stimulation of Malathion onpotential activity of aryl-sulphatase even at double dose

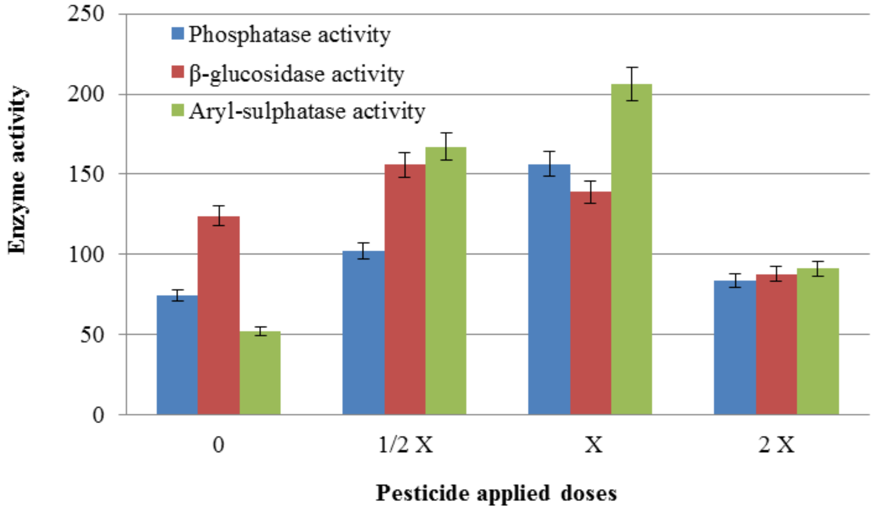

Figure 1. Effect of Cycloate on the enzymatic activies in brown forest soil

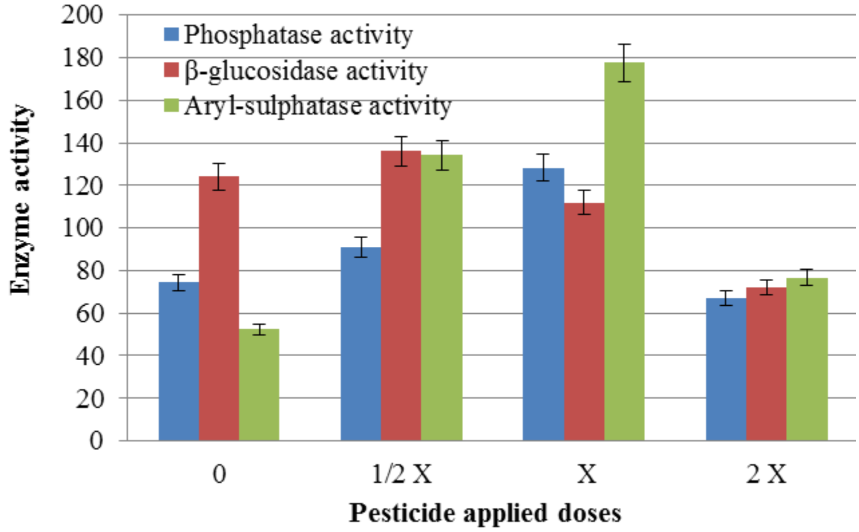

Figure 2. Effect of Vernolate on the enzymatic activies in brown forest

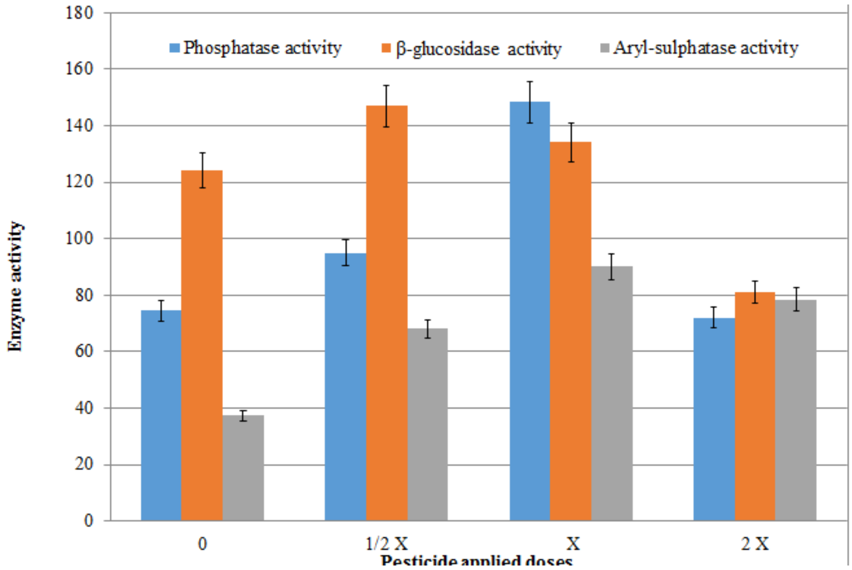

Figure 3. Effect of benomyl on the enzymatic activies in brown forest s

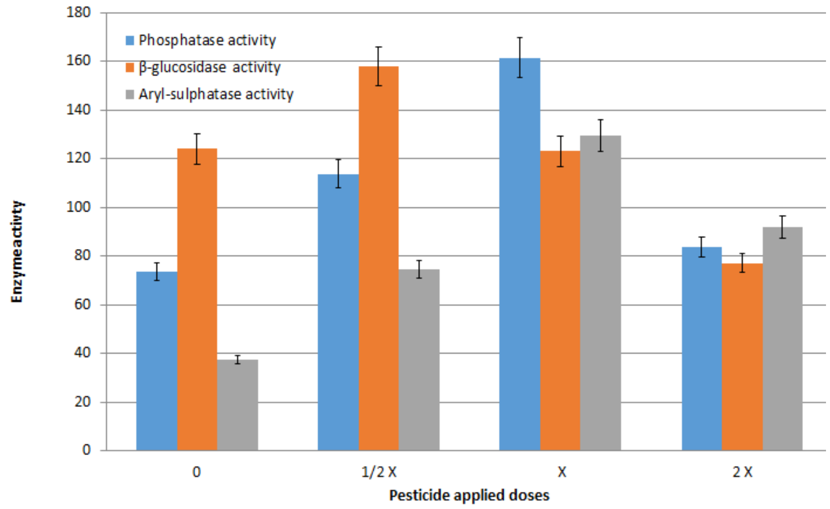

Figure 4. Effect of Mancozeb on the enzymatic activies in brown fore

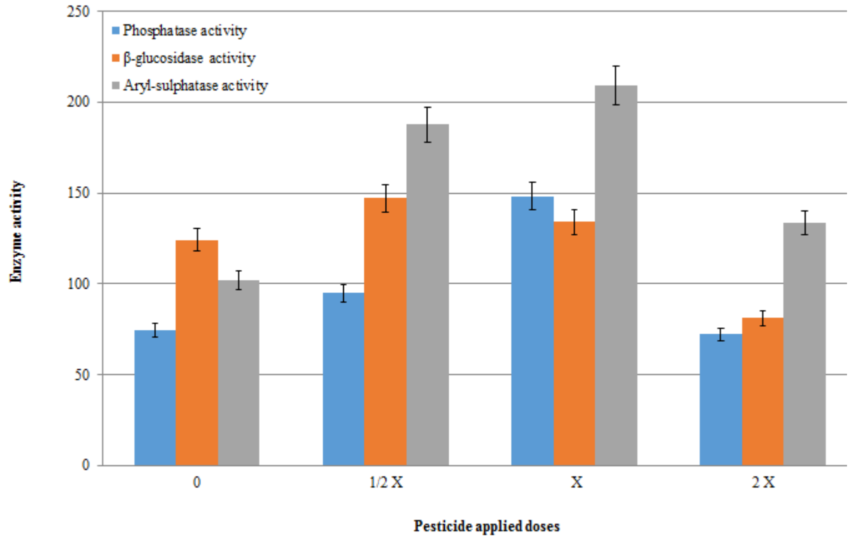

Figure 5. Effect of Dimethoate on the enzymatic activies in brown fore

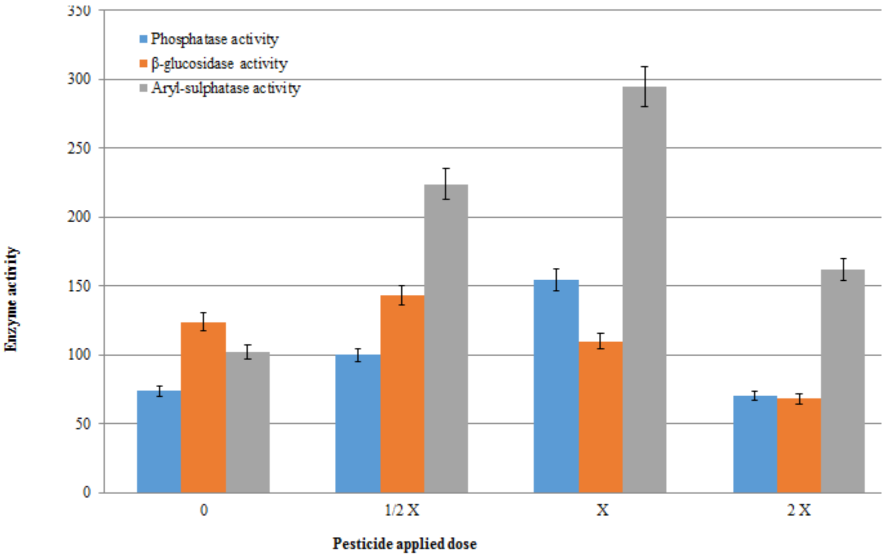

Figure6. Effect of Malathion on the enzymatic activies in brown forest s

CONCLUSION AND FURTHER TASKS

Pesticides are biologically active compounds, and an unintended consequence of its application may lead to significant changes in microbial populations and activities influencing microbial ecological balance affecting soil fertility. The fate of pesticides applied in agroecosystems is governed by the transfer and degradation processes, and their interaction with soil microorganisms. The increasing reliance of sustainable agriculture on pesticides has led to concern about their ecotoxicological effects influencing microbial populations and enzyme activities, which may serve as indicators of soil quality. In this study, the application of herbicides influenced the soil enzyme activity differently. From the present study it can be emphasized that the type of herbicide, its concentration and its time of exposure influence soil enzyme activities. Hence great care is required while applying herbicide to soil. The enzyme activities are considered to be sensitive to chemical pollutants/agrochemicals and have been proposed as potential indicators for measuring the degree of pollution of contaminated soil. The study confirmed that the pesticides may alter the affects the different soil enzymatic activities. Since the investigations were performed *in* vitro in pot experiment, and the effects of pesticides are highly transitory, it is particularly difficult to explain a change of soil enzymatic activities in response to certain factors or to establish the cause-effect relationships between the pesticide treatments and the various components contributing to the variation in overall soil enzyme activities. Among the applied pesticides, Mancozeb was the most toxic one. Further task, it is necessary to strengthen the scientific basis of modern agriculture, because herbicides may be advantageously used only if their persistence, bioaccumulation, and toxicity in agroecosystem are strictly controlled.

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BIODIVESRSITY AND CONSERVATION

Adebayo Raimot ADEJUMOKE

Department of Biology Education, School of Science Education
Federal College of Education (Technical) Akoka- Yaba, Lagos State, Nigeria
Email: princess64raheemat@gmail.com, Tel: +2347030316062

This paper looked into biodiversity and conservation. The need to achieve substantial and improvement in any country is by integrating biodiversity and creating awareness on conservation into national policy for sustainable economic development and national transformation. The presentation involved meaning of biodiversity, types of biological variety, threat to Biodiversity in Nigeria, meaning of Conservation, groups of conservation, Need or Reasons for Conservation, Methods of conserving wildlife, water, forest, soil, air, mineral resources, Importance or Benefit of Conservation of Natural Resources, Benefits of water resources conservation, Benefits of Forest, soil, air and mineral resources conservation. Ways of ensuring the conservation of Natural Resources, Examples of agencies for conservation , Some game reserves in Nigeria Problems and Difficulties Associated with Conservation, Some major challenges to Conservation Practices in Nigeria. Several recommended were made among which is that government should ratify the remaining convention and treaties in biodiversity conservation, the implementation of the millennium development goal with emphasis on poverty reduction which will reverse the degradation of the environment water and sanitation. Also*, government should create more awareness on benefit of conservation, and sponsor teachers on attending seminar , conference and workshop on conservation*

Keywords*: Biodiversity, conservation, Reasons, method, grouping of conservation*

INTRODUCTION

Nigeria as a country is endowed with a variety of plant and animal species. There are about 7, 895 plant species identified in 338 families and 2, 215 genera There are 22, 000 vertebrates and invertebrates species.
The goal of the plan is to conserve Nigeria's biodiversity and enhance its sustainable use by integrating biodiversity conservations into national planning policy and decision making process while emphasis is placed on biodiversity conservation within protected areas such as forest reserves and national parks and 37 gazette and proposed games reserves and sanctuaries exist in Nigeria. There is also the maintenance of a register of introduced species (about 53 alien plant species and 12 exotic animal species. The Nigeria conservation Foundation (NCF) are developing a plan to promote tourism in the park, stimulating the economy through conservation efforts .Nigeria is rich in Biodiversity.

MEASURING BIODIVERSITY

A variety of objective means exist to empirically measure biodiversity. Each measure relates to a particular use of the data, and is likely to be associated with the variety of genes. Biodiversity is commonly measured in terms of taxonomic richness of a geographic area over a time interval (Sala, 2009).

MEANING OF BIODIVERSITY

Biodiversity simply refers to as biological variety and variability of life on Earth. Biodiversity is a measure of variation at the genetic, species, and ecosystem level. Terrestrial biodiversity is usually greater near the equator, which is the result of the warm climate and high primary productivity. Biodiversity is not distributed evenly on Earth, and is richer in the tropics. While these tropical forest ecosystems cover less than 10% of earth's surface and contain about 90% of the world's species Marine biodiversity is usually higher along coasts in the Western Pacific, where sea surface temperature is highest, and in the mid-latitudinal band in all oceans. There are latitudinal gradients in species diversity Biodiversity generally tends to cluster in hotspots, and has been increasing through time, but will be likely to slow in the future as a primary result of deforestation. It encompasses the evolutionary, ecological, and cultural processes that sustain life (Gaston, 2013).

Biologists most often define biodiversity as the "totality of genes, species and ecosystems of a region" An advantage of this definition is that it seems to describe most circumstances and presents a unified view of the traditional types of biological variety previously identified:

1. Taxonomic diversity (usually measured at the species diversity level)
2. Ecological diversity (often viewed from the perspective of ecosystem diversity)
3. Morphological diversity (which stems from genetic diversity and molecular diversity
4. Functional diversity (which is a measure of the number of functionally disparate species within a population (e.g. different feeding mechanism, different motility, predator vs. prey, etc.)
5. Ecological effects of biodiversity
6. Biodiversity supports many ecosystem services

More so, the impacts of diversity loss on ecological processes might be sufficiently large to rival the impacts of many other global drivers of environmental change. Maintaining multiple ecosystem processes at multiple places and times requires higher levels of biodiversity than does a single process at a single place and time. It plays a part in regulating the chemistry of our atmosphere and water supply. Biodiversity is directly involved in water purification, recycling nutrients and providing fertile soils. Experiments with controlled environments have shown that humans cannot easily build ecosystems to support human needs (G. Miller, 2012).

THREAT TO BIODIVERSITY IN NIGERIA

i. Biodiversity Nigeria is seriously under the threat of extinction from climate change, economic development, land use changes from agriculture, invasive species and pollution crude oil exploration and exploitation, canalization that has threatened mainly the mangroves, deforestation, desert encroachment, over hunting, land use, road and residential buildings construction etc.
ii. It is the fear of species extinction emanating from the poor attitude of both government and the citizenry towards the protection of biodiversity in Nigeria that has necessitated this work so that conservation practices should be implemented and taken seriously in the country to avoid a catastrophe of species extinction in the nearest future Africa and incidentally Nigeria have rich and varied biological resources forming its natural wealth in which its socio-economic system is based.
iii. Other threats to terrestrial habitat include bush fire especially in the savanna, soil preparation for agriculture, over fishing, deforestation, roads, residential and commercial centers construction etc.
iv. The problems of gully erosion in Agulu-Nanka of Anambra State and Imo state. [9] Stated that all the 36 states of Nigeria including Federal Capital Territory (FCT) are adversely affected by soil erosion. But the intensity and type vary from region to region. While wind erosion is common in the northern part of Nigeria where the soils are sandy, coastal erosion affect all the states bordering the Atlantic Ocean that includes; Ogun, Lagos, Ondo, Delta, Edo, Akwa Ibom, Rivers state, Bayelsa and Cross River state.

v. Anthropogenic activities that have resulted in the degradation of the forest include, clearing and burning of forest; over harvesting of plants anti animals ,indiscriminate use of persistent or recalcitrant chemical pesticides, draining and filling of wetlands, destructive fishing practices, air pollution and the conversion of protected lands for agricultural and urban development purposes.

CONSERVATION

The word conservation can be defined as the planned or controlled exploitation or judicious use of natural resources to ensure their continuous availability and to preserve the quality or original nature of the environment. In other words, conservation is the preservation of natural resources from loss, waste or exploitation through rational use and to ensure the continued use or availability and preserve the quality or original nature of the natural resources.

GROUPS OF NATURAL RESOURCES

There are two groups of natural resources namely:

i. Renewable natural resources
ii. Non-renewable natural resources.

I. **Renewable natural resources**:

These are the natural resources that are recoverable. Examples are rain, animals, planet, plants, water, air, food and soil.

II. Nonrenewable resources:

These are resources which when exhausted cannot be replaced or recovered. Examples are mainly mineral resources like petroleum, coal, tin, copper etc.

NEED OR REASONS FOR CONSERVATION

i. To prevent destruction of natural environment or to allow for continued use of natural resources for man's benefits.
ii. To preserve rare and valuable species of plants and animals for the future generation or to save them from extinction or permanent destruction.
iii. To preserve naturally beautiful sceneries for their aesthetic values.
iv. To promote the recycling of some scarce mineral resources e.g., water
v. To prevent the destruction of natural ecosystem , this will allow the organisms in the ecosystem to survive
vi. Forest which provides medicinal materials must be conserved to ensure easy availability and continued existence.
vii. Natural resources e.g., wildlife , forest , minerals e.t.c provide basis for research purposes/

NATURAL RESOURCES THAT NEED TO BE CONSERVED

Natural resources that need to be conserved include wildlife, water, forest soil, air and mineral resources.

METHODS OF CONSERVING NATURAL RESOURCES

a. Methods of conserving wildlife

There are various methods namely:

i. Establishment of game or forest reserves
ii. Control of hunting to prevent extinction of some animals species
iii. Prohibition of killing or pro-aching extinction of animals in game reserves
iv. Creation of awareness on the values of wildlife
v. Prevention of pollution to prevent the destruction of aquatic life
vi. Prohibition of bush burning as this may lead to migration of displacement of wildlife.
vii. Prohibition of deforestation and encourage of afforestation or re afforestation.

b. Methods of conserving water

These include the followings:

i. Trapping or storage of water in tanks or wells
ii. Prevention of water pollution by sewage and chemical from industries and homes.
iii. The existence of vegetation also brings about the formation of rainfall
iv. Treatment and recycling of used water.
v. Tree planting which provides vegetation and promote retention.

c. Methods of conserving forest

These include the followings:

i. Cutting of trees without destroying the under growth
ii. Re afforestation or encouraging the planting of trees
iii. Prevention of bush burning or careless forest fires
iv. Educating the public on the value of forests and importance of conservation
v. Prevention of plant pests and diseases

d. Methods of conserving soil

These include the followings:

i. Prevention of over grazing which may cause soil erosion
ii. Prevention of indiscriminate felling of trees or deforestation which exposes the soil to erosion
iii. Adoption of better farming practices e.g crop rotation so as to prevent erosion , leaching ,water logging or acidity.
iv. Prevention of pollution of land so as not to destroy useful soil organism
v. Prevention of bush burning which may expose the soil to erosion

e. Methods of conserving air

These include the followings:

i. Prevention of effluents from factories or factory chimneys which may pollutes the air or cause acid rain.
ii. Prevention of fumes automobile or thermal plants which may affect aerial life or render air unfit for organisms
iii. Proper treatment and disposal of sewage
iv. Proper burning of waste so as to prevent smoke or soot from polluting the air
v. Proper disposal of dust from construction sites which may cause air pollution

f. Methods of Conserving Mineral Resources

These include the followings:

i. There should be legislation against indiscriminate mining of mineral resources
ii. Effective and efficient extraction methods of mining should be adopted to prevent wastage.
iii. Over dependence on a particular mineral resource should be discouraged as this can lead to the depletion of such mineral resources
iv. There should be effective and efficient utilization of available mineral resources human’s use.

IMPORTANCE OR BENEFIT OF CONSERVATION OF NATURAL RESOURCES

i. It provides food for human consumption e.g., meat, fish, eggs etc.
ii. It generated revenue for government
iii. It can serve as tourist centres for pleasant and relaxation
iv. It provides research work for scientists
v. It can generate employment for some people.

Benefits of water resources conservation

These include the followings:

i. It serves as sources of food supply e.g. fish, prawn, Cray fish
ii. It is used for hydro-electric power (HEP) generation which provides electricity e.g. Kainji dam
iii. Water is useful for agricultural purposes i.e. irrigation
iv. Water serves as a medium of transportation in rivers , lakes and oceans
v. Water provides employment for people e.g. fishermen, canoe or ship builders.
vi. Water can used for recreational and tourist purposes

Benefits of Forest conservation

These include the followings:

i. Forests are sources of food supply e.g., fruits, vegetables, meat etc.
ii. Forests are sources of timber for construction purposes.
iii. Forest provide medicinal herbs
iv. Forest provide employment for some people e.g., forest guards , lumbermen and hunters
v. Forests provide raw materials for industries e.g. cotton, rubber, ropes and twine, latex.

Benefits of Soil Resources Conservation

These include the followings:

i. Soil supports agricultural or farming activities.
ii. Soil also supports forests and its resources
iii. Soil supports wildlife resources
iv. It supports the growth of valuable wood for building and furniture making
v. It is the home of some organisms

Benefits of Air Resources Conservation

These include the followings:

i. Air provides oxygen used in respiration by plants and animals
ii. It provides carbon dioxide used by plants for photosynthesis
iii. Air also provide gaseous nitrogen used by plant to manufacture proteins
iv. Air is the habitat of most organisms e.g birds, insects etc.
v. It makes life more meaningful and comfortable

Benefits of Mineral Resources Conservation

These include the followings:

i. Minerals resources provide fuel e.g., coal, petroleum and natural gas, for use.
ii. They are used for construction purposes, e.g. iron, zinc, and aluminium.
iii. Some are used for industrial development e.g., diamond, iron, copper, silver, etc.
iv. Minerals are sources of foreign exchange
v. They also provide employment e.g., miners, drillers, marketers.

WAYS OF ENSURING THE CONSERVATION OF NATURAL RESOURCES

i. **Establishment of agencies for conservation**:

The agencies are establishment to ensure that natural resources are conserved e.g., Preservation of wildlife, forest resources, water resources, air, soil and mineral resources.

Examples of agencies for conservation are:

1. Nigeria Conservation Foundation
2. Forest departments
3. Federal Environmental Protection Agency (FEPA)
4. River Basin Development Authorities (RBDA)

ii. **Establishment of game reserves or national parks**

These deals with game reserves or national parks serve for the protection of wildlife, rare or endangered species and for recreational purposes as well as scientific purposes as well as scientific purposes.

Some game reserves in Nigeria include:

i. Yankari game reserve in Bauchi
ii. Borgu game reserve in Niger State
iii. Shasha river forest in Ogun State
iv. Olomu forest reserve in Kwara State
v. Mamu river forest reserve in Anambra State
vi. Zamfara forest reserve in Zamfara State

iii. **Making of conservation laws, edicts or decrees:**

This implies laws, edicts or decree are made by the government to regulate the felling of trees, hunting or exploitation of endangered species or indiscriminate exploitation of mineral resources. These laws must be obeyed.

iv. **Conservation education:**

This serves to inform the populace about the need to conserve natural resources and the consequence of extermination or exhaustion of such resources like trees, wildlife and minerals.

v. **Setting standards for pollution control:**

These standards help to protect land, water and air resources from certain level of pollution from industries, vehicles, power plants and homes.

PROBLEMS AND DIFFICULTIES ASSOCIATED WITH CONSERVATION

The following Problems or difficulties are encountered in the process of conserving natural resources namely:

i. Soil erosion caused by natural wind, rainfall and run – offs.
ii. Land , air and water pollution
iii. Occurrence of natural disaster such as earth quakes and floods
iv. Overgrazing caused by domestic livestock
v. Indiscriminate bush burning and felling of timber leading to eradication of wild plants and animals
vi. Indiscriminate fishing leading to depletion of aquatic life
vii. Adoption of poor farming methods e.g. bush fallowing , sifting cultivation and continuous cropping which leads to depletion of soil nutrients
viii. Problem of oil spillage which leads to loss of terrestrial and aquatic life.

SOME MAJOR CHALLENGES TO CONSERVATION PRACTICES IN NIGERIA

a. There are many governmental agencies in charge of environmental matters that they work at cross purposes to the extent that statutory delineation is not adhered to. Such attitude may stem from corruption of some officials in agencies. (Aghede, 2004).
b. Conservation projects are seriously threatened by economic development that needs the areas for exploitation, mining, exploration, road expansion and highway networks [8]. Others

are lack of conservation project sustainability, inadequate finance to fund projects, poverty among the local communities etc.

c. Paucity of trained man power and basic information on biodiversity conservation practices.
d. National Legislation on Biodiversity is non-existent
e. Threat of climate change
f. Incomplete knowledge of the species of organisms and their total worth is still unknown.

CONCLUSION

The importance of biodiversity as a natural resource cannot be over emphasized because of the basic needs they satisfy and their role as the vital cultural heritage of the nation, Therefore, there must be a conceited effort by the government and citizens to make wise use of these natural resources to avoid their degradation and depletion.

RECOMMENDATIONS

- Government should ratify the remaining convention and treaties in biodiversity conservation.
- The implementation of the millennium development goal with emphasis on poverty reduction which will reverse the degradation of the environment water and sanitation.
- Poverty reduction through the application of modem agricultural practices such as taungya farming alley cropping, agro pastoral, improved fish farming and possible wildlife domestication.
- Government should create more awareness on benefit of conservation
- Governemnt should sponsor teachers on attending seminar , conference and workshop on conservation
- Non-Governmental Organisation should partner with Governemnt agencies to create Environmental Conservation Club for students in order to be enlighten about safety in the environment.

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Article submitted to the Proceedings Book of the VIth. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

ROLE OF SOIL BIOLOGY IN LIFE: ACHIEVEMENTS AND CHALLENGES

Hosam E.A.F. BAYOUMI HAMUDA[1], Katalin Emese RAB GÁBORNÉ SERESS[2]

[1]Institute of Environmental Engineering and Natural Sciences, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Óbuda University, Budapest, Hungary.
[2]CEE Web for Biodiversity, Green Project, Budapest, Hungary, E-mail:
Bayoumi.hosam@uni-obuda.hu, E-mail_ ke.seress@gmail.com

Soil plays a vital role in sustaining life on the Earth. It is a non-renewable dynamic natural resource that is essential to life. Soil is a critical component of nearly every ecosystem provides a home for organisms. Soil biota plays an integral role in soil ecosystems by decomposing leaves, downed logs, and animals, and providing the primary nutrient source for vegetation. Soil biota includes both flora (plants) and fauna (animals). Soil flora includes organisms as small as diatoms and algae up to the size of tree roots. An important member of soil flora is mycorrhizae, fungi that form a symbiotic (mutually beneficial) relationship with plant roots. Most plants contain roots infected with mycorrhizal fungi. Mycorrhizae enhance water and nutrient absorption by increasing root surface area and accelerate mineral weathering which releases nutrients to the soil Water movement; water quality, land use, and vegetation productivity all have relationships with soil. Nearly all of the food that humans consume, except for what is harvested from marine environments, is grown in the Earth's soils. Other obvious functions that soils provide humans include fiber for paper and clothing, fuel-wood production, and foundations for roads and buildings. Less obvious functions that soils serve are providing a medium to attenuate pollutants and excess water, groundwater recharge, nutrient cycling, and habitat for microorganisms and biota. Soils have many secondary uses such as ingredients in confectionaries, insecticides, inks, paints, makeup, and medicines; uses of clays range from drilling muds, pottery, and artwork, to providing glossy finishes on various paper products. This study introduces many important soil concepts including development, classification, properties (physical, chemical, and biological), quality, and conservation. A general understanding of soil concepts and these interwoven relationships is essential to making sound land management decisions. Soil acts as the basis of the ecosystem foundation, as soil productivity determines what an ecosystem will look like in terms of the plant and animal life it can support. For example, in forest ecosystems, soils can determine species composition, timber productivity, and wildlife habitat, richness, and diversity. The role soil plays in forests is critical to maintaining water quality and long-term site productivity. In cultivated fields, soil quality plays a significant role in crop productivity since soil nutrients and soil physical properties can directly impact yields Collectively, soil biota carries out enzymatic and physical processes that decompose organic matter, build soil humus, and make nutrients available for plants. Decomposition is one of the most critical roles that soil biota play in an ecosystem. Without efficient decomposition, organic material would accumulate on the soil surface and nutrients would be bound within the material. Decomposition is initiated immediately when a leaf, twig, or fruit hits the ground. Once on the ground surface, biota begins to physically break down the material, creating more surface area to which flora can adhere.

***Keywords**: soil life, soil properties, soil microbiomes, soil biology*

INTRODUCTION

Soil is an essential resource for human societies and ecosystems, and it is subjected to permanent and increasing constraints and pressures. Animals and plants each have evolved specialized organs dedicated to nutrient acquisition, and these harbor specific bacterial communities that extend the host's metabolic repertoire. Similar forces driving microbial community establishment in the gut and plant roots include diet/soil-type, host genotype, and immune system as well as microbe-microbe interactions.

Life on Planet Earth is sustained by a small volume of soil surrounding roots, called the rhizosphere. Soil is where most of the biodiversity on Earth exists, and the rhizosphere probably represents the most dynamic habitat on Earth; and certainly is the most important zone in terms of defining the quality and quantity of the Human terrestrial food resource. Despite its central importance to all life, very little is known about rhizosphere functioning. A major issue in research on rhizosphere processes is the intimate connection between the biology, physics, and chemistry of the system which exhibits astonishing spatial and temporal heterogeneities.

Soil is the largest reservoir of biodiversity on Planet Earth. It is important habitat for Prokaryotes and a diversity of Eukaryotes, which comprise fungi among soil microbiomes, and large variety of invertebrates (from protozoa and nematodes to mites, collembola, insects and earthworms). The diversity of Prokaryotes in soil has been estimated to be about three orders of magnitude larger than in all other environmental compartments of the Earth's ecosystems combined (Crawford et al. 2005; Curtis and Sloan 2005).

Rhizosphere ecology is driven by a combination of the physical architecture of the soil matrix, coupled with the spatial and temporal distribution of rhizodeposits, protons, gases, and the role of roots as sinks for water and nutrients. Consequences for plant growth.

Soil health and soil quality are defined as the capacity of soil to function as a vital living system within land use boundaries. This function which sustains biological productivity of soil also maintains the quality of surrounding environment and human health. Thus the two terms are used interchangeably although it is important to distinguish that, soil quality is related to soil function, whereas soil health presents the soil as a finite non-renewable and dynamic living resource. In this review, we deal with soil health concept which includes interactions between plant inputs and soil in creating a healthy environment.

Through many studies it is clear that biological activity may increase the stability of soil within and outwith the rhizosphere. What is evident is the importance of wet~dry cycles to 'lock-in' that stability. Clearly a combination of biophysical factors, the exact nature dependent on a wide range of conditions, impacts on the stability of soil at the root-soil interface. Another important factor relates to the chemical make-up of the carbon involved.

Adverse effects on soil health and soil quality arise from nutrient imbalance in soil, excessive fertilization, soil pollution and soil loss processes that are increasingly becoming common in developing countries. Studies of the biological processes which take place in a soil have been based on the measurement of several variables: microbial biomass (Jenkinson and Ladd, 1981), respiration (Nannipieri et al., 1979), ATP (Brookes et al., 1983) and enzymatic activities (Frankenberger and Dick, 1983). However, the idea of microbiological activity has recently been revised by Nannipieri et al. (1990), who suggest that problems exist if variables such as biomass-C, CO_2 emission or dehydrogenase are to be considered as indices of microbiological activity; these problems are even greater when such complex ecosystems as the soils of arid zones are considered, since they are subject to such enormous imbalances.

Soil is a non-renewable dynamic natural resource that is essential to life. Water movement, water quality, land use, and vegetation productivity all have relationships with soil. **S**oil plays a vital role in sustaining life on the planet. Nearly all of the food that humans consume, except for what is harvested from marine environments, is grown in the Earth's soils. Other obvious functions that soils provide humans include fiber for paper and clothing, fuelwood production, and foundations for roads and buildings. Less obvious functions that soils serve are providing a medium to attenuate pollutants and excess water, groundwater recharge, nutrient cycling, and habitat for microorganisms and biota. Soils also have many secondary uses such as ingredients in confectionaries, insecticides, inks, paints, makeup, and medicines; uses of clays range from drilling muds, pottery, and artwork, to providing glossy finishes on various paper products.

Soil is a critical component of nearly every ecosystem, but is often taken for granted. Soil can be thought of as the ecosystem foundation, as soil productivity determines what an ecosystem will look like in terms of the plant and animal life it can support. For example, in forest ecosystems, soils can determine species composition, timber productivity, and wildlife habitat, richness, and diversity. The role soil plays in forests is also critical to maintaining water quality and long-term site productivity.

In cultivated fields, soil quality plays a significant role in crop productivity since soil nutrients and soil physical properties can directly impact yields. In urbanized areas, soil plays a vital role in reducing runoff through infiltration and nutrient attenuation. The value of soil is easily overlooked until soil quality becomes degraded and the critical services the soil once provided are diminished.

Human activities frequently cause a degradation of soil environment which leads to a reduction in the abundance and to a simplification of animal and plant communities, where species able to bear stress predominate and rare taxa decrease in abundance or disappear. The result of this biodiversity reduction is an artificial ecosystem that requires constant human intervention and extra running costs, whereas natural ecosystems are regulated by biotic communities through flows of energy and nutrients, a form of control progressively being lost with agricultural intensification.

For these reasons the identification of agricultural systems which allow the combination of production targets and environmentally friendly management practices, protecting both soil and biodiversity, is essential in order to prevent the decline of soil fauna and microbiomes communities in agricultural soil.

Soil is the third most important element of the environment. It plays a central role in the physical, chemical and biological processes taking place on Earth in the biogeocycle of elements, but the classification of the biological state is a significantly more complicated task. One of the most important tasks of the soil is to store plant nutrients and make them available to the plants at the right time and in the right form.

Soil is fundamental and irreplaceable; it governs plant productivity of terrestrial ecosystems and it maintains biogeochemical cycles because microorganisms in the soil degrade, sooner or later, virtually all organic compounds including persistent xenobiotics and naturally occurring polyphenolic compounds.

The living population inhabiting soil includes fauna (macro-, meso-, and microfauna) and microflora. This property is due to the complicated physico-chemical-biological role of the soil, the complex system consisting of organic and inorganic substances, to which nutrients, water and soil microorganisms can be connected by physical or chemical bonds of varying strength.

Soil fauna and soil microorganisms, i.e. fungi, bacteria and actinomycetes (actinobacteria), yeasts and algae, etc. they contribute to soil fertility in many ways. The presence and activity of microbiomes are therefore of fundamental importance from the point of view of the fertility of agricultural soils. The beneficial effect of fertilization on soil productivity has been known for a long time. Microbiomes are the largest fraction of the soil biota in terms of mass and number. These miniature "factories" are the driving forces behind many processes of decisive importance in nature, such as the C, N and P recycles.

Microbes ensure the decomposition of organic materials, they play a huge role in plant nutrition (biological nitrogen fixation, mobilization of micro- and macro-elements, nutrient absorption, etc.) and in the formation of soil structure. The functioning of the soil-plant system is unthinkable without billions of microorganisms.

Soil fauna subsists on a wide variety of energy sources, including: living plant material (herbivores), animals (carnivores), dead material (detritivores), fungi (fungivores), and bacteria (bacterivores). Soil fauna and microbiomes are an important reservoir of soil biodiversity and play an essential role in several soil functions; furthermore, it is often used to provide soil quality indicators. Although soil biodiversity was one of the focal points of the Rio conference, in the 1990s virtually no attention was paid to activities for the conservation of soil communities. However, with the new millennium, the conservation of soil biodiversity has become an important aim in international environmental policies, as highlighted in the Planet.

Soil fauna are highly variable and the majority are also highly adaptable with regard to their feeding strategies, ranging from herbivores to omnivores and including carnivores. Depending on the available food sources many soil fauna are able to change their feeding strategies to a greater or lesser extent with many carnivorous species able to feed on dead organic matter in times of low food availability. The interactions between soil fauna are numerous, complex and varied. As well as the predator / prey relationships and in some instances parasitism, commensalism also occurs.

Soil fauna includes earthworms, collembolans, mites, nematodes, and protozoa. These are eukaryotic, heterotrophic, motile organisms that require oxygen for metabolism. There are many evidences on

how the role of soil fauna in food webs will respond to environmental change and influence aboveground processes has advanced considerably.
Loss of species due to varying management practices, erosion, pollution, urbanization, and resulting effects on ecosystem function and services are becoming widely recognized and related to larger issues of biodiversity loss, desertification, and elevated greenhouse gas concentrations.
Microfauna: organisms whose body size is between 20 µm and 200 µm. Just one group, protozoa, is found wholly within this category; among the others, small mites, nematodes, rotifers, tardigrades and copepod crustaceans all fall within the upper limit. Mesofauna: organisms whose body size is between 200 µm and 2 mm.
Microarthropods such as mites and springtails are the main representatives of this group, which also includes nematodes, rotifers, tardigrades, small araneidae, pseudoscorpions, opiliones, enchytraeids, insect larvae, small isopods and myriapods. Macrofauna: organisms whose size is between 2 mm and 20 mm. This category includes certain earthworms, gastropods, isopods, myriapods, some araneidae and the majority of insects. Megafauna: organisms whose size exceeds 20 mm. The members of this category include large size invertebrates (earthworms, snails, myriapods) and vertebrates (insectivores, small rodents, reptiles and amphibians).
The degree of interaction between soil organisms and the soil itself can be highly variable among taxa and dependent on the part of the life cycle that is spent in the soil [2].
In particular, in this regard, combined with the morphological adaptations and the ecological functions of organisms, it is possible to classify soil fauna into four main groups: temporarily inactive geophiles, temporarily active geophiles, periodical geophiles, and geobionts (Figure 1).

Figure 1. The main four grouping that can be individualized between soil invertebrates, depending on their life strategies and how closely they are linked with soil
Source: Menta Cristina (2012). DOI: 10.5772/51091

Many studies have reported increased microbial activities during the passage of food through the gut in earthworms and higher numbers of fungi, bacteria and actinomycetes in vermicasts showed enhanced microbial populations and activity in the freshly deposited pressmud vermicasts in relation to nutrient rich substrate concentrations, multiplication of microbes after passing through the gut, optimal moisture level and large surface areas of vermicasts ideally suited for better feeding and multiplication of microbes. It is important to note that often worm casts are not released in the same layer in which the earthworm fed; in effect the components of the anecic group live at depth and release their mineral-rich faeces on the surface. In contrast the endogeic live at the surface and release their faeces, once again rich in organic matter, at lower depths. These forms of behaviour together with the direct action due to the burrowing, ensure that the soil is mixed, thereby increasing its fertility. The burrowing of the earthworms is also essential for increasing the aeration of the soil and for improving the circulation of water since their tunnels increase the porosity of the ground by 20-30%, enabling those organisms that are not good burrowers to move around easily even at lower

depths of the soil. Other than with their worm casts, earthworms contribute to the increase in the amount of N present in the ground through the excretion of NH_3 and urea, forms that are directly useable by plants; furthermore a sizeable quantity of N is returned to the soil on the death of animals, which have 72% protein content.
Within the context of edaphic fauna it is possible to identify, based on the type of locomotion, swimming organisms, capable of moving around in capillary or gravitational water, reptants that move by taking advantage of natural porosity or cavities produced by other organisms and burrowing organisms. The last-mentioned can open up cavities in the ground in various ways; for example, earthworms compress the ground outside their bodies, diplopods use their legs and backs to push the sediment upwards, the larvae of click beetles use their mandibles, while moles, scarabs and mole-crickets have specialised legs for burrowing. This continual burrowing activity contributes to the creation of spaces within the soil with the resultant increase in its porosity; the increase of the pores between the particles in turn increases the aerobic bacterial activity and the consequent speed of demolition of organic substances. This bioturbation also has positive effects on water retention, percolation processes and the development of the rhizosphere. The burrowing activity also enables the soil to be mixed and organic matter from the surface layers to be incorporated into the lower layers, while mineral substances are brought towards the surface. This process is carried out in a very evident way by the anecic earthworms discussed a little earlier, which moves vertically in the ground even reaching depths of several metres.
According to an ecological and functional classification it is possible to identify three groups of earthworms that differ in size, burrowing capability, type of food and habitat: epigeic, endogeic and anecic. The epigeic, whose sizes ranges from 0.5 to 5 cm, have a red coloured body, are poorly adapted to burrowing and have a good tolerance to low pH values. They inhabit the superficial organic layers where they feed on litter. The endogeic, whose sizes range from 1 to 8 cm, have a non-pigmented body; exposure to soil with pH values below 5 restricts their activity. They live in the first few centimetres of mineral soil, feeding on humic compost and dead roots, they are capable burrowers and they make tunnels that extend mainly horizontally. Earthworms defined as anecic, whose sizes generally are in excess of 5 cm and have a reddish-brown body, are excellent burrowers, making vertical tunnels that can reach several metres in depth; they tend to avoid soil that is asphyxiated or lacking in moisture. They live in the mineral layer of the soil but rise to the surface, mainly at night, to feed on litter. The activity of earthworms produces a significant effect, not just on the structure, but also on the chemical composition of the soil, since a large part of the organic matter ingested by earthworms is returned to the soil in a form easily used by plants. While they are feeding, earthworms also ingest large quantities of mineral substances (minimally so in the case of the epigeic), that are then mixed with the organic matter ingested and, after having been cemented with a little mucous protein, are expelled in piles called worm casts. In addition to being rich in nitrogen and other nutritive substances such as calcium, magnesium and potassium, worm casts also contain a large quantity of non-digested bacteria which proliferate easily in this sub-stratum and contribute to the humification and mineralisation of organic matter. Vermicasts have more favourable physico-chemical properties, increased microbial population, enzyme activities and nutrient mineralization that support plant growth and yeld.
Soil bacteria belong to different taxonomic classes; from the point of view of soil life, species that bind N from the air, nitrify, are very active in breaking down proteins, and convert NO_2 into free N. Ray fungi are important in breaking down cyclic compounds that are difficult to break down such as humus, lignin, etc. Figure 2 represent the soil food web.
Soil microflora includes living organisms as small as diatoms and algae up to the size of tree roots. An important member of soil microflora is mycorrhizae, fungi that form a symbiotic (mutually beneficial) relationship with plant roots. Most plants contain roots infected with mycorrhizal fungi. Mycorrhizae enhance water and nutrient absorption by increasing root surface area and accelerate mineral weathering which releases nutrients to the soil (Fisher and Binkley, 2000). Collectively, soil biota carries out enzymatic and physical processes that decompose organic matter, build soil humus, and make nutrients available for plants.
Algae occur mainly in the surface layers of the soil, where they photosynthesize with the energy of sunlight (photosynthesis), but there are also heterotrophic organisms among them. Some of the fungi are important in the breakdown of manure, in the discovery of raw phosphates, and in the

transformation of toxic substances that have entered the soil, but the fungi that live together with individual plants also play a significant role, helping the higher plant to absorb nutrients.

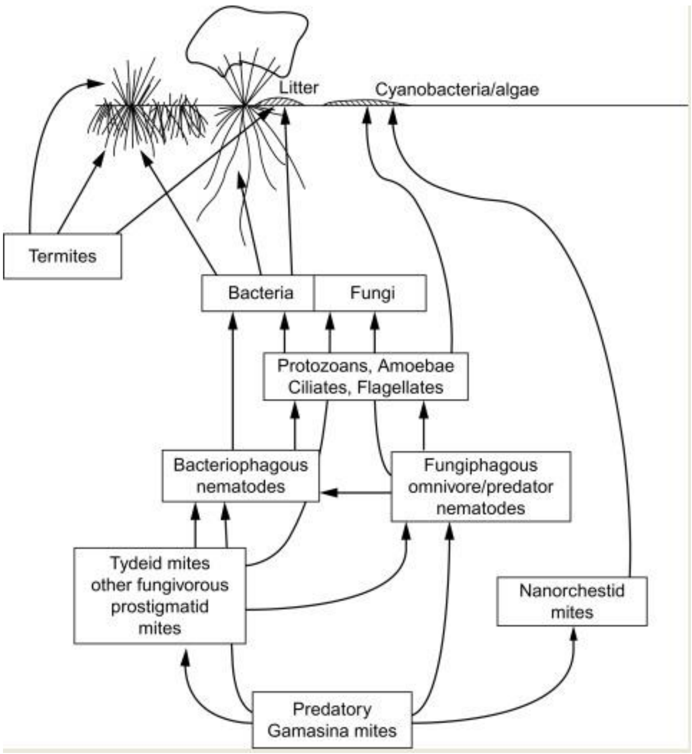

Figure 2. Diagrammatic representation of a soil food web

Microorganisms that cause plant diseases also live in the soil, they infect the soils under agricultural cultivation, and the degree of infection can increase with incorrect agrotechnical procedures and a poorly chosen crop rotation, which can lead to a decrease in crop yield and, in the case of severe infection, to the soil becoming unproductive. The proliferation of saprobiont microorganisms and the increase in their activity reduces the number of pathogenic microbes, also the reduction of pathogens, or its destruction can be achieved by using various biocides and pesticides.

THE ROLE OF SOIL FAUNA IN SOIL ECOSYSTEM PROCESSES

Some researchers have defined edaphic fauna as a “super organism” that assumes a crucial significance due to the chemico-physical and biological processes that are rooted in the soil. Soil biota play an essential role in soil functions as they are involved in processes such as the decomposition of organic matter, the formation of humus and the nutrient cycling of many elements (N, S, C). Moreover, edaphic fauna affect the porosity and aeration of, as well as the infiltration and distribution of organic matter within soil horizons. The ecosystem services provided by soil fauna are one of the most powerful arguments for the conservation of edaphic biodiversity. Decomposition of organic matter by soil organisms is crucial for the functioning of an ecosystem because of its substantial role in providing ecosystem services for plant growth and primary productivity (Maharning et al., 2008).
Due to the absence of light, which makes photosynthesis unfeasible, among the organisms populating the soil it was found very few real phytophages, unless the extend the definition of soil animals to surface organisms, or if it was considered as the pests also include fungivorous microarthropods (Wallwork, 1970).
The activity of animals, among them typically protozoa, nematodes, rotifers, certain springtails and mites, which feed on microflora, consisting of bacteria, actinomycetes and fungi (both hyphae and spores) is of crucial importance both for regulating the density and for diffusing these micro-

organisms. For example, through their faeces, springtails, which feed on fungi, can spread fungal spores that are still viable to areas as far as a few metres away from their point of origin.
The detritus food chain takes on an essential role within the soil, as it becomes the basis of the hypogean food web; in fact, many organisms such as isopods, certain myriapods, earthworms, and springtails, many species of mites, and the larvae and adults of many insects feed on the vegetable and animal detritus that is deposited on the soil. For example in the soil of a temperate forest, in which the contribution of litter each year can amount to 400 g/m^2, about 250 g/m^2 are ingested by earthworms and enchytraeids, 30-40 g/m^2 by mites and 50-60 g/m^2 by springtails.
Soil fauna performs a mainly mechanical action, whereas chemical degradation is essentially performed by fungi and bacteria, both free and intestinal symbionts of other organisms; furthermore during digestion, organic substances are enriched by enzymes that are dispersed in the soil along with the faeces, contributing to humification. Earthworms are among the most important organisms in many of the soils of the world (Figure 3).

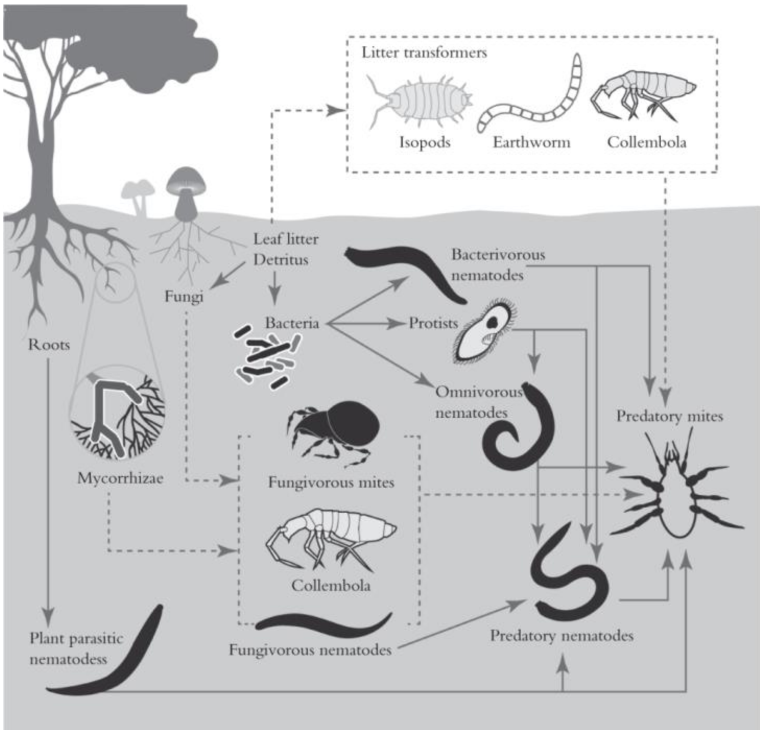

Figure 3. Functional Roles of Soil Fauna

DECOMPOSING PROCESSES AND MINERAL CIRCULATION

Decomposition is one of the most critical roles that soil biota play in an ecosystem. Without efficient decomposition, organic material would accumulate on the soil surface and nutrients would be bound within the material. Decomposition is initiated immediately when a leaf, twig, or fruit hits the ground. Once on the ground surface, biotas begin to physically break down the material, creating more surface area to which microflora can adhere.
Microbial decomposition is favored by an adequate supply of N and P, neutral to alkaline conditions, good aeration, and adequate moisture. Physical breakdown of materials by insects, earthworms, and other animals favors decomposition by exposing more surface area to microbial attack. Good soil quality and structure is extremely important for plant growth, water penetration, gas exchange, and resistance to erosion. Organic matter is also produced within the soil by plant roots. In 1 ha of a 50 year old pine forest, the soil to a depth of 200 cm may contain about 4 tones of living roots less than 0.3 mm in diameter, about 50% of which are replaced each year.

Decomposing processes and mineral circulation are of outstanding agricultural importance, because they influence the nutrient supply capacity of the soil, and can cover a significant part of the nutrient needs of plants. The release of soil organic matter, plant residues, and organic soil conditioners, as well as the breakdown of their nutrients, are processes almost entirely dependent on the activity of microorganisms. From this point of view, N is particularly unique, since the soil reserves of this macro-nutrient occur almost exclusively in organic form. The biological activity of soils is determined by several microbiological soil characteristics together, and can be inferred based on numerous microbiological soil tests. Actual soil biological activity is measured in open field conditions, while potential activity is usually measured in a laboratory, where environmental conditions (temperature, moisture content, aeration, etc.) are controlled. Human intervention, such as different farming methods, different agrotechnical factors, such as monoculture cultivation or even crop rotation, soil cultivation, fertilization, has a great impact on the number, composition, and life activity of the microorganisms living in the soil, and thus on the activity and fertility of the soil, and more safety than the use of chemicals for soil improvement. It is not only the quantification of microbiomes that are important, but also how the microbial composition of the soil, the diversity of species, i.e. biodiversity, changes as a result of cultivation. As a result of one-sided tillage and the excessive use of chemicals, diversity decreases, and thanks to this, the processes taking place in the soil also decrease. All of this leads to the deterioration of the soil structure and a greater leaching of nutrients, possibly erosion.

The most frequently occurring bacteria belonged to the following genera: *Bacillus, Brevundimonas, Cellulomonas, Enterobacter, Micrococcus, Pseudomonas* and *Streptomyces.* The most common isolates were representatives of the genera *Alternaria, Aspergillus, Geotrichum, Penicillium, Rhizopus and Trichoderma and Saccharomyces*.

Many soil microbiotas produce enzymes (phosphatases) that decompose various organic P compounds (nucleoproteins and leciteins) in the soil. In this decomposition organic P is converted into phosphoric acid which combines with the soil bases to produce salts of calcium (Ca^{2+}), magnesium (Mg^{2+}) and iron (Fe^{2+}).

SOIL AND RHIZOSPHERIC MICROFLORA

Globally, an increasing population needs a high yield of crops to compete for this competition, but it must be achieved without, or by minimizing, the application of synthetic products due to high concern about environmental protection. Still, the main source of crop improvement in the agriculture sector is the practice of applying synthetic products, such as commercial fertilizers, nutrient supplements, and pesticides. This action has hazardous effects on the environment and human and livestock health. The farmer communities are convinced to change their old practices by using alternative products that could be environmentally friendly. The biofertilizers and pesticides consist of non-pathogenic microbiomes; this uniqueness in nature facilitates attaining sustainable agriculture and environmental protection from chemical hazards. Additionally, bioformulations might be the best alternative option to reduce environmental degradation and the threat to human health.

Soil and rhizospheric microbiomes especially plant growth-promoting rhizomicrobes (PGPR) have especial roles for promoting the soil quality. In the PGPR tests, the pathogenic opposition of the roots, the production of phytohormones, cyan, siderophores, their ability to dissolve phosphate, and their sensitivity to antibiotics were assessed. The ability to suppress disease was generally greater when more time passed between soil treatments and planting. Increasing the microbiological activity of the soil and the targeted use of microorganisms that compete with pathogenic organisms in the soil are tools that can be used to induce the occurrence of plant diseases less frequently by introducing organic substances into the soil. The specificity of the host plant is clarified during the purchase. If possible, apply the inoculants in spring and autumn, when it is not too hot and dry. Heat and dryness damage microbes. In order to optimize soil life, it is recommended to use broad-spectrum inoculants, because then we can expect good crop results with greater certainty. There is only one known vaccine (EM1 activated) that has been consciously designed in such a way that the microorganisms contained in it multiply and live side by side.

Nitrogen and phosphorus are critical for the vegetation ecosystem and two of the most insufficient nutrients in the soil. In agriculture practice, many chemical fertilizers are being applied to soil to improve soil nutrients and yield. This farming procedure poses considerable environmental risks which affect agricultural sustainability. As robust soil microbiomes, PGPR have emerged as an environmentally friendly way of maintaining and improving the soil's available nitrogen and phosphorus. As a special PGPR, rhizospheric diazotrophs can fix N in the rhizosphere and promote plant growth. However, the mechanisms and influences of rhizospheric N_2-fixation (NF) are not well researched as symbiotic NF lacks summarizing. Phosphate-solubilizing bacteria (PSB) are important members of PGPR. They can dissolve both insoluble mineral and organic phosphate in soil and enhance the P uptake of plants. The application of PSB can significantly increase plant biomass and yield. Co-inoculating PSB with other PGPR shows better performance in plant growth promotion, and the mechanisms are more complicated.

SOIL ENZYMATIC ACTIVITIES

In addition to the physico-chemical parameters, plant cover and microbial activity, the nutrient circulation of the soil are also determined by the activity of the free, even more, the accumulated enzyme fractions. It retains the activity of the accumulated enzyme fraction even if the microbial activity of the soil has ceased or the plant remains have decomposed. Within the accumulated fraction, the immobilized enzymes are chemically bound and protected against denaturation, which is carried out in a model experiment. The maintenance of soil fertility depends on the activity of the microbial biomass present in it. This biomass is a relatively small fraction (1–3%) of the soil's organic matter stock, which, in turn, plays a fundamentally important role in the biological cycle of all the main nutrients required by plants. The activity of hydrolytic enzymes in the soil serves as an indicator of changes in soil fertility, as it is related to C-, N- and P mineralization. Dehydrogenase activity is also closely related to soil microbial activity. Protease activity plays a significant role in the breakdown of N-containing organic materials, during which NH_4 is formed. Urease, on the other hand, can directly break down N-containing urea and produce NH_4. Several enzymes are involved in the breakdown of complex organic-P and -C-containing materials in the soil: acid and alkaline phosphatases stimulate the hydrolysis of organic P-containing parts into phosphates, and β-glucosidase stimulates the hydrolysis of glucose-containing parts. Soil enzymatic activities are involved in soil nutrient recycling dynamics and can catalyze the conversion of nutrient from unavailable to forms readily assimilable by plants and microorganisms. Soil enzymatic activities are believed to be able to discriminate between soil management treatments probably because they are related to microbial biomass, which is sensitive to such treatments. The enzymatic activity was stimulated by increasing organic matter content (Pathak and Rao, 1998). Enzymatic activity is generally higher in rhizosphere than in bulk soil, as a result of a greater microbial activity sustained by exudates, actively or passively released by roots, or due to the release of enzymes from plant roots (Pinton et al., 2001). Among soil enzymatic activities, hydrolase activities of rhizosphere are supposed to play an important role in plant nutrition. For example, the hydrolysis of organic phosphate monoesters by phosphomonoesterases can account for 30-80% of P taken up by plants in agricultural soils (Gilbert at al., 1999). Enzymes are potential indicators of the extent to which soil disturbance by a given activity may affect the immediate environment (Pascual et al., 2000).

Dehydrogenase activity has correlated well with other measures of microbial activity in some studies but has been poorly correlated in others. Enzymes are potential indicators of the extent to which soil disturbance by a given activity may affect the immediate environment (Pascual et al., 2000). Hydrolase activities in the soil can be quantitatively important for plant nutrition; Measurement of soil hydrolases provides an early indication of changes in soil fertility, since they are related to the mineralization of such important nutrients elements as N, P, C (Ceccanti and Garcia, 1994). Protease activity is involved in the hydrolysis of N compounds to NH_4, using low-molecular-weight protein substrates and urease is responsible for breaking down urea into ammonium. Phosphotases catalyse the hydrolysis of organic phosphorus compounds to phosphates and ß-glucosidase catalyses the hydrolysis of the ends unreduced chains of b-D-glucoside to form ß-D-glucose, and indicates the potential for soil organic matter decomposition

SOIL MICROBIAL ACTIVITIES

In general, the microbial biomass of the soil is recorded as a decomposing agent of the organic substances that have entered the soil, apart from this, the importance of its mass in terms of nutrient recycling and degradation processes is little recognized. Soil biomass is the regulator of virtually all nutrient circulation and organic matter storage cycles, as well as the formation of micro-aggregates, which is an essential process in terms of water movement in the soil and soil aeration. Studies investigating the relationship between tillage methods and procedures and soil microbial biomass mostly report on changes in population density and, as a result, soil fertility, while less attention has been paid to the use of biomass as an indicator of soil pollution. The abiotic stress effects caused by heavy metals and various inorganic and organic substances can cause the functional disturbance of soil microorganisms, the denaturation of their proteins, and the disintegration of cell membranes, thus having a harmful effect on the reproduction, morphology and metabolism of microbes. As a result, the contamination of soils with heavy metals can significantly reduce the size and activity of the microbial biomass occurring there. When the mentioned microbial preparations are used, living organisms enter the soil which, through their life processes, promote N, P, K, various micro- (e.g. Zn, Cu, Fe, Mn, Mo, etc.) and macro- (e.g. (S, Ca, Mg, etc.) elements, they bind N and help break down plant residues. All natural biologically active soil conditioners and soil improvers increase the resistance of plants to various pathogens and abiotic stress factors (drought, frost). Only plants with sufficient immunity can deal with the various harmful effects of the environment naturally.

Soil microorganisms are important components in the natural soil sub-ecosystem because not only can they contribute to nutrient availability in the soil, but also bind soil particles into stable aggregates, which improve soil structure and reduce erosion potential (Shetty et al., 1994). Studies of soil microbiota enabled soil biologist to set up a new understanding of soil as a combination of various ecological microenvironments. This concept explains the unique character of soil as a specific biotope, possessing the highest life density and diversity of all environments of the earth. The free – living components of the soil biota are the bacteria, fungi, algae and the fauna. Within each of the free living components, there exist a broad range of morphological and physiological characteristics that has led tom the naming of a large number of taxa for each group (Paul and Clark, 1988).

Microbial activity in soil is controlled by several environmental factors, such as availability of C, mineral nutrients and growth factors, availability water, favourable temperature and pH, composition of soil microflora and ecological interactions between microorganisms (Nannipieri et al., 2003). Microorganisms play an important role in soil fertility because they oxidise organic matter and promote the biogeochemical cycles of C, N, P, and S. Soil enzymatic activities are involved in soil nutrient recycling, dynamics and can catalyze the conversion of nutrient from unavailable to forms readily assimilable by plants and microorganisms. Soil enzymatic activities are believed to be able to discriminate between soil management treatments (Dick, 1993) probably because they are related to microbial biomass, which is sensitive to such treatments.

Indeed, rhizosphere microorganisms can both mobilise and immobilise plant nutrients (C, N and S) and can produce growth promoting substances, such as phytohormones, as well as phytotoxins. Beneficial bacteria such *Pseudomonas, Bacillus, Arthrobacter, etc.* are major component of the microbial flora which live in close association with various types of plants. Their association with plant materials has been related both to their antagonistic activities towards pathogens and to their ability to colonise and produce plant growth promoting compounds within the rhizosphere (Cook et al., 1995). In order to understand microbial behaviour in a certain habitat, it is necessary to know their physiological characterisation. It is important to measure the soil biochemical and biological parameters related to microbial activity in order to evaluate soil quality and productivity (Garcia et al., 1997). Because microorganisms play an important role in establishing biogeochemical cycles and facilitate the development of plant cover and has been assessed frequently through biological and biochemical parameters such as biomass C and enzymatic activities (Caravaca et al., 2005).

In the great majority of natural communities, the primary producers depend heavily on microbiomes. These include the organisms that decompose and mineralize organic detritus, others that promote plant growth and suppress plant pathogens and some that build soil structure. They help the roots take up nutrients, brings nutrient elements into the ecosystems from atmosphere or mineral reserves, break down detritus, release mineral elements in soluble forms and protect the roots from pathogens. They also hold soil aggregates together, creating channels through which roots grow, soil animals move and water percolates. Bacteria occupy a wide variety of habitats and perform many ecological functions. They produce a vast array of chemical metabolites, many of which affect other organisms. Some fix carbon dioxide (CO_2) into organic compounds and are part of the primary level of the food chain. Many are extremely important in cycling nutrients in the soil and in water, making the nutrients more or less available to plants and other organisms.

Air, water, and soil quality can be altered by the activities of bacteria. Soil microbiomes play important roles in maintaining soil quality and plant production, and they have a great influence on soil hydrolysis reactions and these in turn reflected in the natural recycles of C, N, P and other elements. 80-90% of the bioprocesses in soil are reactions mediated by microbiomes.

The study of diversity, distribution, and behaviour of microbiotas in soil habitats is essential for a broad understanding of soil health. The physiological response of bacterial populations following introduction into the natural soil environment is poorly understood. Yet information on the physiology of bacteria in soil in relation to their resistance to soil factors is required to obtain a better in their survival strategies so that effectiveness of bacterial releases can be predicted (Overbeek et al., 2006). Bacteria exhibit many ways of exploiting their environments. Species differ greatly in their biochemical capabilities and utilize many different substrates. Some form mutualistic associations with other bacterial species or other organisms. Most bacteria are exposed to gradients either of substances such as nutrients or of physical factors such as temperature and radiation, and they often have adaptations which allow them to find or remain in the location in these gradients which best meets their needs. Bacterial cells introduced into soil should be able to rapidly adapt to soil conditions in order to persist and reproduce. Survival strategies depend on the physiological adaptation in the introduced cells, such as adaptation to nutrient-limited conditions and/or other physical chemical conditions, efficient utilization of root-released compounds or specific interactions with plants. Therefore bacteria which are well adapted to the soil environment, i.e. that survive and persist, probably have an efficient response to stressful soil conditions, activating molecular mechanisms necessary for their adaptation and survival (Overbeek and elsas, 1997). Soil contains a high number and diversity of microbiomes withy a wide range of metabolic activities and physiological properties. The distribution of bacteria is governed by limiting factors, and each species will exist where levels of factors such as temperature, moisture, nutrient availability, and pH fall within its specific range of tolerance. Because soil is a complex system, the determination of where a soil microorganisms would be found based on limiting factors must take into account interactions between environmental factors, alterations of the organism's range of tolerance by other factors, and variations of environmental factors in both time and space. The range of environmental conditions over which micro organisms can maintain growth and activity increases their importance. Extreme conditions may reduce the activity of some microbiomes but will stimulate that of others, and in many extreme environments microbes are the only contributors to nutrient recycling. Two conditions stressful to bacteria in soil are nutrient (mainly C) starvation and low water activity. The availability of organic nutrients in soil largely depends on the soil sites occupied by the bacterial cells or microcolonies.

Oligotrophy is probably locally dispersed through most soils. Therefore, soil in general can be regarded as a grossly oligotrophic environment (Morita and Moyer 1989). Both starvation and low water activity represent typical stress conditions general in most soil. Other stress conditions like extreme temperatures and pH values or toxic compounds may be more specifically related to the climate geographic location or soil type and site (Overbeeek and Elsas, 1997). The majority of known bacterial species re chemoorganotrophic and are commponly referred to as heterotrophs. Both energy source and C sources are useful for describing basic physiological differences among bacteria as well as among biotic organisms generally. Some functional groups of microbiomes are as following:(1) heterotrophs, (2) N_2-fixers, (3) nitrifyers, (4) denitrifyers, (6) phosphorus, calcium, and potassium solubilizers. These biochemical changes that take place in the soil prove that microorganisms perform numerous essential functions that contribute to the productivity of soil.

Heterotrophs

Heterotrophic bacteria have been assumed to be the dominant types among soil bacteria, since the consumption and mineralization of organic materials represent most of the energy flux though the soil biota. For this reason, all attemptsto culture the majority of soil bacteria has concentrated on the heterotrophic bacteria (Bakken, 1988). For heterotrophic bacteria, it is the distribution of their organic substrates which primarily determines the occurrence of pockets of activity, sometimes referred to as microhabitats. The majority of the organic substrates entering soil are either insoluble or are soluble but packaged in cells. Nevertheless, some soluble materials will diffuse into the soil water and be leached out of the surface horizons (Nedwell and Grey, 1987).

The other components of the microbial C cycle are the conversion of organic compounds into other organic compounds, and the breakdown of organic compounds with the accompanying release of energy and CO_2. Those bacteria that fix CO_2 will also break down organic matter in respiration (Atlas and Bartha 1987). Many bacteria are able to grow heterotrophically, obtaining all their energy and cellular C from pre-existing organic material. They are extremely important in the formation of humus in soil, the cycling of other minerals tied up in organic matter, and the prevention of buildup of dead organic materials.

Heterotrophic bacteria are found in many diverse groups, can be aerobic or anaerobic, and are capable of utilizing a broad array of organic compounds. Microbiomes are unique in their ability to carry out anaerobic or fermentative degradation of organic matter, although C turnover is greater under aerobic conditions. They are responsible for the digestion of polymers such as cellulose and lignin, which multicellular organisms are unable to utilize. Some are able to break down man-made synthetic materials (Atlas and Bartha 1987).

Heterotrophic bacteria play an important role in maintaining soil structure by their involvement in the formation and stabilization of water-stable soil aggregates. Polysaccharides are one of the major agents of soil aggregation, and it is thought that the soil polysaccharides are likely to be of microbial origin and are more resistant to breakdown than animal and plant polysaccharides. Bacteria also release other organic compounds which affect aggregate structure and other soil properties such as water holding capacity. Bacterial cells themselves can hold soil particles together by adhesion or mechanical binding, and even after the bacteria die, their remains continue to bind the particles (Tisdall and Oades 1982). Many heterotrophic bacteria are specialized to the environmental conditions under which they are found. Plant species had strong influence on soil microbial organisms and their activity. According to Merckx et al. (1987), obviously the input of nutrient by the roots into surrounding soil as well as the mineral nutrients levels in the soil are of considerable importance. It was mentioned that root exudates play a key role in the selective stimulation of microbiomes and the plants have an important effect on soil microbiology, due releasing different nutrients and organic compounds into the soil (Grayston et al., 1998).

Oligotrophic bacteria

By general definition, an oligotrophic bacteria predominate in a nutrient poor environment, is isolated using a low nutrient medium and shows relatively high growth rates in cultures at low concentrations of energy yielding substrates (Hirsch et al., 1979). One of the earliest attempts to relate the growth and substrate utilization of soil microbiomes was made by Winogradskiy (1924). The author distinguished between the "zymogenous" microorganisms, which existed mainly in a resting phase with brief periods of activity in the presence of available substrates, and the "autochtonous" microbiomes, which were more or less continually and slowly active. Despite the current paucity for the occurrence of strictly oligotrophic bacteria in soil, it is often regarded as a nutrient poor environment. Oligotrophic bacteria (oligotrophs) are microbiomes that grow in extremely nutritionally deficient conditions in which the concentrations of organic substances are low.

Nitrogen fixers

Nitrogen (N) is an extremely important element to all forms of life. It is found in amino acids and many other organic compounds. It exists in stable valence states from -3 to +5. Large amounts of N

are in N_2 gas in the atmosphere, but utilizable combined forms are limiting in many ecosystems. Ammonium (NH_4^+) and nitrate (NO_3^-), inorganic salts of N, are water-soluble, and are the main forms used by living organisms.
Nitrogen-Fixation (N_2 – NH_3) is carried out only by prokaryotes which may be symbiotic or free living. N_2-fixation requires a considerable amount of energy and it has been calculated that in bulk soil there is not enough available C. However round the roots there may be sufficient exudates to allow some N_2-fixation, the production of which could be available to the plant. Most of oligonitrophilic bacteria have ability to fix N_2. In N poor soils they are widely distributed to compare to other soil.
Biological N_2-fixation is a sensitive indicator of soil contamination with heavy metals. The N_2-fixation of freely pre-heterotrophic microbes, the reproduction and N_2-fixation of cyanobacteria (formerly blue-green algae), and the efficiency of the symbiont nitrogen-fixing *Rhizobium* can decrease in the case of high heavy metal content in soils. The contribution of the activity of free-living soil microorganisms to the available N stock of the soil is relatively small and its agricultural importance is probably small.
For example, free-living heterotrophic bacteria can fix less than 5 kg/ha/year of N, while N_2-fixation by cyanobacteria can reach 10–50 kg N/ha/year. However, symbiont N_2-fixation provides a significant amount of nitrogen to the soil and is of outstanding importance for agricultural production. For example, the amount of N bound by white clover can reach 100-200 kg N/ha/year.

Nitrifying bacteria

In nitrification process, the NH_3 or NH_4^+ is oxidized to NO_2^- and then to NO_3^-. Nitrate is readily taken up by plants and because of its negative charge, moves freely through soil. Both NO_3^- and NO_2^- are also more susceptible to leaching than is NH_4^+. They can become a health hazard when they reach groundwater. Nitrification can also prevent N losses in soils where NH_3 volatilization is a major factor. Nitrification is limited to species of a few genera of aerobic autotrophic bacteria.
Nitrifies are found in most aerobic environments where organic matter is mineralized, and on rocks where NH_4^+ is liberated through weathering. Many are restricted to specific environments. The oxidation of NH_3^- and NH_4^+ to NO_2^- is carried out in most soils by species of *Nitrosomonas*, while the oxidation of NO_2^- to NO_3^- is carried out by *Nitrobacter* (Bock et al., 1990). Species of *Nitrosospira*, *Nitrosococcus*, and *Nitrosolobus* can also be involved in the former oxidation, while species of *Nitrospira*. and *Nitrococcus* can be involved in the latter. The two processes are usually closely coupled. Both oxidations are energy yielding, and the bacteria involved are chemolithotrophic, utilizing the energy to fix CO_2. Because the energy yields of the oxidations are small, large amounts of N are turned over for relatively small cell yields. Nitrification is inhibited by anaerobic conditions or high acidity.

PLANT RHIZOSPHERE

Rhizosphere is a wealthy location of microbes, ecological niche and should be explored for potential plant growth promoting rhizomicrobiomes (PGPR), which developing as bio inoculants for interact with plant roots and enhancement of yield of crop plants. There are several PGPR inoculants that seems to promote plant growth through different mechanism such as plant growth hormone production, nutrient acquisition and plant disease suppression. PGPR are inhabiting rhizosphere are capable of producing plant growth regulators such as auxin, gibberellins and ethylene. Indole acetic acid is a naturally occurring auxin which involves in cellular development and physiological processes in plants. Different soil microorganisms including bacteria (Stein et al., 1990), fungi (Finnie and Van Staden, 1985) and algae (Rifat Hayat et al., 2010) are capable of producing physiologically active quantities of auxins, which may exert prominent effects on plant growth and development. The application of single and combined application of microbes could increase plant growth of cotton due to result of slightly deleterious effect of strain causing increased root leakage/damage, which allows a greater population of aggressive rhizosphere and root colonizers such as Trichoderma viride and Pseudomonas fluorescence (Shanmugaiah et al., 2009)

Hiltner in 1904 recognised the potential importance of microbial activities associated with root systems in plant nutrition and coined the term “rhizosphere”to describe the zone of intense microbial activity around roots of the leguminousae. This term is now used in a more general sense to describe soil influenced physically and or chemically by any root system (Chanway, 2002). The rhizosphere is first of all an unique hot spot in the soil at the viewpoint of microbial ecology as soil microbiomes are considerably stimulated in the vicinity of the roots, as a consequence of the release by roots of a range of C compounds (Hinsinger and Marschner, 2006, Hinsenger et al., 2009). The region of soil surrounding and including the plant root (the rhizosphere) is of crucial importance for plant health and nutrition. It has a high level of microbial activity, particularly because of nutrients secreted by plant roots in the form of soluble exudates as amino acids, organic acids and other photosynthates. The rhizosphere is relatively nutrient rich because 40 % of the photosynthates moving into roots are lost to the soil in the form of soluble exudates, mucilage, and shed. It is a habitat for a vast interactive community of rhizotrophic microorganisms whose activities largely determine the physico-chemical properties of the rhizosphere soil. Exudates from roots have long been recognised as a major potential source of energy for many saprophytic bacteria in soil, being the prime cause of the rhizosphere effect. There is considerable amount of evidence suggesting that loss of soluble organic substances from roots is significantly stimulated by the presence of microbes around them.

Understanding the complexity of this environment and how the microbial community adapts and responds to alterations in the physical, chemical and biological properties of the rhizosphere remains a significant challenge for plant and microbial biologists (Rainey, 1999). The interactions between microbiomes and roots are now considered to occur in the outer, invaded cortical layer, on the rhizoplane when this can be distinguished and also in the surrounding soil, the rhizosphere. Because all soil borne nutrients obtained by the plant rot must pass through the rhizosphere, the potential for microbes to alter these compounds in a way that will affect plant growth is great (Chanway, 2002).

The term “endorhizosphere” may now appropriately be used to describe the multilayered microenvironment, which includes a mucoid layer of plant or microbe derived polysaccharide, the epidermal layer including the root hairs, and the cortical layer. The rhizoplane (root) surface should be defined as the epidermal layer, including its associated polysaccharide matrix.

By comparison ectorhizosphere comprises the rhizosphere soil, which usually extends a few millimetres from the root surface (Sorensen, 1997). The important role of the root cap is its production of mucilage (polysaccharide), which covers epidermal cells and acts as a lubricant while the root advances through soil. It is interesting that the mucilage layer on the young root may contain the chemical components of importance in host-pathogen or host symbiont recognition system. In the young plant root, the uptake of nutrients and water occurs through an intact epidermal layer including the root hairs. Normally, this layer is quite short-lived as a result of the mechanical tension or desiccation of the rhizosphere (Christensen 1995). Living epidermal cells and root hairs become densely colonised by micro organisms, notably bacteria, which depend completely on simple organic molecules exuded from the plant cells (Sorensen, 1997). The exudates are typically carbohydrate monomers (sugars), amino acids, and organic acids, which are suitable substrates for a wide range of rhizobacteria. Roots form an unstable habitat for micro-organisms for the interfaces between the root, soil and microbes are continually changing. Healthy, vigorous root tip elongate so rapidly that bacteria and fungi cannot grow fast enough to colonize them from pre-existing root parts and they are colonized from the soil. The rhizosphere soil contains more soluble sugars but less insoluble material than the surrounding soil and there is less nitrogen but more polyphenols (Campbell, 1985).

RHIZOSPHERE MICROBIOMES

Soil Microbiomes are important for agriculture in rder to promote the recycling the plant nutrients and reduce the need for chemical fertilisers. Plant growth promoting rhizomicrobiomes (PGPR) are able to exert a beneficial effect upon plant growth. Biological N_2- fixation (BNF) provides a major source of N for plants as a part of environmentally friendly agricultural practices. Apart from fixing N_2, PGPR can affect plant growth directly by the synthesis of phytohormones and vitamins, inhibiting plant ethylene synthesis, enhancing stress resistance, improving nutrient uptake, solubilising inorganic phosphate, and mineralising organic phosphate.

In early work on the rhizosphere research the ratio of organism count in rhizosphere soil to count in root-free soil were determined for different plant species and for single species in different soils, under differing climatic regimes and at different stages of phenology. Total microbial counts were commonly found to be increased 10 to 50 fold in the rhizosphere. The rhizosphere harbours a large and diverse community of prokaryotic and eukaryotic microbiomes that interact and compete with each other and with the plant root. The concentration of bacteria that is found around the roots of plants is generally much greater than the bacterial density, or concentration, that is found in the rest of the soil (Lynch 1990). Many bacteria are intimately associated with plants roots. In a zone surrounding the root known as the rhizosphere, the populations of microorganisms differ from those in the surrounding soil both in total number and in species distribution (Atlas and Bartha 1987). The plant alters rhizosphere populations through root exudation and the sloughing of root cells. Most plants interact with specific fungi to form associations known as mycorrhizae, and these have considerable effects on populations of rhizosphere bacteria (Meyer and Linderman 1984).

The rhizosphere is known to harbour proportionately more Gve- bacteria *Pseudomonas*, *Achromobacter* and denitrifiers and fewer Gve+ and Gram variable forms (*Bacillus*, *Arthrobacter*). Increases in the rhizosphere microbiomes are accompanied by heightened faunal activity, especially in those groups that are grazers on the microflora or on roots (Paul and Clark, 1988).

The rhizosphere harbours a large and diverse community of prokaryotic and eukaryotic microbes that interact and compete with each other and with the plant root. Activity of any one member of this community affects the growth and the physiology of the others, and also affects the physical and chemical properties of the soil.

A continuous interaction exists between the plant roots and the rhizotrophic microbiomes and within the various groups of these microbiotas which have an important influences on plant growth. The microbial composition in the rhizosphere often differs greatly from that of the surrounding soil and from one plant species to another, as a result of diverse plant microbe interactions. There are different groups of microbiomes playing in the rhizosphere. Some of them may be deleterious (causing diseases, -) and others may be supporting the plant growth (stimulating the growth, +) and some others may not affect the plant developments (neutral, 0) at all. They are mainly bacteria, fungi, and actinobacteria.

The microbial composition in the rhizosphere often varies greatly from that of the surrounding soil and from one plant species to another, as a result of diverse plant microbe interactions. Some bacteria, such as *Pseudomonas* and *Flavobacterium* spp. tend to be more predominant in the rhizosphere than others, such as *Arthrobacter* and *Bacillus* spp. (Alexander, 1977).

Because of the wide range of microbiomes that is stimulated in the rhizosphere, it is difficult to assess the influence of rhizosphere microbial activity on plant growth. The interaction between bacteria and the roots of plants may be beneficial, harmful, or neutral for the plant. Rhizosphere microbes can both mobilise and immobilise plant nutrients, and can produce growth promoting substances, such as gibberellins, as well as phytotoxins. Rhizosphere microbes, such as species of the fungi *Fusarium*, *Gaeumannomyces* and *Rhizoctonia* can be plant pathogens, as well as antagonist against those pathogens.

The challenges for the next decades include understanding of the behaviour of microbiomes in their natural and often complex habitats, such as the rhizosphere (Lugtenberg et al., 2002). The overall in the rhizosphere, that is on the plant root or its close vicinity, bacteria are abundantly present, most often organized in microcolonies. Some of these rhizobacteria not only benefit from the nutrients secreted by the plant root but also beneficially influence the plant in a direct or indirect way, resulting in a stimulation of its growth (Bloemberg and Lugtenberg 2001).

Rhizosphere bacteria depend on plant root exudates- which are low molecular weight, easily oxidizable compounds – for much of their nutrition (Rovira, 1965). Microbial processes in the rhizosphere of different crop plants are crucial to agriculture. Many rhizosphere colonizing bacteria, including *Bacillus, Azospirillum, Pseudomonas*, etc., typically produce substances that stimulate plant growth or inhibit root pathogens (Glick, 1995). Previous studies of bacteria in salt-affected soils lies behind those on halophiles in extremely saline soils and some bacterial groups related to the nitrogen cycle. Culturability of micro organisms on laboratory media has been the basis for the majority of studies on microbial populations in the rhizosphere. Even cell viability has often determined from estimates of colony forming units (CFU) as percentage of total counts. This figure is variable, but estimate of 10% viability of bacterial population in rhizosphere soil are common (Rovira et al., 1965).

PLANT GROWTH PROMOTING RHIZMICROBIOMES

Plant growth promoting rhizomicrobiomes (PGPR) are the living microbiomes which colonise the rhizosphere or the interior of the plant or promotes growth by increasing the supply or availability of primary nutrients to the host plant when applied to the seed, plant surface, or soil. Bacteria having growth promoting property in plants through the control of deleterious organisms have been categorized as biopesticides and are different from biofertlizers. However, some PGPR promote growth of plants by acting both as biofertilizer and biopesticides. PGPR can be Rhizospheric or Endophytic in nature depending upon their relationship with their hosts. The solubilization of ‘P’ in the rhizosphere is the most common mode of action that increases nutrient availability to host plants. Insoluble inorganic ‘P’ associated with the solid phase can be adsorbed to the surface of soil constituents which occur as Ca, Fe or Al minerals. Mineral ‘P’ is further released and made available to plant mostly by the action of phosphate solubilizing microorganisms. The addition of rock phosphate significantly increased N, P and total plant biomass by arbuscular mycorrhizal infection. P-solubilization ability of the microorganisms is considered to be one of the most important traits associated with plant phosphate nutrition.

Phosphate solubilizing microorganisms (PSM) includes bacteria including symbiotic N_2-fixers like *Rhizobium* as well as fungi. Among bacteria most efficient phosphate solubilizers belong to genera *Bacillus* and *Pseudomonas*. Cultures isolated from rhizospheric and non-rhizospheric soils solubilize phosphate with a fall in pH due to the production of organic acids but no correlation could be established between acidic pH and quantity of P_2O_5 liberated. Rise in pH observed later, may be due to organic acid produced by the organisms.

Many soil bacteria e.g., *Pseudomonas*, *Rhizobium*, *Enterobactor*, *Bacillus Clostridium*, etc possess the ability to solubilize insoluble inorganic phosphates and make them available to the plants. Production of organic acids i.e. lactic, gluconic, fumeric, succinic & acetic acid by these microorganisms results in the solubilizing effect. Also, these microrganisms are also known to produce amino acids, vitamins and growth promoting substances like Indole Acetic Acid (IAA) and Gibberellic Acid (GA), which results in better growth of plants.

There are evidences that show that many PGPR increase the availability of nutrients for the plants in the rhizosphere. The mode of action of the PGPR involves solubilization of available forms of nutrients and/or siderophore production which helps in facilitating the transport of certain nutrients.

Heavy metal toxicity to plants can be reduced by the use of PGPR, e.g., free living soil bacteria, these exert beneficial effects on plant development when they are applied to seed or incorporated in the soil. There has been a tremendous work on P-solubilizing, metal resistant, siderophore producing and PGPR and their mutants.

Phosphate Solubilizing Bacteria

Phosphorus (P) is one of the major nutrients to plants and microorganisms second to N in requirement. It is involved in several physiological processes; approximately 95–99% of phosphorus is present in the soil as insoluble phosphates (PO_4^{3-}) and cannot be utilized by the plants. Organic phosphorus constitutes a large proportion of the total phosphorus in several soils

Mineralization of most organic P compound is carried out by means of phosphatase enzymes. The major source of phosphatase activity in soil is considered to be of the microbial origin. To increase the availability of P for plants, it was found that large numbers of soil microbes including bacteria which are known as ‘Phosphate Solubilizing Bacteria (PSB).’ These kind of bacteria are used for the conversion of soil organic P in to the soluble inorganic forms.

The solubility of P is mobilized by phosphoric acids. This is done by different microorganisms such as *Pseudomonas*, *Mycobacterium*, *Micrococcus* etc. These microorganisms produce acids like sulphuric acid and nitric acid which ultimately help in mobilizing P. The process of conversion of insoluble phosphates into soluble once is known as ‘solubilization’.

Some PSB can accumulate heavy metals and are thus beneficial in eradicating heavy metal Phytotoxicity and promoting growth in plants. Out of added P fertilizer only 10-20% is available for the plants. The rest remains in the soil as insoluble PO_4^{3-} in the form of rock phosphate and tri-calcium phosphate. The PSB significantly convert this insoluble inorganic phosphate and makes it available to the plants. PSB are a group of beneficial bacteria capable of hydrolysing organic and inorganic P from insoluble compounds.
Generally the mechanism of mineral phosphate solubilization by PSB strains is associated with the release of low molecular weight organic acids through which their hydroxyl and carboxyl groups chelate the cations bound to phosphate, thereby converting it into soluble forms. In addition, some PSB produce phosphatase like phytase that hydrolyse organic forms of phosphate compounds efficiently. One or both types of PSB have been introduced to agricultural community as phosphate 'Biofertilizer'.

Role of PSMs in plant disease managemen
Disease causing plant microorganisms adversely affect the crop yields by significantly reducing plant performance and crop quality. The usual method for the control of such phytopathogens is to apply chemical pesticides, but this strategy has led to increased concerns over environmental contamination and has also resulted in the development of resistance against the individual chemical over the time. This needs a constant development of new pesticides77. In this context, rhizobacteria that can provide biocontrol of disease or insect pests (biopesticides) are considered an effective alternative to chemical pesticides (Zahir et al., 2004). A large number of mechanisms are involved in the biocontrol and can involve direct antagonism via production of antibiotics, siderophores, HCN, hydrolytic enzymes (chitinases, proteases, lipases, etc.), or indirect mechanisms in which the biocontrol organisms act as a probiotic by competing with the pathogen for a niche (infection and nutrient sites).
Biocontrol can also be mediated by activation of the acquired systemic resistance (SAR), induced systemic resistance (ISR) responses in plants, and by modification of hormonal levels in the plant tissues (van Loon, 2007; Martínez-Viveros, et al., 2010)
Amendment of soil with decomposable organic matter or plant growth promoting microorganisms is one of the cheapest, hazard-free and environmental-friendly effective methods of modifying soil environment. It was observed that continuous extensive agricultural practices that depend heavily on use of chemical fertilizers have resulted in loss of organic matter, an increase in acidity, and accumulation of toxic elements in cultivated soils creating an environment favorable for development of certain soil-born pathogens. The reduction in common scab of potato (S. scabies) by green manuring through prevention of the buildup of inoculums was the first report of organic amendments as a means of disease suppression. Since this observation of Sanford (1926), numerous reports have appeared regarding the beneficial effects of organic and inorganic amendments of soil

DIVERSITY OF RHIZOBACTERIA

Microbial diversity studies are important in order to understand the microbial ecology in soil and other ecosystems (Garland, and Mills, 1994). Diversity can be regarded as the amount and distribution of genetic information in a natural community. A representative estimate of microbial diversity is a prerequisite for understanding the functional activity of microbiomes in such ecosystems (Simon, et al., 1991). Studies in microbial diversity are important in order to understand the role of microbiomes in the ecology of soil and also in other ecosystems. Analysis of the genotypic and phenotypic characteristics of indigenous rhizobacteria can help to clarify the mechanism of interactions between them and plant roots (Tripathi, et al. 2002).
Alexandre (1977) has made a brave attempt to summarise a great number of classic taxonomical studies of bacteria prevalent in soil and presents the following ranges (%): *Arthrobacter* 5 – 60%, *Bacillus* 7-67%, *Pseudomonas* 3-15%, *Agrobacterium* up to 20%, *Alcaligenes* 2-12%. *Flavobacterium* 2-10%. The arid and semi arid ecosystems may provide an excellent natural research field and information on microbial physiology, diversity and their role in the ecology of soil as affected by gradients of environmental conditions combined with anthropogenic activities (Atlas et al., 1984).

Microbial diversity is a general term used to include genetic diversity, that is, the amount and distribution of genetic information, within microbial species; diversity of bacterial and fungal species in microbial communities; and ecological diversity, that is, variation in community structure, complexity of interactions, number of trophic levels, and number of guilds (Nannipieri et al., 2003). The microbial population in soil is very diverse. Torsvik et al., (1996) calculated the presence of about 6000 different bacterial genomes per gram of soil by taking the genome size of *Esherichia coli* as a unit. Microbial diversity is a general term used to inclue genetic diversity, that is, the amount and distribution of genetic information, within microbial species, diversity of bacterial and fungal species in microbial communities; and ecological diversity, that is, variation in community structure, complexity of interactions (Nannipieri, 2003).

Determining the presence and abundance of specific groups of bacteria can provide useful insight into ecosystem functions. Identification of which species representing a functional group is/are present could enable the choice of indicator species to be monitored during ecosystem disturbances. Species diversity can also be an indicator of soil quality because of its obvious relationship to functional diversity (Visser and Parkinson 1992).

SECONDARY METABOLITES

The research on natural products may offer substantial advantages, like discovery of new drugs with a new mode of action, high selectivity and activity. It is clear that from all microbiomes the procaryotes whose secondary metabolism shows the highest flexibility, are the most suitable. Many bacteria are synthesis secondary metabolites such as certain extracellular enzymes and other bioactive compounds. A diverse group of soil microbes are capable of producing physiologically active compunds that may have pronounced effects on plant growth and development. According scientific reports 86% of the bacterial isolates from the rhizosphere of various plants produced phytohormones, and also different vitamins. Rhizospheral bacteria produce growth promoting substances in culture media, in the rhizosphere and in the rhizoplane of forage grasses and many economically important cereals like wheat, barley and vegetables, tomato and bean plants under cultural conditions (Frankenberger and Arshad, 1990). The study of microbial populations and their biochemical activities associated with herbal plants growth in such unique environment may thus provide valuable information on microbial distribution, their biochemical activities and their role in plant establish and development.

CONCLUSION

The review reflecs the fact that soil is the foundation upon which society is sustained and evolves, that it is a vital component of ecological processes and recycles, as well as the basis on which earthr infrastructure rests. Often not enough importance is given to the fact that soil quality and its protection contribute significantly to preserving the quality of life, and that the nutrition and health of humans and animals cannot be separated from the quality of the soil. Growing pressures from an ever increasing global population, as well as threats such as climate change and soil erosion, are placing increasing stresses on the ability of soil to sustain its important role in the planet's survival. Evidence suggests that soil is one of the fundamental components for supporting life on Earth. It is the processes that occur within soil, which drive ecosystem and global functions and thus help maintain life above ground. Soil performs numerous ecosystem functions and services, ranging from providing the food that biotics eat to filtering and cleaning the water that biotics drink. It is used as a platform for building and provides vital products such as antibiotics, as well as containing an archive of ecosystem cultural heritage in the form of archeological sites. Life within the soil is hidden and so often suffers from being 'out of sight and out of mind. A more complete knowledge of soil biotics is needed for biodiversity conservation. Only by knowing soil in all its complexity, while maintaining its functionality and quality through actions aimed at protecting its properties, and acknowledging the importance it assumes in the quality of life worldwide, can human beings embark on a truly sustainable use of soil perceived as a resource and build a proper man-soil relationship to be left to future generations.

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MANUSCRIPTS OF POSTER PRESENTATIONS

Article submitted to the Proceedings Book of the VIth. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

ASSESSMENT OF GROUNDWATER POLLUTION BY HEAVY METALS IN THE INDUSTRIAL ZONE OF SKIKDA

Amina HAFSI[1], Ahsene BOUREFIS[1], Farès KESSASRA[2], Abdellah BOUSHABA

[1]Affiliation Department of Geology and Environment, University les Fréres Mentouri, Constantine 1., [2]Laboratory of Geological Engineering, Team 3 "Geology", University of Jijel, Algeria, Department of Earth and Universe Sciences, University of Jijel, Central Campus, Algeria, [3]Department of Geology, Sidi Mohamed Benabdellah University, Fes, Morocco

Pumped groundwater volumes have been estimated at 52 hm^3 per year with 12hm^3 per year being abstracted from oil installation industry in Skikda city, situated in the north east of Algeria. Large industrial demands of groundwater have caused prejudicial effect on alluvial aquifer through aquifer depletion and moreover by contamination of aquatic ecosystems. An environmental assessment was carried out on water resources collected from boreholes and river, the aim was to assess heavy metal contamination in water close to our industrial area. Indeed, 20 water samples were collected in December 2021, including surface water and groundwater. results reveal that Safsaf river presents an alkaline pH (7.49), a high conductivity which reached 10620 us/cm exceeding the WHO limit fixed at 2500 us/cm , dissolved oxygen reaching up to 5.21 mg/l, and a maximum BOD_5 of 140 mg/l, this load exceeded WHO standards fixed at 25 mg/l. cadmium concentrations measured at 1.48mg/l as a maximum load which exceed WHO standards fixed at 0.05 mg/l, zinc concentrations show a large peak of 9.3 mg/l, when WHO standards limits it at 3 mg/l in water and arsenic was measured at 1.05 mg/l, *greatly exceeding WHO standards fixed at 0.01mg/l. this high concentration of heavy metals may be of industrial origin, as the river flows through the industrial zone, or anthropic, as Safsaf passes through the entire city of Skikda. On the other hand, groundwater results indicate the presence of cadmium ranged from 0.005 to 5.09 mg/l and largely exceed WHO standards about only 0.003mg/l.* high concentration could be due to anthropogenic and industrial discharge. *And also the presence of a high concentration of Zn ranged from 0.325 to 7.21 mg/l and largely exceeds WHO standards about only 3 mg/l. and which has practically the same sources of pollution as surface water.*

***Keywords**: groundwater, contamination, heavy metal, WHO*

INTRODUCTION

Any increase in production activity results in an increase in waste, and if there is no destruction, recycling, there is pollution (Faurie et al., 2003).The problem of water pollution undoubtedly represents one of the most worrying aspects of environmental degradation by contemporary technological civilisation (Ramade, 2005).

Pollutant discharges can profoundly modify the physico-chemical components of the receiving aquatic environments as well as the biocenoses populating these environments (Pesson, 1980). Our work consists in carrying out an evaluation of water pollution by heavy metals in the industrial zone of Skikda, which is located in a region that receives daily sewage, domestic waste and effluents from the zone. Our objective is therefore to determine the degree of contamination and the fate of heavy metals (As, Zn, Cd) in these waters.

MATERIALS AND METHODS

In July 2018 to March 2022, three water sampling campaigns were carried out in the surroundings and inside the industrial zone of Skikda.(25) stations were selected, (10) samples from the surroundings of the zone, (3) samples from inside the zone, (4)samples from the refinery effluents, and one sample from the sea water. pH, electrical conductivity(δ), temperature(T) and dissolved oxygen(DO) were measured in situ using a multi-parameter suitcase.
All water samples were stored in a cooler, transported to the laboratory.However, prior to storage, these samples were filtered and then stored in a refrigerator at a temperature not exceeding 4°C.Samples for the determination of heavy metals were acidified until their pH was below 2 and then stored in a refrigerator until the day of the ICP reading.The determination of calcium, magnesium and chloride ions was done by the titrimetric method. Sulphates and nitrates were determined by spectrophotometry, sodium and potassium by flame photometry (Rodier J, 1996).

STATISTICAL ANALYSIS AND GRAPHICAL PRESENTATION

The temperature values of the water vary between 21.2 and 14.8°C; they are not dependent on the season.pH values of the stations vary between 7.42 and 9.2; these values exceed the irrigation standard according to FAO (6.50<pH<8.40), and from 6.5 to 8 for the WHO standard. In fact, the pH of the site is alkaline, this alkalinity is related to the lithology of the region which is presented by the predominance of carbonate formations.the electrical conductivity ranging between 334 and 62200 µs/cm, whose minimum content is recorded downstream of Wadi Safsaf (O1), while the highest value is recorded at the level of the P9.
All the values measured exceed the WHO irrigation standard (70-300 µs/cm), as well as the FAO standard (700µs/cm). Dissolved oxygen levels vary from a minimum value of 5% to a maximum value of 30%. These values generally exceed the irrigation standards defined by the FAO and the WHO standards, which range from 70 to 90%, but the E2 effluent is extremely low in oxygen, at 4.2%, due to the high pollution load it carries. From Table 1 and Figure 1, it can be seen that calcium ions are in close concentration in the different stations, with calcium contents varying between 250 and 421 mg/l. These contents are classified in the range of 0.5 to 0.5 mg/l. These levels exceed the FAO irrigation standard (200 mg /l). Magnesium contents vary between 13.44 and 40.22 mg/l, with the lowest content recorded in the middle of oued Safsaf (P5) while the highest value is recorded at the upstream end of the wadi (P4).

Table1. physico-chemical parameters analysed in the water

	$N0_3$	NO_2	NH_4	SO_4
p1	0.558	0	0	11.62
p2	2.659	0	0	236.33
p3	3.7	0.01	0.02	294.62
p4	1.6	0.02	0.06	187.59
p5	0.3	0	0	186.5
p6	0.809	0	0.07	268.92
p7	1.52	0	0.16	88.11
p8	2.987	0	0.67	382.88
p9	2.77	0	0.16	294.5
p10	3	0.01	0.02	279.39
p11	1.09	0	0.13	172.49
p12	6.58	0.01	0.37	258
p13	0.79	0	0.13	271.7
p14	9.12	0.01	0.37	325.84
p15	0,79	0.01	0.07	256.66

p16	1,55	0.02	0	173.74
p17	2,25	0.08	0	13.96
p18	2,6	0.15	0	97
p19	3,3	1.02	0.08	193.5
p20	0.8	1.14	0	133.28

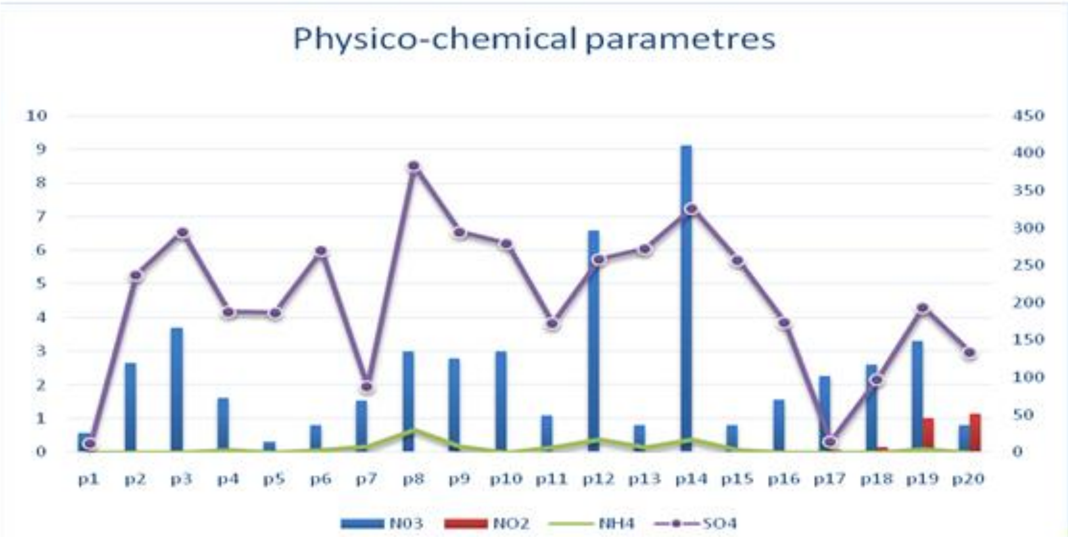

Figure 1. Graph of physic-chemical parameters

RESULTS AND DISCUSSION

All points sampled show concentrations above the FAO standard (150 mg/l). The Ca^{2+} and Mg^{2+} ions come mainly from the dissolution of carbonate formations (limestone, dolomite, magnesite, etc.). The sodium and potassium contents show a great difference from one station to another; an average sodium concentration is around 200 mg/l. The potassium content of the three stations studied ranges from 12 to 236 mg/l. The distribution of chloride concentrations in the water of Wadi Safsaf varies between 50 mg/l at station P6 and 380 mg/l at station P1. The totality of the measured water points have concentrations higher than the irrigation standard fixed by the FAO at 350mg/l, and 250 mg/l according to the WHO.
The levels of sulphates found in the water of Wadi Safsaf oscillate between 20mg/l at the station (P5) and (P9) and 792 at the station (P12). The values obtained for nitrates are 12mg/l and 299mg/l respectively for station (P7) and station (P11).
Copper levels in the different stations of oued safsaf vary between a minimum value of 2.3 mg/L recorded in the effluent station (O1) and the maximum value of 8.7 mg/L at the station (P3). Cadmium levels are above the European (0.150 mg/L) and WHO (3 mg/L) standards. The minimum value of zinc is recorded in the station (P12) downstream of the wadi of the order of 0.12mg/L.
Generally, zinc and copper levels are low in the natural surface waters of Wadi Safsaf because the aquatic environment is dynamic and the mobility of chemical elements and heavy metals is greater.
In addition, the high rainfall recorded in the region, on average 1000 mm/year, contributes to the dilution process of the concentrations in the water. It should be noted that as the pH of the water is mostly alkaline (above 9), this alkaline environment favours the hydrolysis of Zn^{2+} and therefore, the decrease of its content in the aqueous phase (Burnol et al.2006). The threshold of toxicity of this trace element in irrigation water of the WHO is fixed at 10 µg/L. In our study, the surface waters of oued safsaf in the Skikda region have concentrations ranging from 125.8 µg/L to 160.2 µg/L. These concentrations are quite high and exceed the above-mentioned standards.
Cadmium can be released into water through natural weathering processes, discharges from industrial facilities or wastewater treatment plants, atmospheric deposition, leaching from landfills or soil or phosphate fertilizers (ATSDR, 2012). At the study site, these high concentrations could be due either to geogenic factors that favour the release of cadmium into water, related to the geological nature of the terrain, mainly the presence of carbonate formations and probably basement formations, or to anthropogenic discharges.

On the site of the industrial estate, the combustion of fossil fuels and road transport may contribute small amounts of cadmium (Figure 2) comparing with Zn and As..

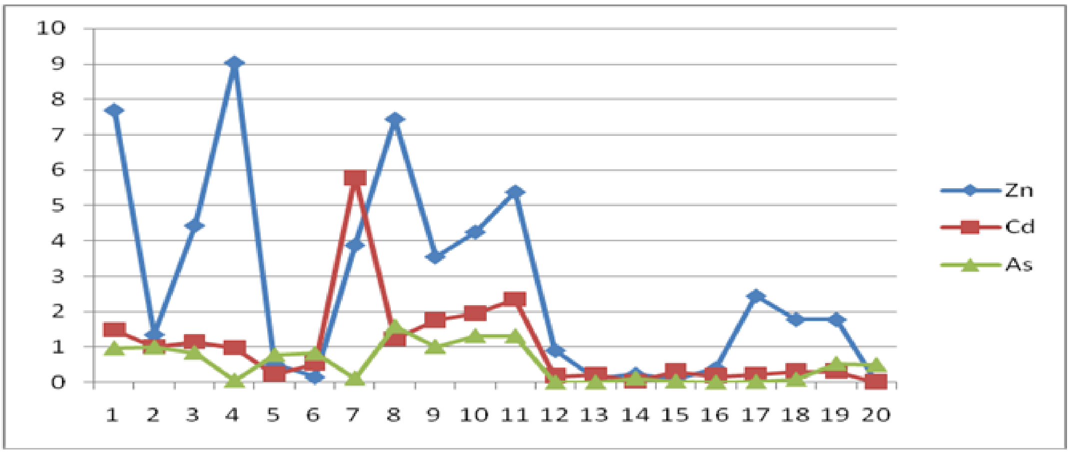

Figure 2. Graph of heavy metal parameters.

CONCLUSIONS AND RECOMMENDATIONS

Spatial variations of physico-chemical parameters, major elements and heavy metals in groundwater in the different sampling stations showed that: Wadi Safsaf water has an alkaline pH, a very high conductivity. A high concentration of heavy metals (Zn, Cd, As) in wadi water, as well as groundwater seems to be affected, except that we report a high contamination of these waters by cadmium which is found concentrated and exceeds the required standards, However, it has been established that for all the sampling TMEs carried out, a metallic contamination in the soil (Cd, Zn and As). Our results may lead to consider the contamination status of surface and groundwater. A temporal follow-up is recommended, other compartments (sediments, atmosphere) and other MTE such as iron, lead, mercury should complete our impact study.

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Article submitted to the Proceedings Book of the VIth. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

COMPARISON OF DEEP ROOTING OF WILD BOAR ON SOIL PROPERTIES IN THE MÁTRA MOUNTAIN AND THE GÖDÖLLŐ HILLSIDE

Ádám FEHÉR[1], Csaba CENTERI[2*], Pari ALKHASOVA[2], Krisztián KATONA[2]

[1]Independent Researcher, Apc, Hungary, e-mail: feher.adam.hun@gmail.com, [2]Institute for Wildlife Management and Nature Conservation, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary, e-mail: centeri.csaba@uni-mate.hu, alkhasovapari@gmail.com, katona.krisztian@uni-mate.hu

Wild boar is known to create deep and shallow rooting in forests and this activity has a continuous disturbing effect on soil. There has been an ongoing discussion whether wild boar rooting can be considered as negative or also positive impact. Our hypotheses were that there are differences in the thickness of the humus-rich horizons between clayey and sandy soils and between rooted and control areas. Two sites were analysed, one in the Mátra Mountains (Apc) and the other in the Gödöllő Hillside (Babat-valley). Five deep rooting were investigated on both sites. The depths of the soil horizons and total soil depths were measured in the ring, in the rooting, and in a nearby control area to show the horizontal and vertical effects of wild boar rooting. We used a generalized linear mixed model to evaluate the thickness of the humus-rich A-horizon in the function of wild boar impact. Site effect and soil texture were additional explanatory variables. The differences between sites (Apc: 46±18 cm; Babat 48±21 cm) and disturbed vs. control plots (rooting: 46±16 cm; ring: 52±23 cm; control: 44±22 cm) were marginal. Therefore, the generalized mixed model has not confirmed any difference between sites, rootings or soil texture. Our preliminary results suggest that wild boar affects soils by local soil redistribution rather than expressing a significant impact on topsoil thickness.

***Keywords**: soil depth, vertical soil change, humus, clayey soils, sandy soils*

INTRODUCTION

Wild boar (*Sus scrofa*) is believed to live and influence the landscape components, including forests, meadows and recently, arable lands, their soils and vegetation in the Carpathian Basin for thousands of years (Figure 1).

Figure 1. Wild boar resting in mud (Photo: Cs. Centeri, 2019)

Concerning soils, rooting impacts have continuously shaped the properties and productivity of temperate soils for approx. 10 000 years, started after the last cold period. These soils were formed under their strong influence as their rooting has a considerable effect by redistributing soils, especially in the humus-rich upper layers. Nowadays, the wild boar is one of the main sources of human-wildlife conflicts due to the significant density increase both in its native and exotic range. Rooting impact on soil productivity, native plant communities, biodiversity and forest regeneration can have either negative or positive consequences [1] depending on specific site-related factors. Therefore, the ideal and adaptive population management techniques which minimize rooting damages but support the ecosystem engineer functions of wild boar [2] are particularly context-dependent [3]. Our research towards a better understanding of wild boar rooting impact on soil properties and plant communities consists of several methodological approaches that have been conducted in different forested areas in Hungary [4]. In this paper, we evaluate the preliminary results of soil profile analyses performed on rooted and intact plots of two characteristic forest habitats of the country: a dry-mesic oak forest with pedunculated oak (*Quercus robur*) and field maple (*Acer campestre*), and a spontaneously afforested area with black locust (*Robinia pseudoacacia*). We hypothesized that the topsoil (A) and the related humus-rich transitional horizons (AE, AB) are significantly thicker 1) in the clayey soil of oak forest than in the sandy soil of black locust forest; 2) on the intact plots of an area than on rooted ones due to the prevalent redistributed and overturned surface on these disturbed patches.

MATERIALS AND METHODS

The situation of the study sites

The dry-mesic oak forest is situated in Babat-valley, Gödöllő Hillside, Pest County near the city of Gödöllő (47°36'56.61"N, 19°22'50.40"E) while the black locust forest is located at the SW edge of the Mátra Mountains, near to the village of Apc (Figure 2) in Heves county (47°48'22.36"N, 19°41'50.96"E).

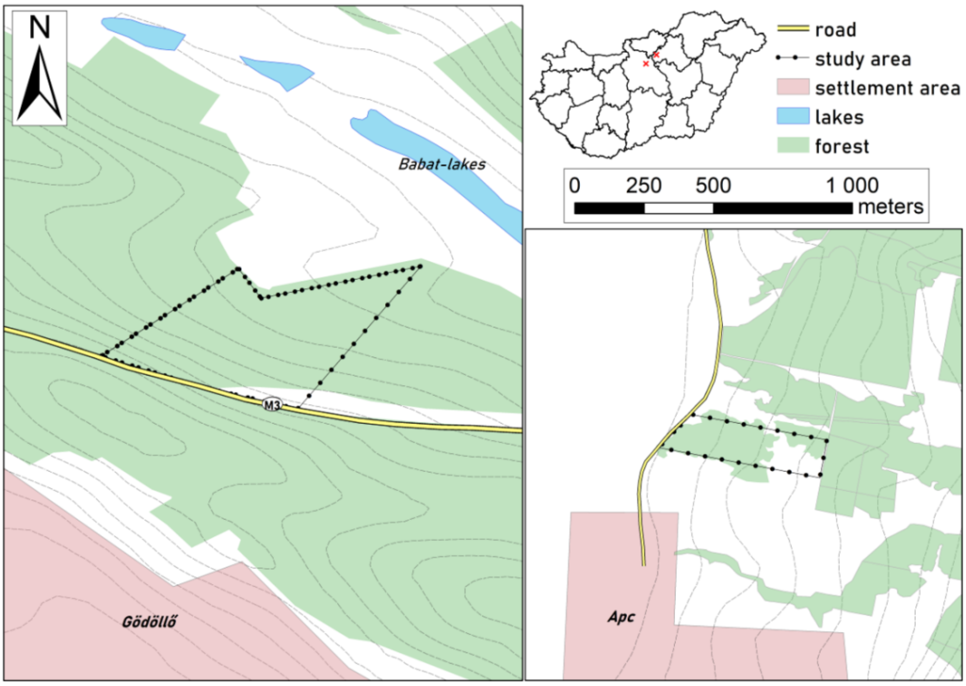

Figure 2: Map of the study area in Gödöllő Hillside (left) and the SW edge of Mátra Mountains (right) and their situation in Hungary (upper right)

General geographical description of the examined area close to Gödöllő

The Gödöllő Hillside is surrounded by the Pest plain to the west, the Danube-Tisza sand dune region to the south, the Cserhát Mountain to the north and the alluvial plain of the Northern Great Plain to the east. The majority of the Gödöllő Hillside is a landscape protection area.

Based on basic geographical conditions, this region is a transitional zone between the Great Plain and the Northern Central Mountains. Due to its transitional nature, a special mesoclimate was created here, which provided an opportunity for the development of unique vegetation. Hornbeam (*Carpinus betulus*) mixed with field maple-pedunculated oak and small-leaved linden (*Tilia cordata*)-oak forests are known here. These forests are the representatives of the cool continental forest-steppe vegetation in Hungary [5].

Areas that are higher than 200 m or in the northern region have a cool to a moderately dry climate, while other areas have a moderately warm dry climate. The number of sunny hours per year is around 1950. The average annual temperature is 9.5–9.7 °C in the north and 9.7–10.0 °C in the south. The frost-free period is 186–190 days in the east and 195 in the south. The average maximum temperature in summer is 32.5–33.0 °C, and the average minimum temperature in winter is -16 °C. The annual rainfall is between 540–580 mm. The average number of days covered by snow is 36–40, with a maximum snow thickness of 22 cm [6].

Looking at the vegetation cover, the overall picture is characterized by a vivid mosaic of different forest associations [7]. Forests occupy the largest part of its territory, it is 39.1% of the hills, which means 19970 ha, followed by arable land, which makes up 38.9% of the region, which is 19859.6 ha [6]. The hill stretches from Budapest to the East and extends to the Galga River. Its highest point is Margita (345 m). Its surface waters are Naplás, Veresegyházi, Babatpuszta and Isaszeg lakes.

There is also a forest reserve within the district, which consists of two areas; the core area and the protection zone. The core area is highly protected, while the protection zone is accessible. The Nagy-Istrázsa-hegy forest reserve was declared as one of the 63 reserves by the Minister of the Environment in 2000 [6].

General geographical description of the examined area close to Apc

The area belongs to the Zagyva Valley micro-region; however, it is very close to the border of the foothills of the Mátra Mountains to the east. The micro-region is situated between 125 and 376 m above sea level. It is an asymmetric river valley between the Cserhát and the Mátra Mountains. The erosion rate is high. The base of the examined area of the valley is made of andesite and andesite tuff materials.

The climate of the area near Apc is moderately warm-dry. The number of sunny hours per year is around 1900. The average annual temperature is 9.8–10.0 °C. The frost-free period is 180–185 days. The long-term average maximum temperature of the warmest day in summer is 31.0–33.0 °C, and the average minimum temperature in winter is -16 °C. The average annual sum of rainfall is between 560–580 mm. The average number of days covered by snow is 30–35, with a maximum snow thickness of 18–22 cm [6].

Black locust often becomes the main element of spontaneous successional vegetation on abandoned arable lands [8], such invasion took place on our second study site since the 1980s. Black locust occupied various sized patches which merged into a closed canopy forest on approx. 4ha large area. Turkey oak (*Quercus cerris*) and field maple is the second most common tree species in the understory among shrubs such as dog rose (*Rosa canina*), hawthorns (*Crataegus* spp.), blackthorn (*Prunus spinosa*), bramble (*Rubus caesius* and *Rubus fruticosus*) after the predominant black elder (*Sambucus nigra*) in nitrogen-rich patches. The dominant herbs and grasses also indicate the actual ruderal and disturbed habitat conditions: barren brome (*Bromus sterilis*), chervil (*Anthriscus cerefolium*), common nettle (*Urtica dioica*) greater celandine (*Chelidonium majus*) or wood avens (*Geum urbanum*). The oak forests of the region are mainly developed on lithomorphic and brown forest soils (Cambisols) with shallow topsoil on andesite bedrock. However, the current site is rather Arenosol with a decent humus-rich layer (25cm on average) with a quick transition to sand in the C horizon, thereby the subsoil thickness is variable.

FIELD STUDY AND STATISTICAL ANALYSIS

Soil profiles were described on the field using a Pürckhauer soil core sampler up to 1m depth. We chose 5-5 deep rootings on each study site and took one sample 1) from inside the rooting (called rooting); 2) from the edge of the rooting where the soil was redistributed from the center of the rooting (called ring); 3) from the intact control area located at least 1 but no more than 3m from the rooting edge (called control). The samples were evaluated on the field: the thickness of the actual horizons (in cm), soil texture (clay – loam – sand) and test for lime with 10% hydrochloric acid (Figures 3 and 4).

Thickness data of main and transitional soil horizons were documented separately. The depth of humus-rich horizons was expressed by taking the mean of the summarized topsoil (A) and related transitional (e.g., AE, AB, AC) horizon thickness data grouped by sampling location (rooting vs. ring vs. control) and study site (Gödöllő vs. Apc).

Figure 3. Photo of a soil profile with the habitat from the Mátra Mountains, Apc sampling site, black locust (*Robinia pseudoacacia*) forest, 15th of November, 2021 (Photo: Cs. Centeri)

Figure 4. Photo of a soil profile with the habitat from the Gödöllő Hillside sampling site, oak forest (Quercus spp.), 25th of November, 2021 (Photo: Cs. Centeri)

The thickness of the humus-rich horizons was statistically evaluated in function of the rooting and study site. Since the soil attributes are not independent between observations within the sampling plots and thickness data were not normally distributed, we implemented a generalized linear mixed model in R [9] with the package *lme4* [10].

RESULTS AND DISCUSSION

Field examinations – one descriptive example

In Table 1. we can see an example of soil description from the rooting, the ring and the control from the black locust forest, Apc area.

Table 1. Description of soil horizons of the rooting, the ring and the control samples from Rooting No. 001 of the black locust forest, Apc area (15th of November, 2021)

Sample type	Soil horizon	Depth (cm)	Color	Texture	Other
Rooting	A	0–9	dark brown	sandy loam (clayey)	The B horizon is a buried former B horizon. A trunk of a former wine plant was found, these were vineyard terraces before.
	AC1	9-24	reddish light brown (darker)	sandy loam (clayey)	
	AC2	24–55	reddish light brown (lighter)	sandy loam (clayey)	
	C	55–100	yellowish-brown	sandy loam (clayey)	
	B	67–100	light reddish brown	clay	
Ring	A	0–10	dark brown	sandy loam	This looks like a different soil type, compared to the rooting.
	AC	10–37	mixed	sand	
	C	37–	dirty whitish	sand	
Control	A	0–32	dark brown	sandy clayey loam	Extremely compacted from 50 cm.
	C	32–100	yellowish-brown	sandy clayey loam	

The thickness of the humus-rich A horizon in the control sample was 32 cm. The total of the horizons where the humus material was present was 55 cm in the rooting and 36 cm in the ring. The C horizon (parent rock) was very close to the surface and there was no sign of any mixture of the horizons in the control sample. The rooting was the most disturbed with the most mixed layers. The ring had just one AC horizon that we can consider as mixed by the wild boar rooting.

Figure 5. Due to former land uses, such as building terraces and mining activities, the recent soils are sometimes very shallow (Control of Site No. 002), Apc, 15th of November 2021 (Photo: Cs. Centeri)

Figure 6. A typical soil profile in the oak forest, Gödöllő area, 25th of November 2021 (Photo: Cs. Centeri)

The typical soil type of the Gödöllő Hillside is the rusty brown forest soil. Under the forests, we can expect a considerable thickness of the humus-rich layer (20-30 cm). However, soil erosion is also a widespread phenomenon as slope steepness is often above 17%. It means that the humus-rich layer is very shallow or missing in some of the profiles.

RESULTS OF THE STATISTICAL ANALYSES

The fitted generalized linear mixed model could not confirm any significant effect of rooting disturbance on the humus-rich horizons' thickness (Table 2). The effects of rooting were statistically not different from zero, and the sites had statistically similar soil thickness.

Table 2. Coefficients (Beta) of the generalized linear mixed model with their 95% confidence intervals and p-values.

		Beta	95% CI (lower)	95% CI (upper)	p
Rooting effect	Intercept (*Control*)	-0.403	-1.132	0.326	0.23
	Ring	0.175	-0.011	0.361	0.07
	Rooting	0.104	-0.082	0.289	0.27
Site effect	*Oak-forest*	0.314	-0.705	1.34	0.5
Variance of random effects: 0.534 (30 observations from 10 plots)					

A closer look at Table 2. shows that the p-value in the ring is very close to the significance level of 0.05 (being 0.07), so the thickness of the ring can be considered very close to prove our hypothesis that it should be thicker. Only slight differences were found between rooted and control samples at both sites (Figure 7). However, we measured extreme deep humus-rich horizons in the oak forest at Babat valley on two occasions: their thicknesses were 98cm and 95cm in the control and the ring of the same sampling plot, respectively, which nearly exceeded the measuring range (100cm) of the implemented soil core sampler tool. The differences between sites (black locust forest: 46±18 cm; oak forest: 48±21 cm) and disturbed vs. control plots (rooting: 46±16 cm; ring: 52±23 cm; control: 44±22 cm) were only marginal.

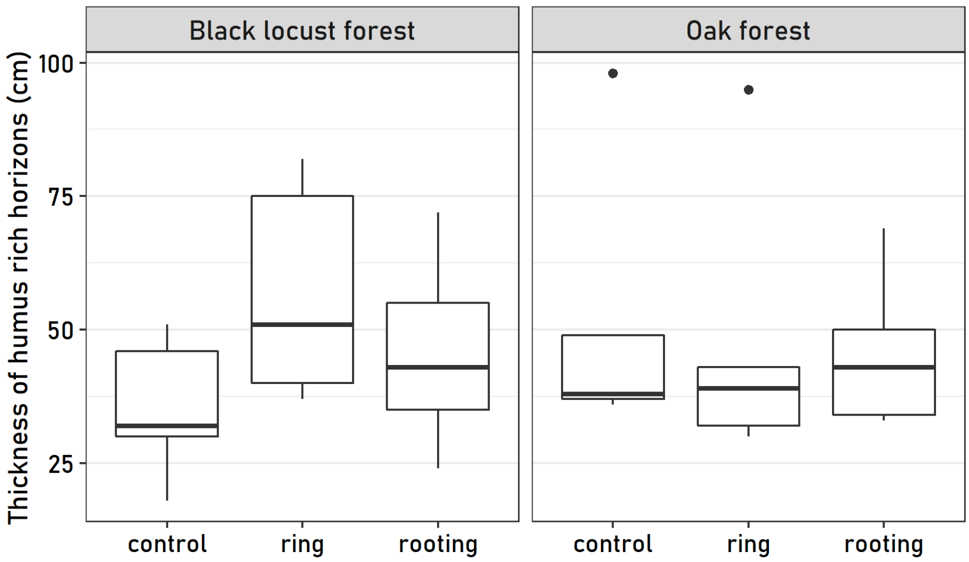

Figure 7. Boxplot of the thickness (cm) of humus-rich horizons in the examined black locust and the oak forest areas

Regardless of the statistical results, the black locust areas seem to show a bigger difference between the control and the ring, the ring having a bigger thickness of the humus-rich horizons, while the rooting areas are situated in between the ring and the control. We expected the ring to have much thicker humus-rich horizons, and the rootings to have much lower humus-rich horizons, so our findings are against the original expectations (null hypothesis). The expected order was not detected in the oak forest, either.

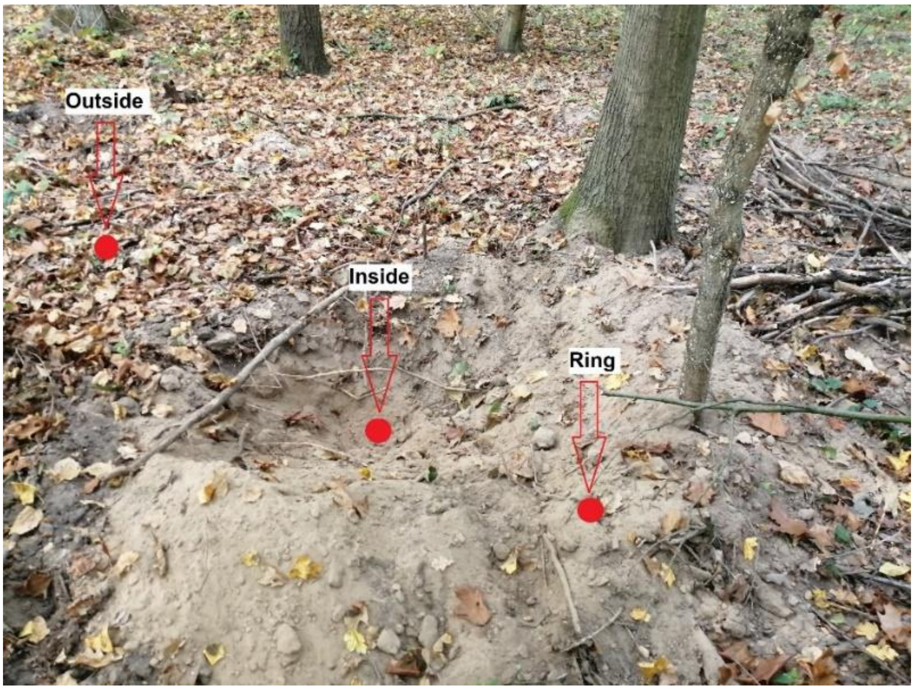

Figure 8. Visible huge differences in soil layer thickness after a fresh rooting at the Gödöllő site (Photo: Pitta N. 2019)

The reason for this can be the temporal factor, since the field measurements were done in the autumn and the rootings originate from the springtime. The natural conditions favored erosion and collapse of the very loose soil created by the wild boar.

Furthermore, it is an important result that the thickness of the humus-rich horizons is more than 50 cm on average in areas with wild boar rooting, so it is obvious that wild boar rooting is not causing the depleting of the humus-rich horizons, rather mixing them. It is also proved by [11], who found that wild boar and red deer (*Cervus elaphus*) were the two, most often mentioned hunted animals in the Jura area between 9500-7000 cal BC.

CONCLUSIONS AND RECOMMENDATIONS

Our null hypothesis was that deep rootings of wild boar cause differences in the thickness of the rooting and the ring, compared to the control areas. Based on the comparison of 5-5 rootings from two sampling sites from two distinct geographical regions, we cannot conclude that there are any statistically proven differences between the thickness of these soil layers. However, we can conclude the prevalence of tremendous differences between the rooting, ring and control plots based on our former measurements of the fresh rootings, because the rooting is deeper than 30 cm and the ring is at least 20 cm high, compared to the original soil surface (see Figure 8). After all, it is better to measure the soil thicknesses in fresh rootings to show differences between the rooting, ring and control groups, since the time passed from a rooting event seems to be an important factor.

ACKNOWLEDGEMENT

We thank the ranger of the Danube-Ipoly National Park Directorate to support us with our research in the area of Gödöllő.

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Article submitted to the Proceedings Book of the VI[th]. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

FORGOTTEN PRESERVERS OF PROTECTED PLANTS: ORCHARD GRASSLANDS IN HUNGARIAN HILLY AREAS

Ákos MALATINSZKY

Department of Nature Conservation and Landscape Management, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary, Malatinszky.Akos@uni-mate.hu, +36-30-566-3869

Among the agricultural areas, orchard grasslands play an important role in the preservation of rare plant and animal species. Besides their conservation value, they are recognized as valuable landscape elements all over Europe (but especially in Central Europe). They are formed by fruit trees, usually belonging to traditional varieties and landraces, sparsely distributed on mowed (or grazed in some places) grassland. The old trees create habitats for bats, birds and saproxylic beetles. Although the grasslands underneath the trees are of secondary origin, their structure and species stock refer to close-to-natural conditions. Thus, besides serving the production of fruits without pesticide use, they host protected botanical values such as Anemone sylvestris, Centaurea triumfettii, Clematis integrifolia, Dianthus collinus, D. deltoides, Epipactis helleborine, Gentiana cruciata, Gymnadenia conopsea, Iris variegata, Lilium martagon, etc. Unfortunately, most of their stands have been abandoned during the past 50 years due to the lack of mowing (caused by lack of livestock, ageing local population, etc.), which caused scrub encroachment. However, those stands that open up without scrub infestation may give home for Aster amellus, Chamaecytisus albus, Orchis purpurea, O. tridentata, O. militaris, O. morio, O. ustulata, Polygala major, Ornithogalum pyramidale, Prunella grandiflora, etc.

***Keywords**: mowing, nature conservation, orchard floor, rare plant species, traditional fruit variety*

INTRODUCTION

Agricultural production usually uses its environment and the natural stock intensively. There are only a couple of forms that do not cause severe harm on the biodiversity, or even enrich the landscape with new habitats and thus, create new opportunities for the plant and animal species to thrive [1]. Most of these non-intensive methods have evolved during the past centuries as traditional landscape management patterns. The local people recognized the ecological backgrounds, including the weather circumstances, hydrological features, and soil basis, as well as the barriers that limit the agricultural production, and contributed to the evolvement of multifunctional landscapes [2]. These traditional land uses resulted usually in smaller harvest than the intensive forms, but of better quality and tastiness, while maintaining the natural environment. One of the best example for this type of land use is the orchard grassland (called also as meadow orchard), a traditional type of agroforestry, once widespread in Central and Eastern Europe.

As the various symptoms of the global ecological crisis are interrelated, it is inevitable to explore the biodiversity of any land use type, in order to recognize the role of agricultural production, and especially the above-mentioned traditional landscape management forms, in biodiversity conservation. Another reason for the recognition of these patterns i.e., the orchard grasslands is their capability to produce healthy food without residues, due to the lack of using any artificial fertilizer or pesticide in these orchards. The fruit trees usually belong to old varieties, sometimes landraces, and have adapted to the local conditions during the past centuries. Thus, they are resistant against several plant diseases. Therefore, the preservation of their valuable gene stock is of utmost importance [3].

These factors together determine their high value for nature conservation. This is why my aim is to explore their stands in the Hungarian hilly areas.
Orchards grasslands may host several taxonomic groups of animals, plants, and fungi. Orchard grasslands are of secondary origin. Their area was once covered by thermophilous oak forests in the most cases, cut by the local people in order to create agricultural land. The grasslands have usually evolved below the sparsely distributed fruit trees due to the regular mowing in order to avoid scrub encroachment and re-forestation (as the propagules remained in the soil seed bank and forest patches remained in the close vicinity) as well as to produce hay for winter forage. Due to the high plant diversity in these secondary grasslands, including several aromatic and medicinal herbs, the hay quality and nutritive value is high. Its regular mowing stabilized these grasslands and enriched the landscape with new habitat patches that give home for several plant species that are hosts of butterflies and feed Hymenopterans; old fruit trees that supply birds, dormouse species and beetles with nests, and fungi with wood mould; etc. The most spectacular taxonomic group in the orchard grasslands is the vascular plants, consisting of numerous native species and several protected ones among them. The current paper focuses on the plant species that are protected by law.
Land abandonment has been typical in rural Hungary since the mid-20th century (i.e., after collectivisation), and has boosted during the past 30 years; and affects several traditional landscape management methods. In parallel, the regeneration of the abandoned areas plays a significant role in habitat dynamics and biodiversity relations as well [4]. The direction of these processes leads our attention onto several challenges of nature conservation.

MATERIALS AND METHODS

In the case of Hungary, orchard grasslands lie in the place of one-time forests, mainly turkey oak, thermophilous oak, or oak–hornbeam forests, in lowland and hilly areas (i.e., between approximately 100 m and 400 m above sea level). Their area is usually inappropriate for arable land management; this is why this alternative way of usage has been applied since the medieval times. According to the monograph of the Hungarian habitat types [5], orchard grasslands as a habitat type was reported from the Central, the Southern and the South-western Transdanubia, as well as from several parts of the Northern Hungarian Mountain Range. I made my investigations basically in these regions after contacting some of those botanist experts who delivered data during the country-wide habitat mapping that resulted in the mentioned compilation of habitat types in Hungary.
During my first field observations, the species richness of the studied orchard grassland mosaics was highly visible, and this encouraged to more detailed surveys. Besides floristical data, also habitats in a close-to-natural state were taken into account during the research work. A detailed and frequent (2–3 times per year) botanical survey started in 1998, and the first results were published for various types (orchards, vineyards [7]) of abandoned and still managed grasslands.
Plant names refer to the database of Plants of the World online (http://www.plantsoftheworld online.org/,accessed on 17/03/2022), while animal names refer to the Fauna Europaea online (https://fauna-eu.org/, accessed on 17/03/2022).

RESULTS AND DISCUSSION

History and evolution of the orchard grasslands

The management of orchard grasslands has been present in rural Hungary since the Middle Ages. After the 1880s, when the vine-pest (phylloxera) destroyed almost all the vineyards in hilly areas, several parcels that had previously been used for grape production were re-planted with fruit trees and thus, the coverage of orchard grasslands has grown [7]. Although reintroduction of grape yards has also started closely after the vine-pest epidemic, several grape parcels remained out of any kind of management [8], and natural re-vegetation processes started to create a favourable surrounding environment for the orchard parcels with diverse microhabitats and fringes that are beneficial e.g. for pollinators of the fruit trees, or predators of fruit pests.

The mosaic-like pattern of lands under slight (non-intensive) agricultural management and relatively intact habitats assisted the new expansion of natural vegetation on the abandoned parcels and, as a result of becoming grassland again, secondary slope grasslands generated, giving home for valuable plant species. Eroded slopes of former, abandoned grape yards served the generation of secondary dry grasslands similar to the steppe meadows. The exposition of the slopes usually played a significant role in their abandonment. Those ones with north-western exposition might have been abandoned from grape production as early as before the vine-pest epidemic, i.e., even cca. 200 years ago according to the First Military Mapping (www.mapire.eu, accessed on 11 February 2022), therefore, the time that had passed since then could have been long enough for the revegetation processes and the generation of a secondary dry grassland, which refers to the structure of dry loess steppes on plain areas. Taking into consideration that these habitats have almost disappeared from the Hungarian Great Plain due to intensive arable land management, their species stock (both the plants and the animals tucked to them) could survive in these lower hillsides, which gives a new perspective for their legal protection by nature conservation.
A majority of the orchard grasslands are situated on eastern, south-eastern, southern, south-western, and western slopes, with various slope angles. They might appear on slope bottoms (close to the valley) and top regions as well (Figure 1).

Figure 1. Abandoned orchards on the northern slope and top plain area, vine parcels on the opposite (Ragály, NE-Hungary). Photo: Á. Malatinszky

The grassland below the foliage of the fruit trees has been mown regularly. Due to regular mowing usually once a year (during July or August, also to ease the collection of fruits), secondary mesophile grasslands generated that are similar to those of forest-steppes or hay meadows, providing a home for nature-protected plant species. Among habitat types registered during my researches, the following ones are declared as priority habitat type of community interest in the Annex I of the Habitat Directive (92/43/EEC) of the EU:

- no. 6210 that is Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) as important orchid sites
- no. 6510 that is Lowland hay meadows (*Alopecurus pratensis, Sanguisorba officinalis*).

After development of heavy industry in the 1960's, a significant part of the rural inhabitants became employed in mining and industrial centres and moved away from the observed area or started to commute, therefore the traditional land use was abandoned in several parcels. Similar processes are reported from throughout the second half of the 20th century in both democratic and socialist parts of Europe [9], e.g., radical decline of the orchard grasslands area was reported from central Slovakia between 1950 and 2010 [10]. The area of non-forest woody vegetation, including fruit trees and a number of individual features, declined in the second half of the 20th century in the hilly region of eastern Czech Republic as well [11]. At present, orchard grasslands are further threatened by agricultural intensification, urbanisation [12], and the abandonment of undergrowth and tree management. As described for the case of Slovakia, many orchard grasslands are managed by the elderly, and thus the land maintenance in rural regions is threatened by the loss of traditional approaches and emigration of younger generations to urban regions [13] (Figure 2).

Figure 2. A plum stand abandoned recently (left) and 13 years later, suffering from scrub encroachment (right), but still hiding some remaining old fruit trees (Zádorfalva, NE-Hungary). Photos: Á. Malatinszky

The vegetation and protected plant species of the orchard grasslands

The dominant grass species are different among the regions and based on the microclimate, soil conditions, geographical situation, management history, etc. as well. Usually, the characteristic grass species of hay meadows (*Alopecurus pratensis*, *Anthoxanthum odoratum*, *Arrhenatherum elatius*, *Briza media*, *Cynosurus cristatus*, *Festuca pratensis*, *F. rubra*, *Lolium perenne*, *Poa pratensis*, and *Trisetum flavescens*) dominate the mesophilic and humid stands of orchard grasslands. While *Brachypodium pinnatum* and *Bromus erectus* (usually *Arrhenatherum elatius*, *Dactylis glomerata* and *Helictotrichon* spp. appear as well) refer to semi-dry conditions and host valuable steppe or forest-steppe species.

The lawn provides a home for valuable plant species such as *Anemone sylvestris* (Fig. 3), *Centaurea triumfettii*, *Clematis integrifolia*, *Dianthus collinus, D. deltoides*, *Doronicum hungaricum*, *Epipactis helleborine, Gentiana cruciata*, *Gentianopsis ciliata*, *Gymnadenia conopsea, Iris variegata* (Fig. 3), *Lilium martagon*, and *Listera ovata*. Abandoned stands that open up without scrub infestation host *Anacamptis morio*, *Aster amellus*, *Chamaecytisus albus*, *Linum tenuifolium*, *Neotinea ustulata*, *Ophrys apifera*, *Orchis purpurea* (Figure 3), *O. tridentata*, *O. militaris*, *Ornithogalum pyramidale*, *Polygala major*, *Prunella grandiflora*, *Pulsatilla grandis* (Natura 2000 designative species) and *Scabiosa canescens.*

In the ecotone towards thermophilous forest fringes and white oak thickets, *Dictamnus albus*, *Geranium sanguineum* and *Prunus fruticose* may enrich the habitat that is dominated by hawthorn (*Crataegus monogyna*) and sloe (*Prunus spinosa*). Even the strictly protected and Natura 2000 designative species such as *Iris aphylla* or Lady’s slipper orchid (*Cypripedium calceolus*) might appear here.

Some less rare species still refer to semi-natural circumstances, such as *Betonica officinalis*, *Cardamine pratensis*, *Centaurea* spp., *Inula* spp., *Jacobaea erucifolia*, *Polygala comosa*, *Potentilla alba* and *Pulmonaria mollis*, with *Colchicum autumnale* patches during autumns. At the edges adjacent to wetter and cooler habitats, tall herb fringe communities might evolve with *Inula helenium* or common dogwood stand (*Cornus sanguinea*) with the rare fern *Dryopteris dilatata*. More diverse exposure (southern, south-eastern, eastern, south-western, western) and slope angles (steeper or milder; tops and foothills or even valley bottoms as well) guarantee higher diversity of species and habitat types.

Figure 3. Protected plants in orchard grasslands: The snowdrop windflower (*Anemone sylvestris*) (left), *Iris variegata* (centre), and lady orchid (*Orchis purpurea*) among fruit trees (Alsószuha and Szuhafő, NE-Hungary). Photos: Á. Malatinszky

Other values of the orchard grasslands

Orchard grasslands function as important on-site gene banks of traditional fruit varieties as well. The most frequent fruit types are traditional regional or local varieties, and even some landraces, of apple (Figure 4), pear, plum, peach, walnut, cherry, and quince or sometimes sweet chestnut, medlar, or service trees. Apricots and almonds might also appear, but only in warmer regions of the country. The mosaic-like pattern of the orchard grasslands as well as abandoned or still managed vineyards, pastures, unmanaged natural grasslands, small parcels of croplands (at the foothills), and thermophilous thickets or low oak forests ensure a picturesque landscape view. This gives an extra value to the orchard grasslands, being attractive for those urban people who seek opportunities for slight tourism.

Figure 4. Sixteen different traditional apple varieties in the orchard of an old homestead, Bakony Mts. (NW-Hungary). Photo: Á. Malatinszky

FURTHER INSIGHT

The results of this study proved that the non-intensive management of orchard grasslands had an important role in protecting Hungarian natural values and agrobiodiversity, the gene stock of traditional fruit varieties [14], with ensuring picturesque landscape features as well, besides fruit production. Although they emerged as a consequence of human land-use, and thus, are of secondary origin, these ecosystems are more resilient towards climate change due to species and genetic diversity, undisturbed soil, constant grass cover, and well-structured habitats that retain water and contribute to slighter erosion in the case of extreme weather events.

Orchard grasslands depend on continuous agricultural activity and remained unaffected by agricultural collectivization, thus, ensure stabilized conditions for those plant and animal species that no longer find their homes in those agricultural landscapes that have been converted to highly intensively managed areas. However, despite their natural values, ecological role, and healthy fruits, orchard grasslands are endangered all over Central Europe. Their decline were reported from Germany [12, 15, 16], the Czech Republic [17, 18], and Slovakia [19, 20]. The main reason for this trend is that they have been marginalized during the past half century due to the lack of rural people with interest towards their management, and are no longer a subject of interest from a production perspective as well due to the smaller harvest and no potential for mechanisation. The decrease in the economic importance of orchard grasslands is attributed to transformations in fruit supply chains, that is, there is an overall move to intensively managed orchards and the separation of integrated land uses into singular ones – fruit production in one place and arable land or grassland in another [9]. The fruit production of orchard grasslands is perceived as one of the most vulnerable ecosystem services in the cultural landscape of the Swabian Alb [21]. Because of these, the fruit trees are in various health states. Turkey oaks overgrow those stands that have been abandoned several decades ago, and several shrub species dominate the scrub encroachment process, such as sloe (*Prunus spinosa*), hawthorn (*Crataegus monogyna*), and common dogwood (*Cornus sanguinea*). Diverse grasslands that lack mowing are overgrown by bushgrass (*Calamagrostis epigeios*). Unfortunately, even the invasive alien species spread in the abandoned stands, such as black locust (*Robinia pseudoacacia*). There are some occurrences, however, where the shrubs were cut after some decade-long abandonment, and the grassland is mown or grazed again (Figure 5).

Figure 5. A former abandoned orchard (left) has recently been opened up for sheep grazing (right) (Kánó, NE-Hungary). Photos: Á. Malatinszky

Since the orchard grasslands are often managed by elderly people [22], there is a threat that traditional ecological knowledge connected with the care of fruit trees will fade away. Public awareness must be enhanced to attract younger people to adopt skills from people who still use them. Genetic stock preserved in the fruit trees of these orchards might serve as basis for organic agriculture and bio-food due to their resistance and resilience [23].

ACKNOWLEDGEMENT

The author would like to thank the local people who still have their memories on the fruit varieties and previous management regime of the orchard grasslands for their involvement and contribution to this study.

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Article submitted to the Proceedings Book of the VIth. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

RISK ASSESSMENT OF HEAVY METALS IN THE COMPLEX TERMINAL AQUIFER DATA FROM BISKRA, SOUTH-EST ALGERIA

Reghais Azzeddine*, Drouiche Abdelmalek, Zahi Faouzi, Debeiche Taha-Hocine

*Geological Engineering Laboratory (Lgg), University Of Mohamed Seddik Benyahia - Jijel, Algeria, *E-Mail: Selmahadef18000@Gmail.Com, Phone: 0783 085-766, Corresponding Author: a.reghais@univ-Jijel.dz*

Due to its availability in arid regions, groundwater is increasingly used for drinking water supply and irrigation. Unfortunately, human activities such as agriculture have substantially impacted water quality, rendering it unsuitable in some cases. This study aims to evaluate the level of heavy metal contamination in the groundwater of the Terminal Complex in the region of Biskra (south-east Algeria), which is considered a region with a strong agricultural vocation. Six heavy metals (Mn, Fe, Cu, Zn, Cr, and Pb) were analyzed by atomic absorption spectrometry (AAS) in 45 water samples collected in April 2019. The results obtained show the existence of water contamination by lead and chromium, with levels well above the World Health Organization (WHO) standard for respectively 29 and 10 boreholes for each element. As for the other elements, most of the boreholes show levels below the standards. The heavy metal contamination index (HPI) indicates a high risk (average HPI = 550), which means the groundwater is unfit for human consumption. In contrast, the geo-accumulation index (Igeo) of the analyzed elements is in the following order: Pb > Mn > Cu > Zn > Cr > Fe, with an average level below the specified background level, except for Pb. Its average values for all elements analyzed range from -0.79 to 1.47, implying some borings were clean and others moderately contaminated. On the other hand, the Pb Igeo shows that 35.56% of the wells are not polluted, and 2% are highly contaminated. While the Igeo of the other elements (Fe, Cu, Zn, and Cr) oscillates between the uncontaminated and moderately contaminated classes.

***Keywords**: Heavy Metal Pollution Index (HPI), geo-accumulation index (Igeo), Water quality Heavy metal Complex Termail aquifer, Biskra*

INTRODUCTION

Groundwater is a valuable source of drinking water, however maintaining its quality and availability has become currently one of the most important challenges to environmental sustainability [1]. Many regions in the world can no longer provide reliable and consistent water services, particularly in arid and semi-arid climates, due to demographic pressures, urbanization, and accelerating industrialization that are increasing water consumption at more than twice the rate of population growth [2]. At the same time, groundwater reserves and their quality have been greatly affected by overexploitation and inappropriate waste disposal [3], [4]. For this reason, water pollution monitoring and assessment have become an essential topic of research, and a serious ecological issue.

Heavy metals are among the most common environmental pollutants. Their presence in groundwater can originate from natural sources such as chemical weathering of minerals and soil leaching, or can be from anthropogenic sources mainly associated with industrial and domestic effluents, landfill leachates, coal and mineral mining, air pollution and agricultural activities [5], [6], [7], [8], [9]. Moreover, heavy metals in water can cause significant damage to the biological environment and human health (accumulation in specific tissues of the human body, notably the brain, liver, bones and kidneys) due to their unique properties such as toxicity and low biodegradability [10], [11], [12]. The region of Biskra in Algeria has become an agricultural pole for the production of dates, fruits and various vegetables, through agriculture development programs launched by Algeria over recent decades. This development has greatly influenced the future of groundwater quality in the region. Therefore, their protection is considered as one of the major challenges for the managers and decision makers of the Wilaya. The main objective of the present research was to assess the heavy metal contamination status of groundwater. Pollution indexes, such as Heavy metal Pollution Index (HPI) have been calculated to evaluate the overall groundwater quality. Furthermore, the Geo-accumulation Index (Igeo), has been calculated for the assessment of the anthropogenic fraction of Heavy Metal in the groundwater of Biskra region.

MATERIALS AND METHODS

Study area

The Biskra region is located about 400 km south-east of the Algerian capital (South-East Algeria) between 4°55'30" and 6°46'20" East longitude, and 34°17'00" and 35°17'00" North latitude, with an area of 10245.70 Km2 [13], it extends on the southern side of the Aurès massif, in the transition zone between the Saharan Atlas and the South Atlantic flexure (Figure 1).
According to the Biskra meteorological station (1974-2011), the study region is characterized by highly irregular average annual rainfall ranging from 31.9 mm in 1993 to 407.1 mm in 2009.
Temperatures are consistently above 20°C throughout the year, in winter the minimum temperature is 3°C, while in summer it is about 23°C and reaching 44°C in July and August [14]. According to the RGPH, the population in this region reached 770613 inhabitants in 2012, with forecasts of 891231 and 1023148 inhabitants for 2020 and 2030, respectively.

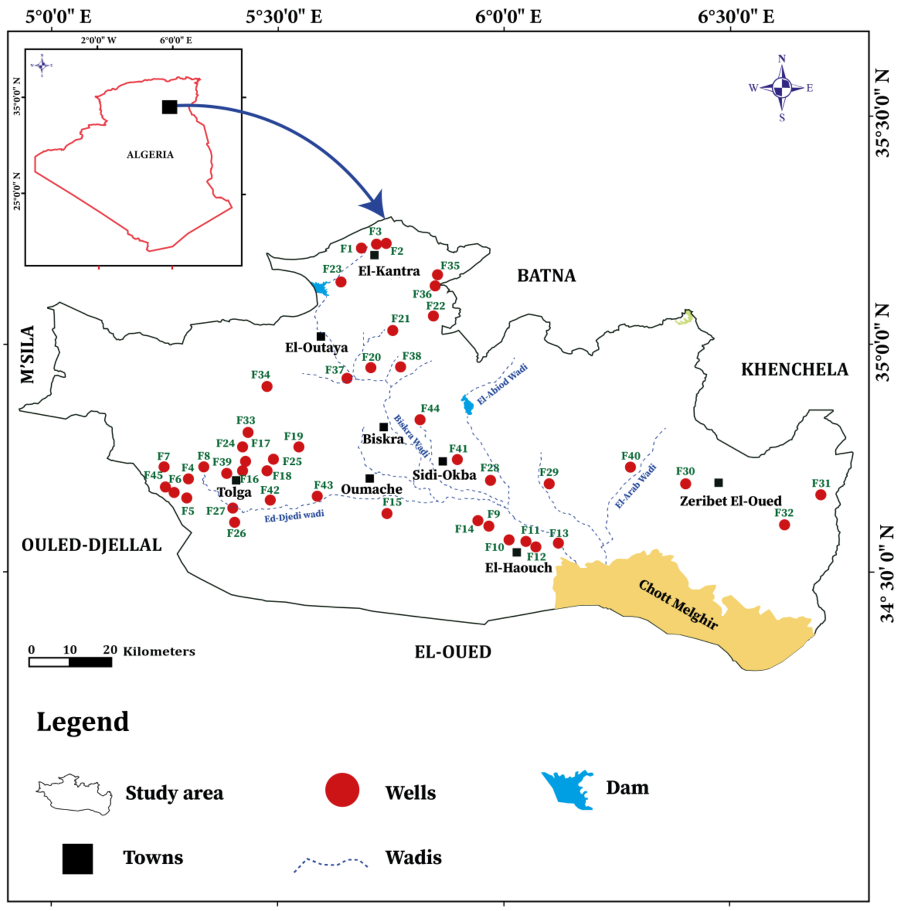

Figure 1. Location map of the study area

Geologically, the Biskra region represents a country of structural and sedimentary transition.In the North, it is a mountainous country, while in the South, it is a depressing country that is part of the Northern Sahara. The transition between these two distinct domains is made through an ensemble of

flexures, folds and faults of West-East orientation called "Saharan Flexure".The Saharan flexure developed during the paroxysmal Pliocene and post- Pliocene phase of the Auressurrection. This orogenic phase responsible for all major deformations of the entire Neogene continental (Mio-Pliocene).It is characterized by sedimentary terrain dating from the Quaternary at the summit to the Barremian at the base (Figure 1).
The wilaya of Biskra presents an important groundwater resource, represented by three aquifers which are respectively (i) the Quaternary phreatic aquifer (generally located in the alluvial accumulations); (ii) the aquifer of the Terminal Complex, which consists of two aquifer units: (1) the Mio-Pliocene sand aquifer (formed by alternating levels of clay, sand and pebbles of Mio-Pliocene age) and (2) the Lower Eocene and Senonian limestone aquifer (consisting mainly of fissured limestone of Lower Eocene age); (iii) and the Intercalary continental sandstone aquifer (This is a very important reservoir made up essentially of sandstone and marl of Albian and Barremian age).
The Biskra region has a strong hydro-agricultural potential with vast agricultural plains (El-Ghrous, Tolga, El Outaya, Zrebet El Oued) with a surface area of about 1652751 ha, i.e. about 77% of the surface area of the wilaya of Biskra [15]. The region has a total water supply over 1017 million m^3 , of which surface water accounts for 22 million m^3 (2.16%) and groundwater for 995 million m^3 [15], [16].

Sampling method

Groundwater samples were collected from 45 well-distributed boreholes in the Biskra region (April 2019) using a portable global positioning system (GPS), in clean, sterile 200 mL glass bottles that were immersed overnight in a 5% HNO_3 solution and rinsed with demineralized water. According to the sampling protocols, the sample bottles were sealed, labelled, transported and analyzed for six heavy metals [17], [18].
Parameters such as temperature, pH, electrical conductivity (EC) and total dissolved solids (TDS) electrical conductivity, pH/Eh and water temperature (T) were measured in the field using multiparameters (HANNA Instruments, model: HI 9143). While, Heavy metals were analyzed using an atomic absorption spectrophotometer (AAS) (model: Pinaacle 900T, WinLab32 software for AAS) at the Scientific and Technical Research Centre for Arid Regions (CRSTRA), Biskra, Algeria.

Assessment of groundwater contamination

The present study was designed to assess groundwater quality in the Biskra region in order to better understand groundwater pollution degrees, using various criteria and pollution indexes such as the Heavy Pollution Index (HPI) and the Geo-accumulation Index (Igeo). These indices make it possible to quantify the impact of heavy metals on water quality and to identify the potential sources of their contamination.

Heavy pollution index(HPI)

The heavy metal pollution index (HPI) method was created by assigning a score or weighting (W_i) to each parameter and choosing the pollution parameter on which the index would be based, as well as determining the groundwater parameter upon which the index should be constructed. The placement of each water quality measure indicates its importance, ranging from almost zero to one (0-1).
The suggested standard (S_i) for each parameter can be inversely proportional to that parameter [19].
For this study, the WHO standard [20] was used to determine the concentration limits, i.e. the highest permissible value for drinking water (S_i) and the maximum desirable value (I_i) for each parameter. The highest permissive value (S_i) refers to the maximum acceptable concentration in drinking water, while the maximum desirable value (I_i) indicates the standard limits for the same parameters in drinking water (I_i).
The HPI is calculated according to the formula (1) of VenkataMohan et al. [19].

$$HPI = \frac{\sum_{i=1}^{n} W_i * Q_i}{\sum_{i=1}^{n} W_i} \quad \textbf{(1)}$$

Where; Q_i is the sub-index of the Iithparameter, W_i is the unit weight of the I_i^{th} parameter, and n is the number of parameters used in the calculation. Q_i was determined using the followingequation (2):

$$Q_i = \sum_{i=1}^{n} \frac{|M_i - I_i|}{S_i - I_i} * 100 \qquad \textbf{(2)}$$

Where; M_i denotes the monitored heavy metal and I_i and S_i denote the ideal and standard values for the i^{th} parameter, respectively. The negative algebraic sign was ignored in the difference . The I_i values came from the metals' MAC values, and the Si values were derived from the WHO standard values [20].

Geo-accumulation index (Igeo)

The geo-accumulation index (Igeo) was proposed by Muller [21] and has been largely used in the evaluation of the heavy metal pollution. It reveals the relationship between heavy metals in sediments and geochemical background values. The Igeo value is described as follows equation (3):

$$I_{geo} = log_2 \left[\frac{C_n}{1.5 * B_n} \right] \qquad \textbf{(3)}$$

Where C_n is the observed total concentration of metals in groundwater samples (Ug/L), $B_n$is the geochemical background values of metals (Ug/L), and 1.5 is the lithogenic effects background matrix adjustment factor.
In this study, an isolated sample, far from any industrial or agricultural influences, was chosen as a geochemical background value, the concentration of metals (ppb) at the reference sample in this paper were: Pb (10), Mn (18), Cr (28), Zn (16), Zn (16), Cu (20) and Fe (40). The Igeo scale has seven levels (0-6) ranging from uncontaminated to heavily contaminated (Table 1).

Table 1. Geo-accumulation index classes

Index classes	Igeo values	Level of contamination classification
0	Igeo< 0	Uncontaminated
1	0 <Igeo< 1	Uncontaminated to moderately contaminated
2	1 <Igeo< 2	Moderately contaminated
3	2 <Igeo< 3	Moderately to heavily (strongly) contaminated
4	3 <Igeo< 4	Heavily (strongly) contaminated
5	4 <Igeo< 5	Heavily (strongly) to extremely contaminated
6	Igeo> 5	Extremely contaminated

STATISTICAL ANALYSIS

Hierarchical cluster analysis (HCA) was used to detect spatial similarities of the analyzed elements in water samples for six heavy metal parameters measured (R-mode) with Ward's method and the Euclidean distance as a measure of similarity using the XLSTAT plug-in (Version 2014.5.03).

RESULTS AND DISCUSSION

Statistical summary

Temperature, pH, electrical conductivity, total dissolved solids, and heavy metal concentrations in groundwater samples collected are summarized in Table 2. The pH values in the research region do not differ significantly from one another (SD =0.20). The pH of the groundwater samples ranged from 6.67 to 7.79, with a mean of 7.21 indicating neutral milieu.
According to World Health Organization (WHO) [20], all the water samples showed pH values within the permissible limit of 6.5 to 8.5. Also, noting that high pH values favor the precipitation of metals by forming insoluble carbonates. Alkaline pH also accelerates the adsorption process of some metals, such as Zn and Cu, and plays a prominent role in the precipitation of Pb [22], [23]. The water samples' electrical conductivity (EC) ranges from 600 to 10360 µS/cm. 64.44% of the water samples have an electrical conductivity exceeding the limit authorized by the WHO (2800 µS/cm), indicating charged water. The TDS varies from 455 to 7635 mg/l, it increases from the north (El-Kantra zone) considered

as a recharge zone to the south (discharge zone) because of the time of interaction water-rock relatively long. Heavy metal concentrations below WHO standards were recorded for zinc (Zn), copper (Cu), and iron (Fe) at all sampled wells. On the other hand, lead (Pb), manganese (Mn), and chromium (Cr) exceeded the WHO maximum recommended values in respectively 30, 10, and 2 wells (Table 2).

Table 2: Statistics of the concentrations of various heavy metals in the Biskra region

Parameters	TDS	PH	T	EC	Fe	Cu	Zn	Cr	Mn	Pb
	mg/l		°C	*µS/cm*			*µg/l*			
Drinking guidelines[a]	1500	6.5-8.5	25	2800	300	2000	5000	50	50	10
N° Wells exceeding tolerable limits	39	0	18	29	0	0	0	2	10	30
% Wells exceeding tolerable limits	86.66	0	40	64.44	0	0	0	4.44	22.22	66.66

Drinking guidelines [a] *: The World Health Organization (WHO) standard 2006*

The highest concentrations of manganese (Mn), and chromium (Cr) were recorded in wells W43, and W35 could indicate a geological origin of weathering rather than an anthropogenic contribution. The wells sampled in the El-Kantra region presented the highest Pb concentrations (4.46 mg/L as the maximum content), this can be explained by the weathering of natural lead carbonates ($PbCO_3$).
Wells located in the Tolga oasis area in the west of the Biskra region and the agricultural areas in the east (Zeribet El-Oued and SidiOkba) also have high levels of lead, this is due to the use of fertilizers and pesticides containing lead (Endosulfan, Aldrin, Deieldrin, etc.) for agriculture [24].
Figure 2 shows the average concentrations of six heavy metals and their standard deviation for all wells. Overall, the highest average concentrations recorded per element were 0.077 ± 0.087 for Pb, 0.026 ± 0.024 for Mn, 0.01 ± 0.014 for Cr, 0.033 ± 0.027 for Fe, 0.01 ± 0.013 for Cu and 0.006 ± 0.018 for Zn.

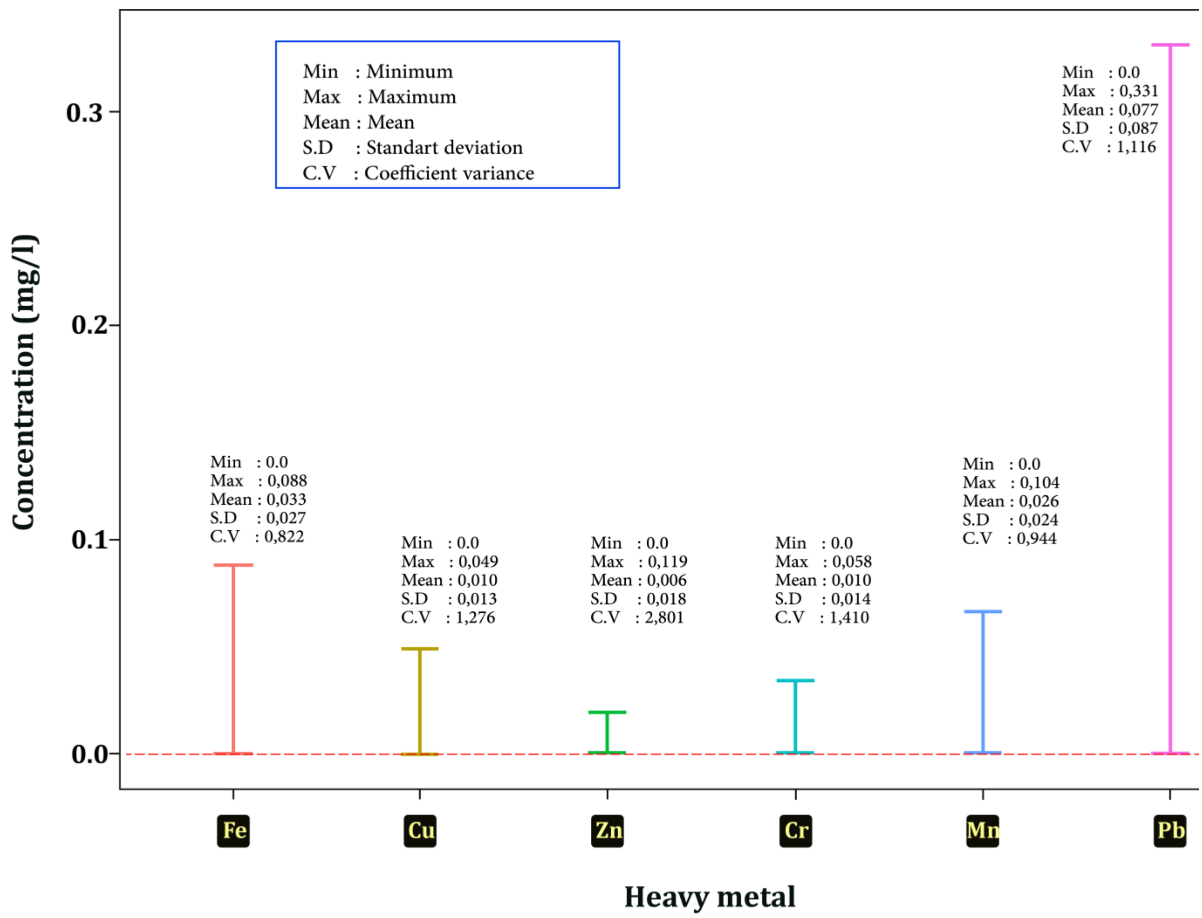

Figure 2. Average values of heavy metals content in the groundwater of Biskra region

Heavy metal pollution index (HPI)

The HPI was calculated from the average concentration values and WHO standards [20]. The HPI classification below from Ghaderpoori et al. was used [25].

- <100 Low risk
- 100 Threshold risk
- >100 High risk water that cannot be used for drinking.

HPI values for six heavy metals in 45 groundwater samples collected in the study area range from 2.73 to 220.98, with an average concentration of 535.49 (Figure 3).

The limit value of 100 is exceeded in 67.66% of the groundwater samples, indicating that they are not suitable for human consumption.

The most contaminated wells are in the regions of El-Kantra and Ain Zaatout at the extreme north (F1-F3 and F36), in the Chott region at the extreme south (F10, F11, F13 and F14) and in the Oasis region at the extreme west (F4-F8, F24-F26, F33, F42 and F43), in the Outaya region (F37 and F38) and in the eastern zone at Zeribet El-Oued (F31 and F32).

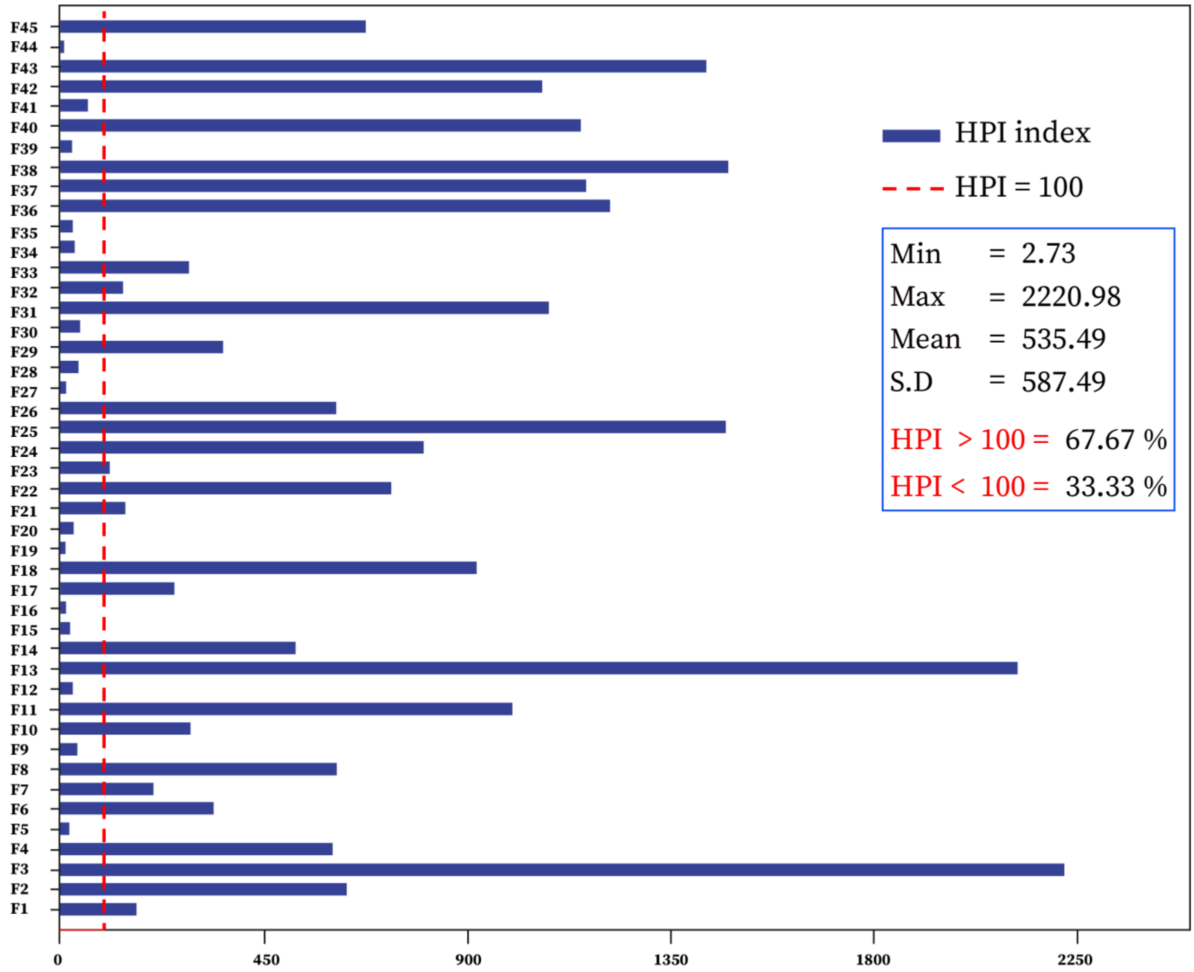

Figure 3. Graphic representation of the heavy metal pollution index (HPI

The geo-accumulation index (Igeo)

Table 3 summarizes the calculated geo-accumulation index (Igeo) for heavy metals in the groundwater samples; the I-geo ranges from -5.90 to 4.46. It is ordered as follows: $I_{geo}Pb > I_{geo}Mn > I_{geo}Cu > I_{geo}Zn > I_{geo}Cr > I_{geo}Fe$.

Table 3. Geo-accumulataionstatistic

	Geo-accumulation index					
	$Igeo_{Fe}$	$Igeo_{Cu}$	$Igeo_{Zn}$	$Igeo_{Cr}$	$Igeo_{Mn}$	$Igeo_{Pb}$
Min	-5.90	-3.90	-4.58	-5.39	-4.75	1.22
Max	0.55	0.70	2.30	0.46	1.94	4.46
Mean	-0.79	-0.37	-0.57	-0.77	-0.24	1.46
S.D	1.38	0.87	1.20	1.21	1.22	1.92

The graphical representation of the Igeo (Figure 4) shows that the majority of the wells are in the practically uncontaminated class for the metals Fe, Zn, Cu, and Cr. However, the Igeo for Pb and Mn in the groundwater samples ranged from -3.90 - 4.46 and -4.75 - 1.94, respectively, indicating uncontaminated to highly contaminated levels for Pb and uncontaminated to moderately contaminated for Mn.

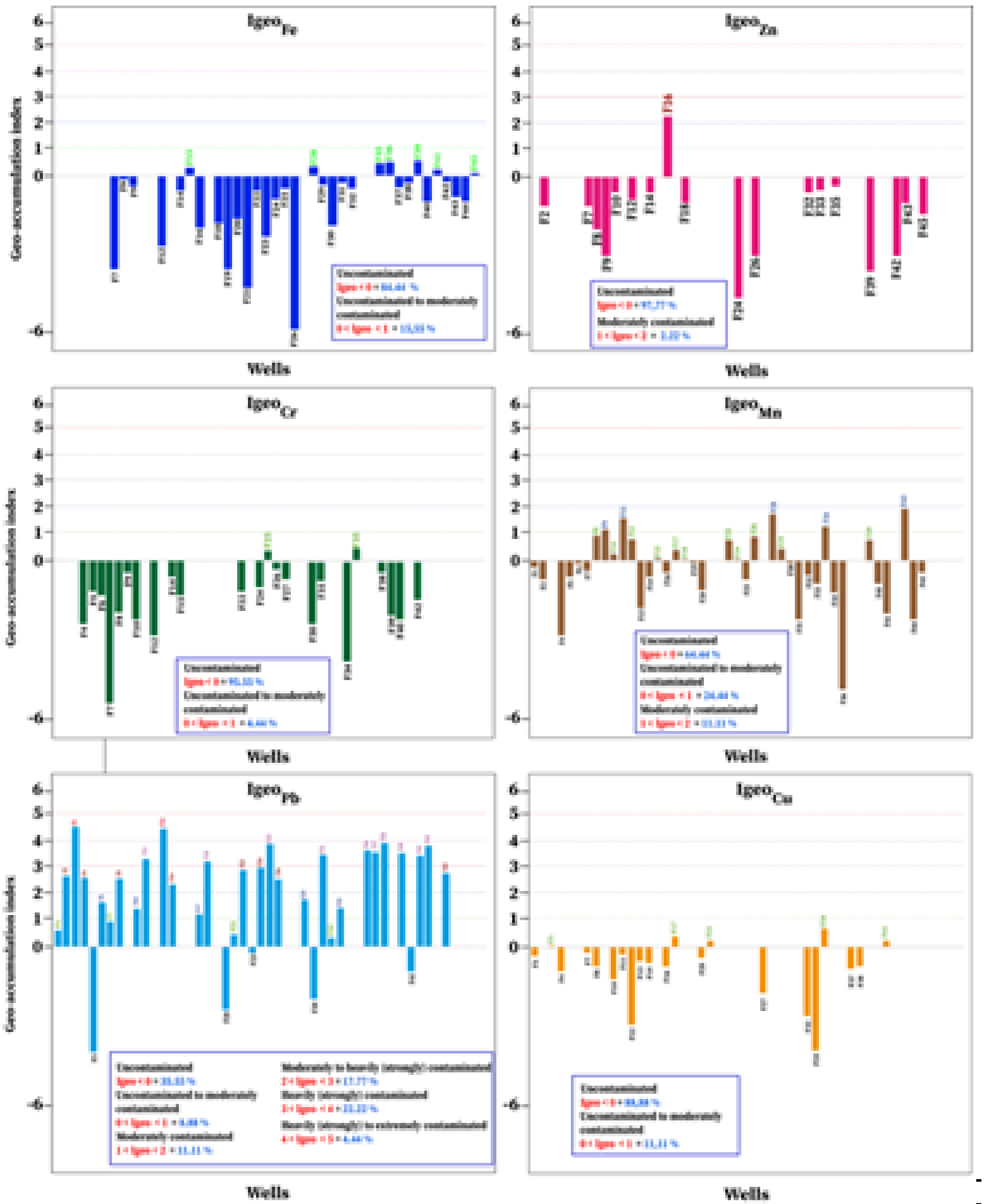

Figure 4. Igeo values of heavy metals in the groundwater of Biskra region

Hierarchical cluster analysis (HCA)

CA is applied to the mean values of heavy metals by using Ward's method and Euclidean distance as a measure of similarity (Figure 5).This cluster analysis (CA) permitted the division of heavy metals into two main groups: Group I (Pb, Fe and Cr), and Group II (Mn, Cu and Zn). From the results of the CA, it was found that Pb and Fe have similar sources of origin, while Cu and Zn have similar sources of origin.

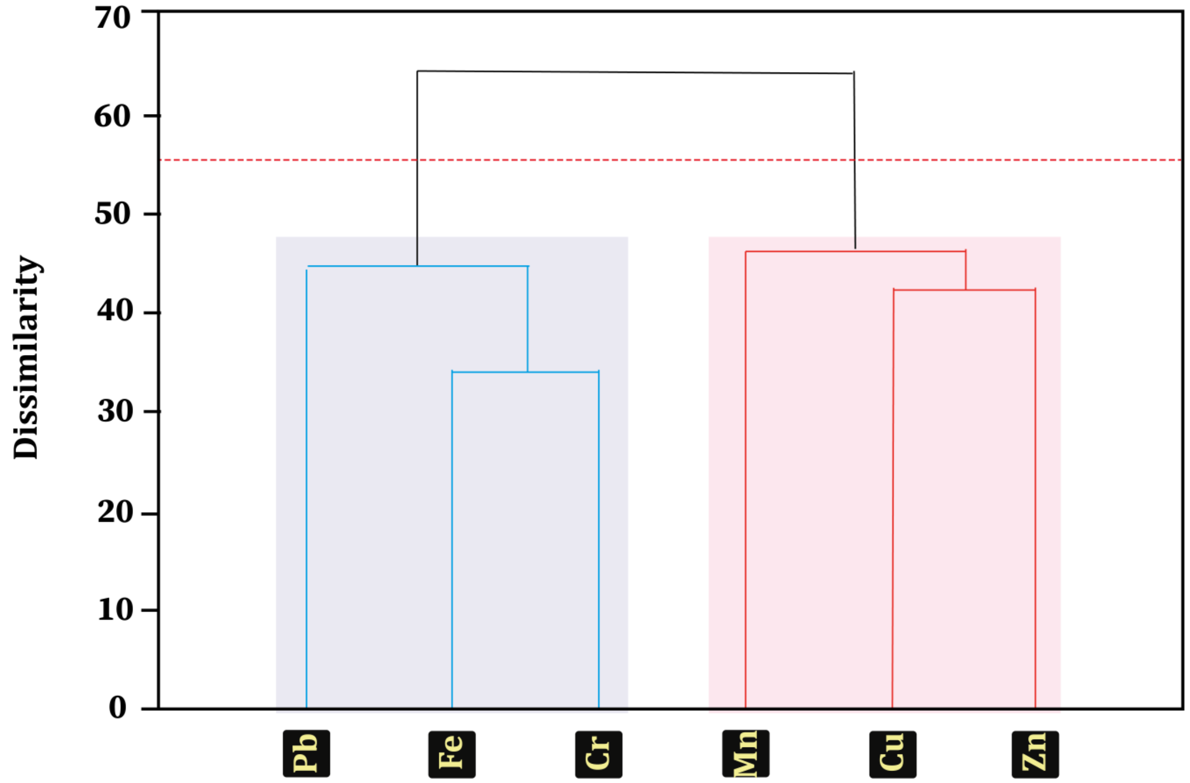

Figure 5. Cluster analysis of heavy metals in groundwater

CONCLUSION

In this study, the analytical results of the physiochemical parameters of the groundwater indicate that the concentrations of heavy metals in the water samples are within the limits authorized by the WHO (2006) for drinking water. Two metals of them (Pb and Mn) were detected in several wells above the permitted limits. According to the Igeo pollution assessment index classification, the majority of the samples reveal a null to moderate pollution level in the study area. However, the Heavy Metal Pollution Index (HPI) revealed that the threshold 100 was exceeded in 67.66% of the groundwater samples, indicating that they are unfit for consumption. The HPI and Igeo indices developed in this paper indicated that lead and manganese are at significant risk of toxicity in groundwater in the study area. The results of this research will be useful to policy makers in developing strategies to attenuate heavy metal pollution problems.

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IMPACTS OF MOLE ACTIVITIES ON SOIL PROPERTIES

Csaba CENTERI[1*], Viktória VONA[2], Márton VONA[2], Zsolt BIRÓ[3]

[1*]*Department of Nature Conservation and Landscape Management, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary, Centeri.Csaba@uni-mate.hu, +36-30-202-7336,* [2]*Csernozjom Ltd., Nagykörű, Hungary, vona.viktoria@csernozjom.com, vona.marton@csernozjom.com,* [3]*Department of Wildlife Biology and Management, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary, biro.zsolt@uni-mate.hu*

Biological activity is one of the main actors of soil formation. The purpose of the present paper is to provide information on mole activities on soil properties. The hypothesis is that soil properties in molehills differ from the intact areas, serving as controls nearby these molehills. The question is what we can learn from these molehills in relation to one of the most important issues nowadays: soil organic carbon and its sequestration. The present paper is providing an additional explanatory view on wildlife impacts on soil in natural areas, supporting the former researches on wildboar rootings. The molehills and the nearby, intact, control areas were compared. The areas in question were forests and grasslands. The surface of the molehills and the nearby soils were measured with a Near Infrared Device of Agrocares Ltd. (Nl), measuring soil organic matter, pH, N, P, K, Ca, Al, Fe, clay and soil moisture. The results show that there are measurable differences in some of the soil parameters, e.g. on a forested sampling site the soil organic matter content is higher in the control areas (control 7,1%, molehill 4,9%), phosphorous content is higher in the molehill (32,83 mg/kg in the molehill, 19,96 mg/kg in the control), potentially mineralizable nitrogen content is higher in the control (95,53 g/kg in the molehill and 169,33 g/kg in the control). We can conclude that there are measurable effects of mole activities on the soils' parameters and these differences can further explain soil formation processes and vegetation as well.

***Keywords**: molehill, nutrients, pH, soil formation, wildlife effects*

INTRODUCTION

The continuous growth of the number of humans, causing an increase in the number of anthropogenic effects, including soil sealing (road and building constructions) leads to the decrease in available non-urban and non-man-made environment, regardless of being natural or under human use (e.g. agriculture). This reduction of available land surfaces leads to an increasing number of conflicts between different stakeholders (landowners, land users, forestry, hunters, etc.). One of the conflicts is the effect of wildlife that being tremendous is often considered as damage and not as an effect. This is why it is of utmost importance to find appropriate indicators to evaluate the effect of wildlife on the area where they live. The effect of wild boar is widely known and frequently discussed [1] but other vertebrates might also cause a visible surface disturbance. The mole (*Talpa europea*) is one of these vertebrates and is often considered inconvenient [2], mainly in urban areas, more than that, in private lawns.

The main question is how these mole burrows change the characteristics of the soils where they act, as, similarly to wild boar, these animals have been here for thousands of years and play a crucial role in the ecosystem, and the formation of our soils. So, in non-urban areas, we can investigate how big is their effects and what do these effects might mean to the local soil conditions and for the local species of plants.

The Google Scholar, where we can search for scientific articles found only 10 hits on the following search inputs: "Talpa europea"+"mound"+"soil"+"pH" and even with the removal of “pH” there is still only 34 hits. So, we can conclude that the subject is not deeply investigated and is worth further analysis. One of the publications that published measured soil parameter results on the effects of soil-disturbing vertebrates is by Platt et al. [3], who investigated the publication trends in the soil-disturbing vertebrates’ literature with emphasis on physical and chemical properties of soil.
Our null hypothesis was that there are differences in the magnitude of some soil characteristics (pH (H_2O), carbon content, total N, P, exchangeable K, Ca and Mg, CEC (Cation Exchange Capacity), total Al and Fe). Furthermore, our assumption was that, since the mole is bringing up soil materials from the deeper horizons where the examined parameters are normally having less amounts, the mixing effect of the mole results in lower amounts of nutrients, higher pH (by bringing up materials from limy area) and CEC.

MATERIALS AND METHODS

The situation of the study sites

The dry, mesic oak forest is situated in Babat-valley, Gödöllő Hillside [4-6] near the city of Gödöllő (Figure 1) while the beech forest is located at the eastern edge of the Bükk Mountains [5,7], near to the village of Lillafüred (Figure 2).

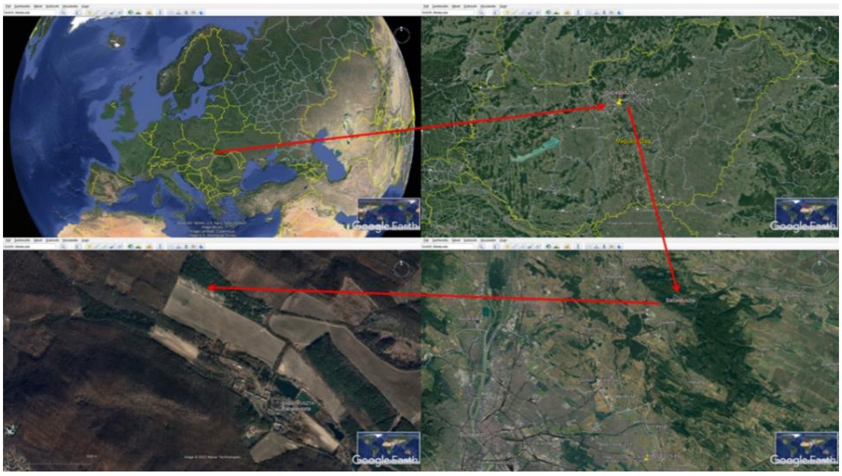

Figure 1. Situation of the sampling sites of the mole burrows in the Babat Valley (Source: Google Earth)

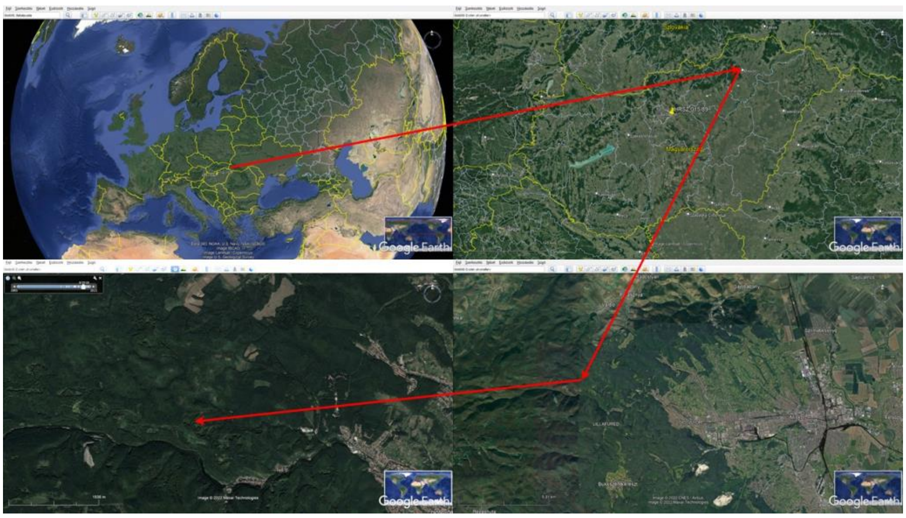

Figure 2. Situation of the sampling sites of the mole burrows in the Bükk Plato (Source: Google Earth)

General geographical description of the examined area close to Gödöllő

The Gödöllő Hillside is surrounded by the Pest plain to the west, the Danube-Tisza sand dune region to the south, the Cserhát Mountain to the north and the alluvial plain of the Northern Great Plain to the east. The majority of the Gödöllő Hillside is a landscape protection area.

Based on basic geographical conditions, this region is a transitional zone between the Great Plain and the Northern Central Mountains. Due to its transitional nature, a special mesoclimate was created here, which provided an opportunity for the development of unique vegetation. Hornbeam (*Carpinus betulus*) mixed with field maple-oak and small-leaved linden (*Tilia cordata*)-oak forests are known here. These forests are the representatives of the cool continental forest-steppe vegetation in Hungary [5].

Areas that are higher than 200 m or in the northern region have a cool to a moderately dry climate, while other areas have a moderately warm dry climate. The number of sunny hours per year is around 1950. The average annual temperature is 9.5–9.7 °C in the north and 9.7–10.0°C in the south. The frost-free period is 186–190 days in the east and 195 in the south. The average maximum temperature in summer is 32.5–33.0 °C, and the average minimum temperature in winter is -16°C. The annual rainfall is between 540–580 mm. The average number of days covered by snow is 36–40, with a maximum snow thickness of 22 cm [5].

Looking at the vegetation cover, the overall picture is characterized by a vivid mosaic of different forest associations [4]. Forests occupy the largest part of its territory, it is 39.1% of the hills, which means 19970 ha, followed by arable land, which makes up 38.9% of the region, which is 19859.6 ha [6]. The hill stretches from Budapest to the East and extends to the Galga River. Its highest point is Margita (345 m). Its standing waters are Lake Naplás, Veresegyházi, Babatpuszta and Isaszeg lakes. There is also a forest reserve within the district, which consists of two areas; the core area and the protection zone. The core area is highly protected, while the protection zone is accessible. The Nagy-Istrázsa-hegy forest reserve was declared as one of the 63 reserves by the Minister of the Environment in 2000 [5].

General geographical description of the Bükk sample site

The area belongs to the Bükk Plato micro-region between 425 and 959 m a.s.l. It is an area with cool-wet climate. The number of sunny hours per year is around 1900 to 1950. The average annual temperature is approximately 6 °C. The frost-free period is 160 days but can be shorter on higher grounds. The average maximum temperature in summer is 26–28 °C, and the average minimum temperature in winter is -16– -18 °C. The annual rainfall is 800 mm. The average number of days covered by snow is 80–100, with an average maximum snow thickness of 50 cm [5].

The vegetation is mainly characterized by montane beech forests. Large areas are covered by relicts of Tilio-Fraxinetum excelsioris of the cool-continental climate on rocky surfaces. On southern slopes there are rocky grasslands. There are some endemic species, such as the *Hesperis matronalis* subsp. *vrabelyiana* and *Sesleria hungarica*.

FIELD MEASUREMENTS OF MOLE BURROWS

Five fresh mole burrows were examined in the Babat Valley (Figure 3) and 3 burrows were examined in the Bükk Mountain site (Figure 4). Five and three control (nearby each mound, as close as possible, only a few cm away) spots were also examined. After removing the dry, 2-3 cm thick surface layer, a Near Infrared (NIR) device was used on-site. Soil chemical characteristics pH (H_2O), carbon content, total N, P, exchangeable K, Ca and Mg, CEC (Cation Exchange Capacity), total Al and Fe are the parameters that we can measure with the device. NIR spectrometer is using a wavelength range of 1300–2600nm (MEMS technology). It is produced by the AgroCares company and works with the SoilCares mobile application. The burrows of Babat Valley were in a peaty, forested area, alongside the border of a small, approximately 10-15 m^2 pond that had no water surface at the time of the measurements (it was not dry, the soil moisture content was high) but it is normally having some surface water and thus favored by wild boar.

Figure 3. Nine mole burrows in a row along the edge of a small pond in an *Alnus glutinosa* dominated forest in Babat Valley, nearby Gödöllő (Photo: Cs. Centeri)

There were also older mole burrows on the other side of the pond. Those were drier and more eroded, so it was obvious that they are not fresh. The burrows of the Bükk Plato were nearby the Lilla Cave, just outside of the dolina where the cave's entrance is situated (Figure 4).

Figure 4. Soil analyses with a NIR (Near Infrared) device in the beech forest of the Bükk Plato (Photo: Cs. Centeri)

STATISTICAL ANALYSIS

The Shapiro-Wilk test was used to test the normality of the data. If data had normal distribution, an independent two sample t test was performed for checking equality of means. The Levene test was used to check the equality of variances. In case of the non-normal distribution of the data, the Mann-Whitney U-test was used.

RESULTS AND DISCUSSION

Results of the analyses of the mole burrows and the controls of the Babat Valley
According to the Shapiro-Wilk test, all data but the amount of K had normal distribution. Based on the t test, the pH, the Fe and the clay content are similar in the burrows and in the control areas, while carbon content, total N, P, Ca and Mg, CEC, total Al show significant differences between the control and the burrows. In case of the K content, there are significant differences between the burrows and the control areas (U=25; n1=n2=5; p=0.08). These results prove our null hypotheses about the differences.

Results of the analyses of the mole burrows and the controls of the Bükk Plato
The pH was similar in all cases, so it was not included in the analyses. The following parameters had normal distribution: SOM, P, N, K, Ca, CEC, potentially mineralizable N, total Al and Fe.
There were significant differences between the burrows and controls in case of SOM, P, total N and potentially mineralizable N. These results also prove our null hypotheses about the differences.
In case of the Mg (U=5; n1=n2=3; p=1) and clay (U=9; n1=n2=3; p=0,1) there were no significant differences.

Results of the comparison of the mole burrows of the Babat Valley and the Bükk Plato
The K and the clay had non-normal distribution, so the Mann-Whitney U-test was used and proved that there are significant differences between the sites and there are bigger amounts in the Bükk Plato (K: U=15; n1=5; n2=3; p=0.036, clay: U=15; n1=5; n2=3; p=0:036). These results also prove our null hypotheses about the differences.
The other data showed normal distribution, so according to the t test, there are significant differences between the burrows and the control area in case of the P, Al and Fe, and there are bigger amounts in the Bükk Plato area. These results also prove our null hypotheses about the differences.

Results of the comparison of all the mole burrows with all the controls of the Babat Valley and the Bükk Plato
According to the Shapiro-Wilk test, the values of K, Al, Fe and clay had non-normal distribution and there were no significant differences between the burrows and the controls (K: U=48.5; n1=n2=8; p=0.083, clay: U=44.5; n1=n2=8; p=0.195, Al: U=24; n1=n2=8; p=0.442 and Fe: U=38.5; n1=n2=8; p=0.505).
In case of SOM, P, N, Ca, CEC and potentially mineralizable N, there were significant differences between the burrows and the control areas (SOM p=0.014, N p=0.008, Ca p=0.018, Mg p=0.006, potentially mineralizable N p=0.01, CEC p=0.006). These latter results also prove our null hypotheses about the differences.

CONCLUSIONS AND RECOMMENDATIONS

Our null hypothesis was that there are differences in the soil of the mole burrows and the nearby control areas. This hypothesis was well-proved, based on these analyses.
It is interesting however, that not all the parameters and not in all the cases show significant differences. On the other hand, increasing or decreasing trend in favor of either the burrows or the controls were not the case in all the measured parameters, e.g. SOM, total N, Ca, Potentially Mineralizable N and CEC are bigger in the control, while P is bigger in the burrows. We can conclude that further investigation of different soil types (or soil characteristics, e.g. clayey versus sandy soils or humus-rich versus humus-poor soils) or geographical regions with different parent rocks can

provide further insight on the mole activities and their effects on soil parameters. This way the effects of soil disturbing vertebrates on soil formation can be understood better.

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ASSESSMENT OF SURFACE WATER QUALITY OF THE KEBIR-RHUMEL WADI (NORTH- EAST, ALGERIA)

***Fouzia* HIZIR[1], A. KRIKA[2], F. KESSASRA[1]**

[1]Geological Engineering Laboratory (LGG), University of Mohamed Seddik Benyahia, Jijel, Algeria, [2]Laboratory of Biotechnology, Environment and Health, University of Mohamed SeddikBenyahia, Jijel, Algeria, e-mail: aminajijel18000@gmail.com, Phone: 0790 18 14 56

Water quality is an important factor for health and safety issues associated with public health and also for aquatic life. The Kebir-Rhumel Wadi, one of the longest and most important Wadis in the east of Algeria and indiscriminate discharge of various types of effluents from different industries and domestic sewage entering this wadi leads to heavy pollution, which can produce detrimental effects on water quality, agriculture, and in the long run to human beings. During this study, the spatial variations of physico-chemical parameters of water such as : pH, EC, NO_3, NO_2, NH_4, DCO and DBO_5, were investigated to assess their effects on health of this aquatic ecosystem influenced by anthropogenic activities. Results show that there are significant variations of physico-chemical parameters of water among the sampling sites and the levels of all investigated parameters were above the limits specified by relevant regulation, except for pH, EC and NO_3, which were in accordance with the limits decreed by Algerian standard. The values of DCO/DBO_5 ratio ranged between 3.61 and 34.85 indicates a predominance of non-biodegradable organic matter, reflecting the influence of the wastewater discharges (industrial and agricultural) rejected directly, without prior treatment into the wadi

***Keywords**: Algeria, Kebir-Rhumelwadi, physico-chemical parameters, water quality.*

INTRODUCTION

Water is a vital and fundamental source for all living beings and also for the development of a country in different fields but it has also become the most threatened by human activities [1, 2]. On our planet there are 13600 million km^3 and only 0.014% of the freshwater usable by humans in the form of surface water [3, 4]. In Algeria, the exploitation of these resources is done in an intensive way with the growing needs related to the demographic growth and the socio-economic development [5] and the principal cause of the deterioration ofthese resources coming from the agricultural activities, industrial and domestic effluents rejected in the receiving environment without treatment [4]. Among the watercourses of north-eastern Algeria, the Kébir-Rhumelwadi are of great importance given its flow, its socio-economic impact on the region and its vulnerability to pollution problems (industrial waste, domestic wastewater, agricultural water, etc.) [6].
The aim of our study is to evaluate the water quality of Kebir-RhumelWadi. This study envisaged a physico-chemical characterization to highlight several parameters that come into play in determining the quality of this water such as: pH, conductivity, nitrate and others parameters.

MATERIAL AND METHODS

Study area

The catchment area of Kebir-Rhumel is one of the large hydrographic basins in Algeria, it is subdivided into 7 sub-basins with an area of 8815 km^2, having a maritime facade of about 7 km. it extends from the Seybouse catchment area in the East, to the Setifian Highlands in the West (36° of North latitude, 7° of East longitude) The basin is limited:

- To the North by the two coastal basins Constantinois West and Center, to the South, the basin of the Constantinois Highlands and to the West the basins of the Algerois-Hodna-Soummam and to the East the basin of the Seybouse [7].

The Kebir-Rhumel basin is subdivided into three major parts:

-The upper basin or domain of the high plains, which corresponds to the Rhumel Wadiand its tributaries. The middle basin or tell South, which corresponds to Endja and Rhumel wadi from downstream Constantine to their confluence around Sidi Marouane ;

-The lower basin or tell North, which corresponds to the Oued Kebir, after the confluence of the Endja and Rhumel Wadi.

In this investigation, we are interested in the Kebir-Rhumel wadi considered as the most important watercourse of the Kébir-Rhumel watershed and of the North-East of Algeria (Figure 1).208 km long, it originates in the high plains of Sétif (the region of Bellaa wilaya of Sétif). It occupies the upstream and downstream part of the catchment area of Kebir-Rhumel and flows into the sea. Its waters are used for drinking water supply, industry and irrigation.

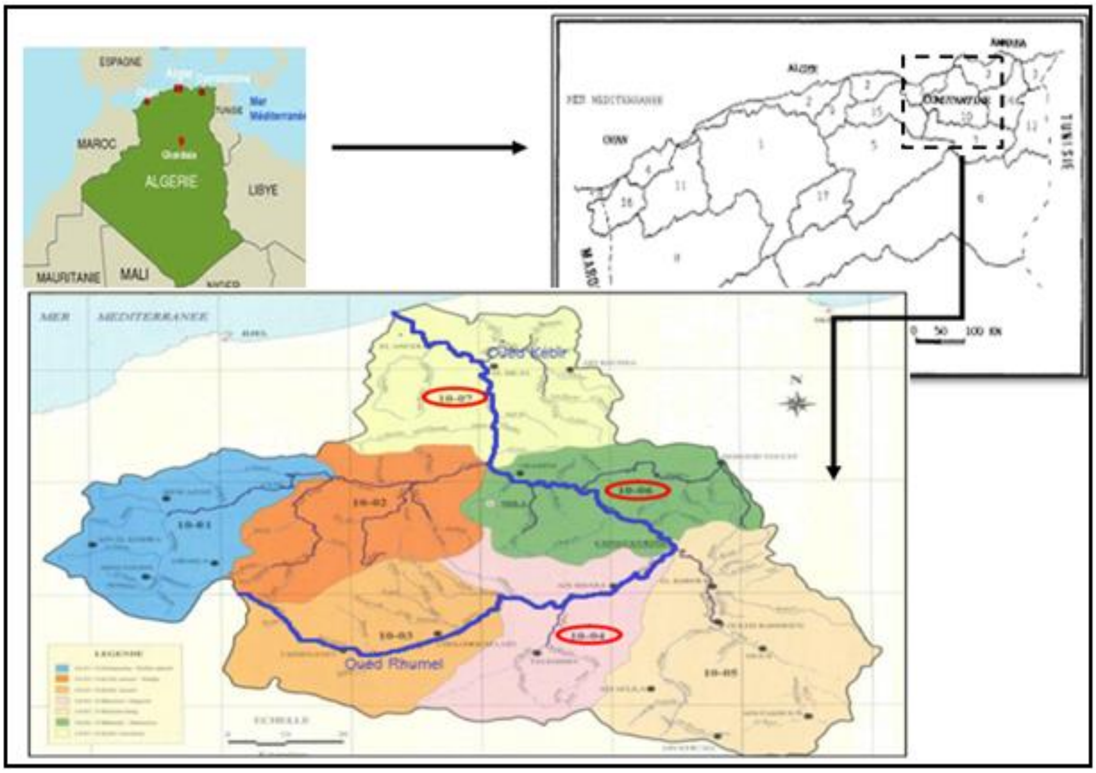

Figure 1. Study area localisation.

It is drained several very different geological and hydrogeological domains and it goes without saying that this heterogeneity of the watershed causes different influences on the regime of the watercourses together with those due to the distribution of precipitation so it is characterized by 5 major geological and hydrogeological domains which are:

- The domain of the Southern High Plains of Constantine;
- The Neogene basin of Constantine-Mila;
- The domain of the tectonic "nappes" of Djemila;
- The domain of the Kabyle ridge and the Numidian sandstone massif;
- The domain of the granitic and crystallophyllic basement of the small Kabylie of El Milia.

The Wadi Kebir-Rhumel is crossed two different bioclimatic zones: the semi-arid for the two regions of Constantine and Mila and a wet stage for the region of Jijel [8] and this annualprecipitation increases from upstream to downstream with a ratio that can go from simple to double [9].

The study area has recently experienced a large population explosion accompanied by an expansion difficult to control the urban fabric anarchic, industrial and agricultural activities. The latter are the main sources of various liquid and solid discharges that are discharged directly without any control in the wadi and subsequently affect the water quality of the wadi and human health [8].

ANALYRICAL METHODS

To estimate the impact of organic pollution of the waters of Wadi Kebir-Rhumel, eight sampling stations was selected (Figure 2). The water samples were taken in July 2020 in polyethylene bottles previously rinsed with water from the station and are clearly identified and accompanied by sufficient information about the nature of the sample and the reasons for which the examination is carried out and transported in a cooler with a temperature of 4C °.
The estimation of the pollution is evaluated by the determination of pH (pH meter), electrical conductivity (conductivity meter), the contents of the biochemical oxygen for 5 days (BOD_5, BOD meter), the chemical oxygen demand (COD at the Oxidation by potassium dichromate ($K_2Cr_2O_7$)) (Buhungu, 2018) and the concentration of nutrients: Ammonia nitrogen, nitrite and nitrate by applying the molecular absorption spectrophotometry method of analysis [10].

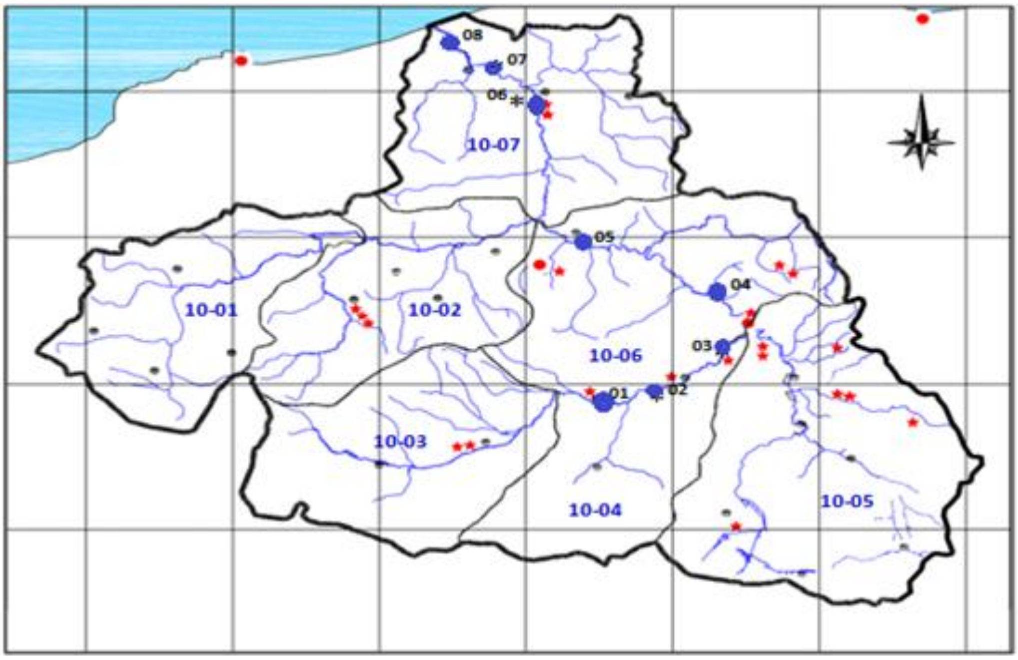

Figure 2. Location of sampling points

RESULTS AND DISCUSSION

Electrical conductivity (EC)

Conductivity is the opposite of resistivity and is related to the concentration of dissolved substances in water. It gives an idea of the general mineralization of the water and depends on the nature of the dissolved salts and the temperature of the water. It is expressed in micro siemens/cm [11, 12].
The average measurements of all the samples of the wadi Kébir Rhumel (Figure 3) show that the average values fluctuate between 870 µS/cm and 1926.66 µS/cm, it exceeds the norms fixed by the WHO (1500 µS/cm) in some station (S4, S7, S8), These values testify a strong to excessive mineralization generated by the organic contributions and the discharges discharging in the wadi.

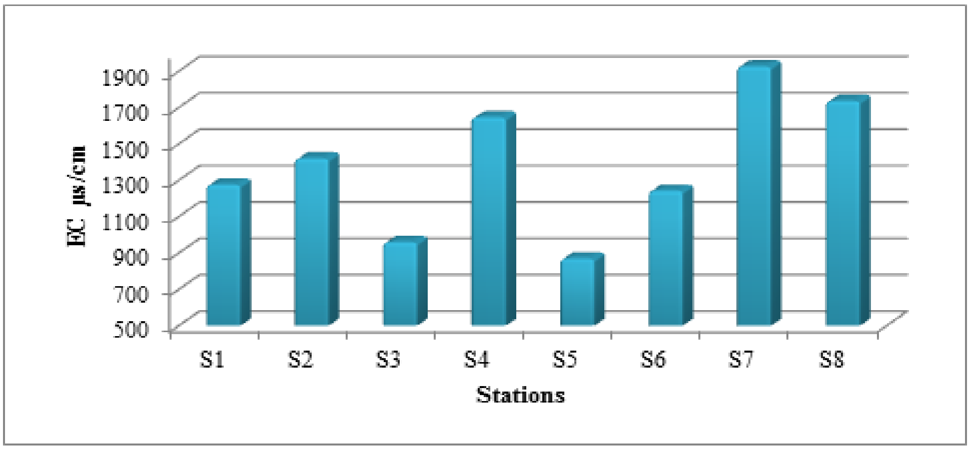

Figure 3. Spatial variations of EC

Hydrogen potential(pH)

The pH of water is an essential parameter for the determination of water quality, it measures the concentration of H+ protons contained in water. Protons contained in the water. It summarizes the stability of the equilibrium established between the different forms of carbonic acid and is related to the buffer system developed by carbonates and bicarbonates [13, 14, 15, 16].

The average values observed (Figure 4) reveal that the pH is slightly alkaline almost in all stations of the wadi Kebir Rhumel, it varies between 8.11 and 8.65 and also does not exceed the standard set by the WHO for surface water (6.5 - 8.5) due to the calcareous nature of the land crossed.

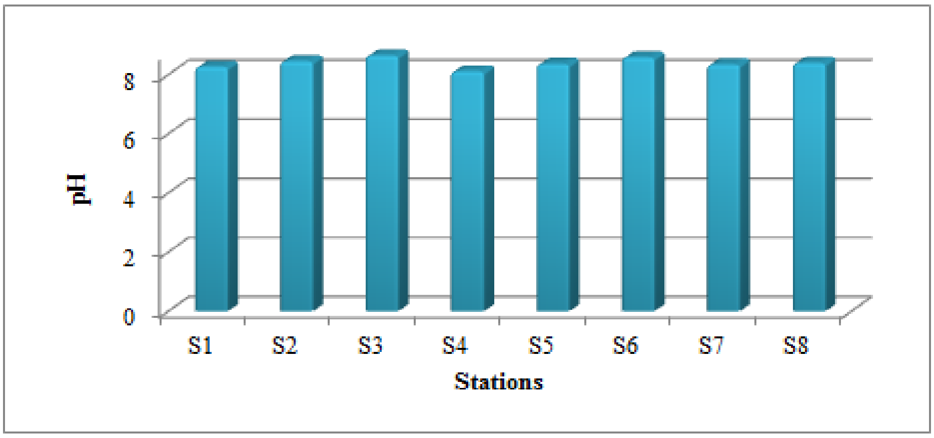

Figure4. Spatial variations of pH

The Nitrogenous compounds

Nitrogen is a fundamental element for the construction of the living cell and is also considered a very good indicator of organic pollution. It is present in two forms: organic (proteins, amino acids, etc.) and mineral (ammonium, nitrites, nitrates, etc.). The forms of nitrogen studied are: ammonia nitrogen (NH_4^+), (NO_2^-) and nitrates (NO_3^-) [16].

The Nitrates (NO_3^-)

Nitrates are the final stage of nitrogen oxidation, and are the most highly oxidized form of nitrogen present in water. Their concentrations in natural waters are between 1 and 10 mg/l. However, their levels in untreated wastewater are low [17, 16]. The average nitrate levels recorded during the month of July 2020 (Figure 5) vary between 7.53 mg/l (S4) and 34.2 mg/l (S5), (Figure 5). This remains largely lower than 50 mg/l, fixed by the WHO standards. These results allow us to conclude that the waters studied along the wadi Kebir Rhumel do not present any risk of pollution by nitrates.

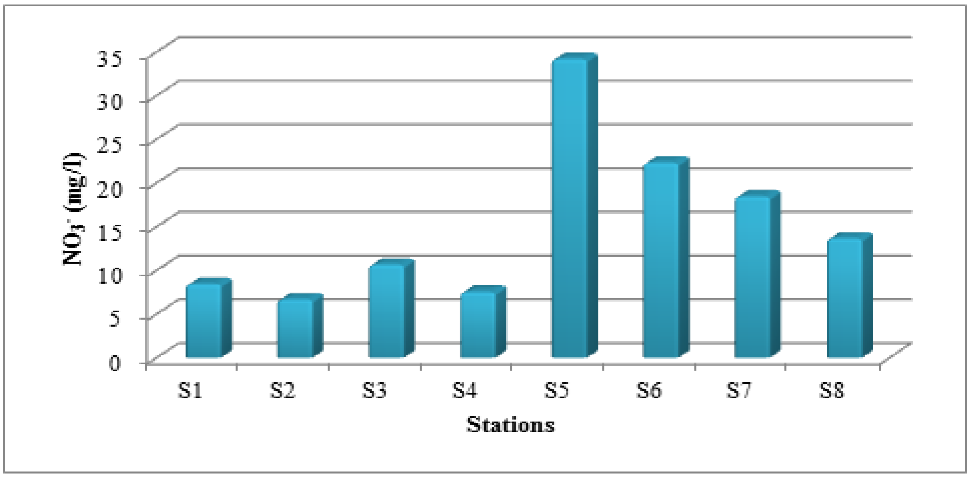

Figure 5. Spatial variations of nitrate

The Nitrites (NO_2^-)

Nitrite is the form of the passage between nitrates and ammoniacal nitrogen; it is less oxygenated and less stable. Their presence is due either to the oxidation of ammonia or to the reduction of nitrates [18]. High nitrite concentrations often indicate the presence of toxic materials toxic substances [19, 20].

The average nitrite concentrations (Figure 6) vary between 0.57 mg/l at S1 and 2.59 mg/l at S4, thus exceeding the WHO standard (0.1mg/l) in all stations. The excess of nitrite ion in surface waters comes from an incomplete oxidation of ammonium which appears essentially in urban and industrial discharges and also in agricultural activities.

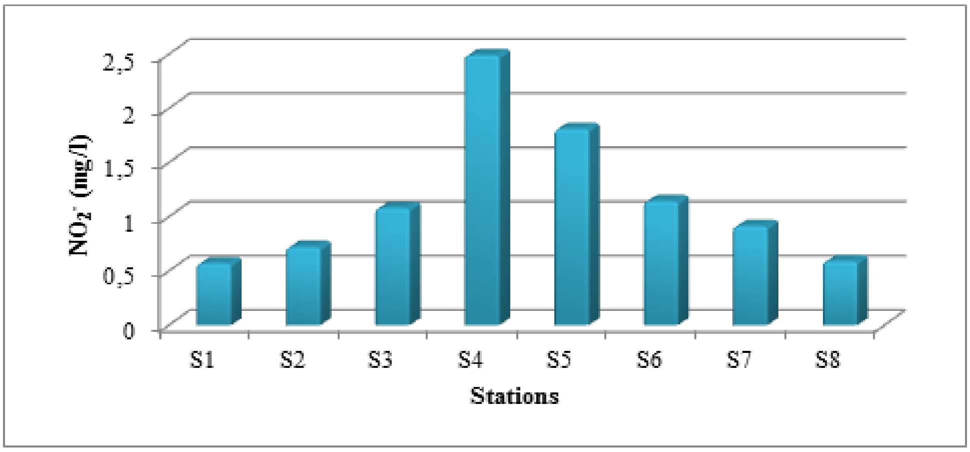

Figure6: Spatial variations of nitrite

The Ammoniacal nitrogen (NH_4^+)

Ammonia nitrogen is a gas soluble in water. It finds itself in natural waters with faint fables concentrations (lower than 0.1mg/l). It is a good indicator of the pollution of watercourses by urban effluents. In surface water, it comes mainly from nitrogenous organic matter and gaseous exchanges between water and the atmosphere. [21, 16].

The analysis of the ammonium profile (Figure 7), shows high contents varying between 1.15 mg /l (S4) and 15.06 mg /l (S8) exceeded the standard set by the WHO (0.5 mg/l) in all stations. These high concentrations reflect the process of incomplete degradation of organic matter due to the large volume of domestic wastewater as well as the effluents of industrial establishments which are discharged directly into the wadi without control due to the absence of wastewater treatment plants.

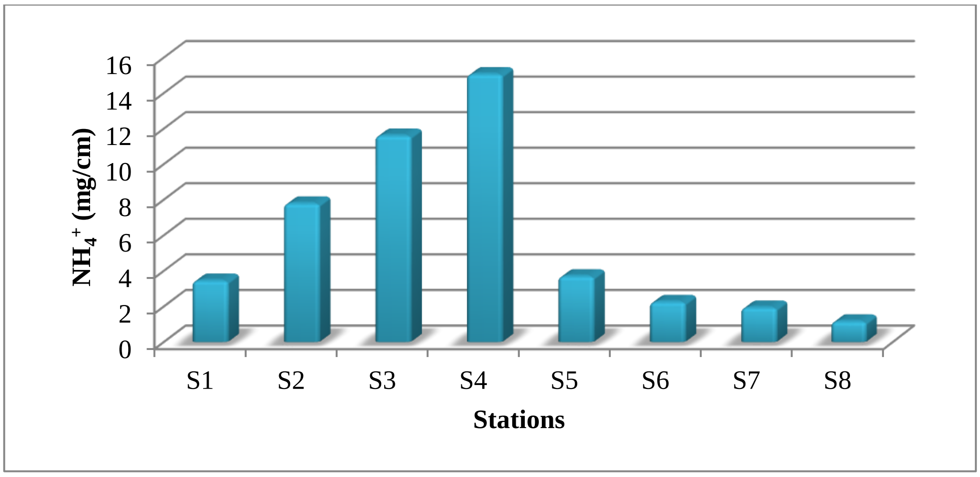

Figure 7. Spatial variations of ammonium

Chemical oxygen demand (COD)
The Chemical oxygen demand allows us to appreciate the concentration of organic or mineral matter, dissolved or suspended in water, through the amount of oxygen required for their total chemical oxidation [22]. The variations of COD contents, during our study are represented in Figure 8. They oscillate between 54.53 mg/l and 112.1mg/l. They are higher than the standards of potability fixed by the WHO (20-25 mg/l) in all the stations. This indicates an increase in organic matter.

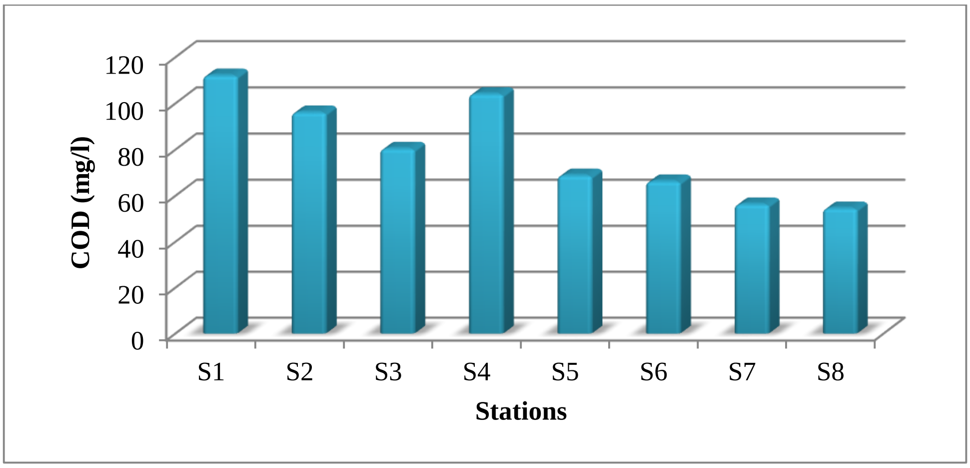

Figure 8. Spatial variations of chemical oxygen demand

Biochemical oxygen demand (BOD_5)
BOD5 is an expression to indicate the amount of oxygen that is used for the destruction of decomposable organic matter by biochemical processes [16].
At the wadi level, the BOD_5 varies between 3.21mg/l at the station (S1) and 22.24 mg/l at the station (S3) (Figure 9).
In general, these values are considered very high and most of the concentrations exceeded the standard of potability set by the WHO (3-5 mg/l). These high levels indicate a high organic matter load. Indeed, the increase in BOD_5 levels in dry periods can be explained by the establishment of conditions for the degradation of organic matter by microorganisms whose activity.

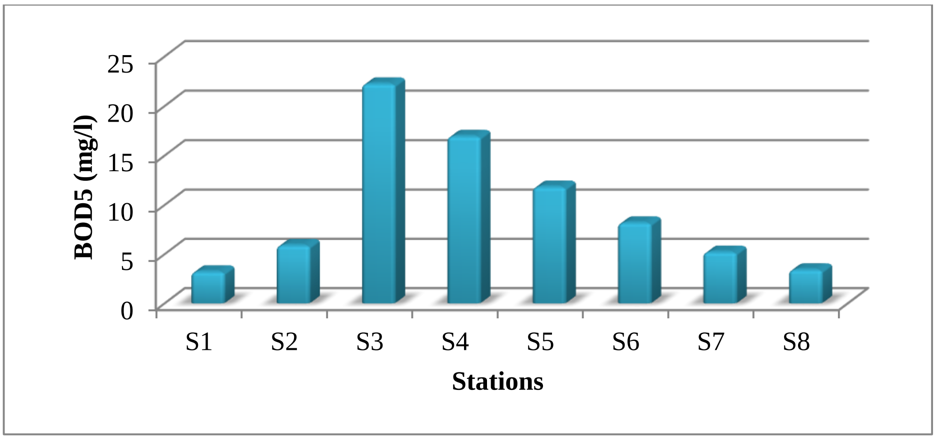

Figure 9. Spatial variations of biochemical oxygen demand

The BCO/DBO$_5$ ratio

The COD/BOD5 ratio has an importance for the definition of the treatment chain of an effluent. Indeed, a low value of the COD/BOD$_5$ ratio implies the presence of a large proportion of biodegradable matter and allows considering a biological treatment. Conversely, a high value of this ratio indicates that a large proportion of the organic matter is not biodegradable and, in this case, it is preferable to consider a physicochemical treatment [22].The evaluation of the COD/BOD$_5$ ratio of the Wadi Kebir-Rhumel shows values higher than 3 in all stations (Fig.10). These results are an indication of the importance of non-biodegradable organic matter from industrial and agricultural discharges.

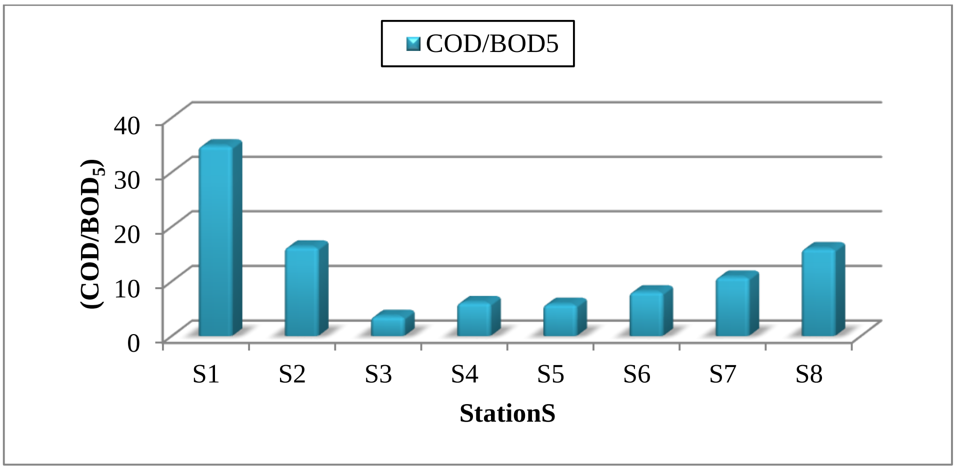

Figure 10. Spatial variations of COD/BOD$_5$

CONCLUSION

This monthly monitoring study over a period of one year is carried out with the aim of characterising the quality of the water of the Kebir-Rhumel Wadi. This work provides important information on the basis of physico-chemical and bacteriological descriptors. The results obtained in this work have enabled an evaluation of the physicochemical quality of the waters of Oued Kébir Rhumel. The physico-chemical analyses revealed an alkaline pH (between 8.11 and 8.65) and a conductivity that varies between 870 and 1926.66 µs/cm and nitrate levels that do not exceed 34.2 mg/l as well as nitrite levels that are between 0.57 mg/l at station S1 and 2.59 mg/l at station S4 and ammonium varies between 1.15 mg/l at station S8 and 15. 06 mg/l at station S4. The values of biochemical oxygen demand (BOD$_5$) ($3.21<BOD_5<22.24$) in most of the stations exceeded the range of potability standards set by the WHO (3-5 mg/l), while the values of chemical oxygen demand (COD) were very

high (54.53 <COD<112), thus exceeding the standard allowed by the WHO (20-25 mg/l). The COD/BOD_5 ratio shows that the values range from 3.61 to 34.85 (above 4). Thus the evaluation of the chemical and biological parameters of the waters of the Kebir-Rhumel Wadishows a dominance of non-biodegradable organic matter, reflecting the influence of industrial and agricultural discharges. In order to protect the waters of this river against all types of pollution, it is necessary to:
-Inform and sensitise farmers on the use of fertilisers and pesticides along the wadi and particularly the upstream part (S1). -Avoiding direct discharge of wastewater into the wadi without treatment and installing treatment plants to control industrial and domestic discharge.

ACKNOWLEDGEMENT

I would like to thank the Geological Engineering Laboratory (LGG) and the Laboratories' Biotechnology, Environment and Health of the University of Mohamed Seddik Benyahia, Jijel for their help in carrying out the analyses that I have presented to you, and also the two supervisors, Krika Abderrezak and Kessasra Farés, who helped to carry out this work.

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Article submitted to the Proceedings Book of the VI[th]. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

THE EFFECT OF DIFFERENT LAND-USES ON SOIL ORGANIC MATTER CONTENT IN THE ZSELIC REGION, HUNGARY

Malihe MASOUDI[1], Csaba CENTERI[1], Gergely JAKAB[2,3], Zsolt BIRÓ[1], Lyndre NEL[1], Eszter KOVÁCS[1], Viola PROHASZKA[4]

[1]Institute for Wildlife Management and Nature Conservation, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary, e-mail: Masoudim65@gmail.com, centeri.csaba@uni-mate.hu, lyndrenel@gmail.com, kovacs.eszter@uni-mate.hu, [2]Geographical Institute, Research Centre for Astronomy and Earth Sciences, Budapest, Hungary, e-mail: jakab.gergely@csfk.org, [3]Institute of Geography and Earth Sciences, ELTE Eötvös Loránd University, Budapest, Hungary, [4]Doctoral School of Landscape Architecture and Landscape Ecology, Hungarian University of Agricultural and Life Sciences, Gödöllő, Hungary, e-mail: prohaszka.viola@gmail.com

There is a broad agreement that land-use change is a major driving force for soil organic carbon, thorough altering soil carbon turnovers, decomposition, and soil erosion. However, detailed land use dynamics on soil organic carbon remains an active research field. This study investigated the impact of different land-uses, including garden, orchard, forest, meadow/grassland, on soil organic matter content in the 0–30 cm layer. Our study is done in an area named Zselic in the south part of Hungary. 61 soil samples were analysed in a Hungarian accredited laboratory. The carbon determination is based on the Walkley-Black method. According to measured organic matter percentage, land use of forest showed the highest value (3.09%), followed by garden (2.64%), orchard and grassland (2.46-2.46 %), respectively. Based on the results, there were significant differences between the soil organic matter content of the different land uses (p=0.045). One-way ANOVA (Duncan range test) showed a significant difference between forest-orchard and forest-meadow/grassland, while the garden has an overlapping category between the two groups of grassland and forest.

***Keywords**: forest, orchard, grassland, garden, humus*

INTRODUCTION

Assessing Soil Organic Carbon (SOC) contents is of high significance as this soil property is a vital indicator for evaluating soil condition and it has been frequently used as one of the most important indicators when soil quality/health has to be evaluated [1]. Many years of research have demonstrated that the maintenance of SOC concentrations is strongly linked to biological activity and agricultural productivity [2].

Organic carbon content as an essential soil chemical property affects soil hydraulic properties (like water retention) [3] and water holding capacity by affecting both soil structure and adsorption properties and thereby controlling flooding and erosion as one of the ecosystem services. It is also an essential regulator of nutrient availability and plant growth [4], which helps to protect soil resources and maintain crop yields thus contributing to food security [5]. SOC content is influenced by the organic matter input, the abundance and type of mineral surfaces, physical disturbance and land-use management, and also climate [6].

There is a broad agreement that land-use change is a major driving force for SOC. Land-use type and agricultural management practices can cause immediate soil disturbance and ambient environmental changes, affecting carbon inputs as well as the composition and quality of organic

matter in soils [7]. Lal [8] described the potential of SOC sequestration to decrease CO_2 emissions from the terrestrial carbon pool and increase agricultural productivity. In consequence, understanding the interrelations between land use and SOC dynamics is fundamental for sustainable resource management and climate change mitigation [8]. Thus, the effects of detailed land use dynamics on SOC remains an active research field. Various studies have been conducted to assess the effect of different land uses and agricultural management on soil's physical and chemical properties [9, 10, 11, 12, 13, 14, 15, 16, 17, 18].
In most of the studies, croplands with different tillage systems, forest lands, and grazing lands are compared and results showed that SOC decreased in croplands as compared to forest lands. For example, Guo and Gifford [9] reviewed the literature to survey the influence of land-use change on soil carbon stock from 74 publications, their result showed that soil carbon stocks decline as follow: pasture > plantation, native forest > crop, pasture > crop. However, still little is known about the spatial variance of SOM content within various land-use types in a hilly subhumid region. Therefore, in this study, the effect of different land-uses on SOM concentration in the south part of Hungary will be investigated.

MATERIALS AND METHODS

Study area and sampling:
Soil samples were collected from four land-uses of garden (small areas, 100-200 m^2, organic farming in Visnyeszéplak and Gyűrűfű and intensive farming in Magyarlukafa) orchard (grassed), forest (most of them natura but includes some black locust forests as well, with a minimum of 10 years of age and not older than 30 years), grassland (mixed use of mowing and grazing) located in the Zselic region, which is a hilly range in South-West of Hungary (46.2186° N; 17.8801° E). It has an elevation of 183 m a.s.l. The land-uses are investigated in three villages named: Visnyeszéplak, Magyarlukafa and Gyűrűfű. Figure 1 shows the location of the study area.

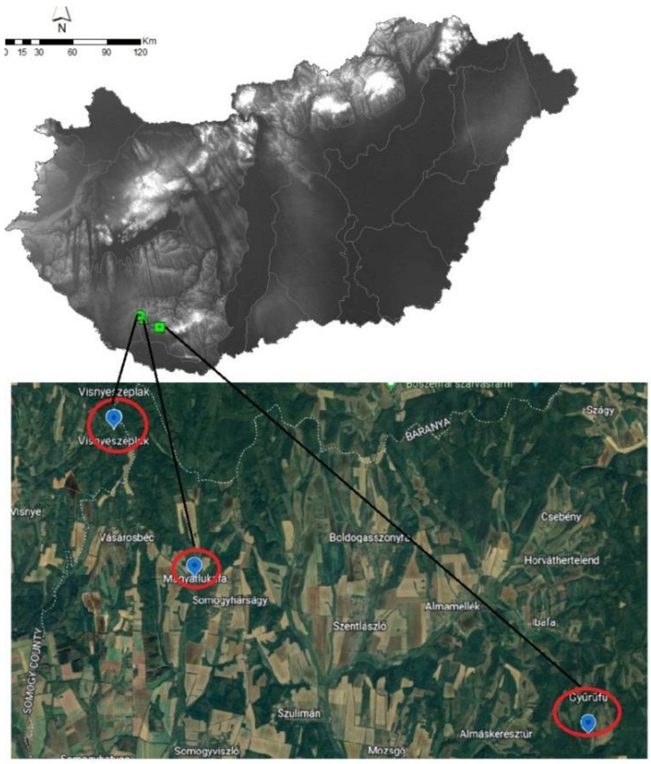

Figure 1. Location of study areas where soil samples were taken for soil organic matter content comparison in Hungary

Totally 61 soil samples were collected from 0-30 cm layer (15 repetitions for each land-uses except garden (16 repetitions) and after preparation (air-dried, and the roots were picked out of the soil by hand) were analyzed in a laboratory. In this Zselic Region almost all of the soil types were Luvisols, and or related to Luvisol.

The samples were analysed by the Hungarian Standard MSZ-08-0210-1977 for measuring their SOC concentration. To find differences in SOM content between these land-uses and the effect of different land-uses on soil organic carbon content, one-way ANOVA was used. In this regard, P-value is used to predict the statistical significance of the estimated effect of land-uses on SOM content. P-values below 0.05 indicate statistically significant non-zero correlations at the 95.0% confidence level. Statgraphics 18 software was used for the statistical analysis.

STATISTICAL ANALYSIS AND GRAPHICAL PRESENTATION

A one-way ANOVA analysis was used to investigate the various land management effect on the soil organic matter content. Also, the Duncan range test (multiple comparisons ANOVA) was used to find which land-uses are different from which land-uses. In the procedure of one-way analysis of variance for SOM, various tests and graphs construct to compare the mean values of SOM for the four different land-uses.

The ANOVA table decomposes the variance of SOM into two components: a between-group component and a within-group component. This analysis was done using stratigraphic software (versions R4.0.3 and Stat graphics 18). A variable analysis illustrates the important features of the measured SOM content (Table 1). Also, a bar chart of mean SOM for each land-use is provided in Figure 2.

Table 1. Summary statistics for SOM distribution of various land-uses

Land-use	**Count**	**Average**	**Median**	**Standard deviation**	**Coeff. of variation**	**Minimum**	**Maximum**
garden	16	2.67	2.52	0.87	32.78%	1.57	4.37
forest	15	3.09	3.26	0.63	20.37%	1.88	3.97
grassland	15	2.45	2.34	0.69	28.34%	1.23	4.01
orchard	15	2.45	2.38	0.50	20.40%	1.32	3.35
	Count	Lower quartile	Upper quartile	Interquartile range	Stnd. skewness	Stnd. kurtosis	
garden	16	1.97	3.38	1.404	0.711	-0.764	
forest	15	2.52	3.64	1.122	-0.814	-0.615	
grassland	15	2.12	2.92	0.806	0.597	0.508	
orchard	15	2.095	2.78	0.684	-0.564	0.642	

RESULTS AND DISCUSSION

A variable analysis illustrates the important features of the measured SOM content (Table 1). According to table 1, and also Shapiro wilk test the distribution of the data is normal. As Figure 2 shows, the forest has the highest percentage of SOM measured compared to other land-uses, after that, the garden has a higher percentage of SOM compared to the grassland and orchard.

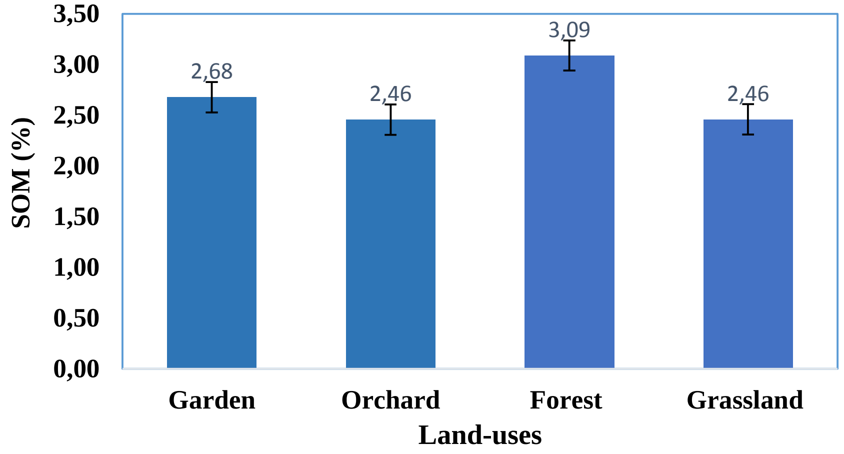

Figure 2. Mean and standard deviation of the measured SOM

Orchard and grassland show almost the same value. Based on one-way ANOVA (Table 2) there is a significant difference between different groups (The F-ratio, which in this case equals 2.857, is a ratio of the between-group estimate to the within-group estimate. Since the P-value of the F-test is less than 0.05, there is a statistically significant difference between the mean SOM from one level of land-use to another at the 5% significance level).

Table 2. ANOVA Table for soil organic matter by land-uses

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Between groups	4,184	3	1.395	2.857	0.045
Within groups	27,819	57	0.488		
Total (Corr.)	32,003	60			

So we could apply, Duncan's Multiple Range Test (MRT) to provide multiple comparison procedures and determine, which mean values are significantly different from which others (Table 3). The results showed statistically significant differences at the 95.0% confidence level between forest and grassland and also between forest and orchard. In other studies, scientists found a significant difference between different land-uses [19, 3].

However, garden (which can be considered as land-use based on cultivation) is an overlapping category between the two groups of forest and grassland. It means we can't see a strong decline in SOM in this land-use. This result is inconsistent with Yeasmine et al. [20] who found significantly higher TOC (0.44–1.79%) under undisturbed soils (grassland and fallow land) than in disturbed soils (orchard and cropland) (0.39–1.67%), they attributed that, to the above biomass and fine root density of naturally grown grasses and shrubs in grasslands.

The reason of having the gardens as an overlapping type is because 10 of the 15 examined gardens are organic, using a lot of mulch and laying big emphasis of having as long period with soil cover as possible, so the organic matter content of the soil is high, due to the big amount of plant residues, thanks to this farming system. However other environmental properties, like climate conditions play an important role in the amount of SOC that soil can accumulate.

As several authors have observed lower SOC levels in Mediterranean conditions, characterized by seasonal dryness due to hot-dry summers and mild wet winters than in temperate areas [19, 21].

In another study Wiesmeier, et al [22] found, lightly lower (<20%) and even higher SOC stock under cropland compared with forest land for different soil classes. A comparison of different soil classes under grassland and forest land also showed no considerable differences in SOC stocks. These results agree with our study result. Its cause could be Soil tillage most likely promotes the formation of organo-mineral associations, and relocating SOC with depth which may reduce its decomposition [22]. Also using fertilizer would enhance carbon content in surface soil [23].

Probably some environmental property (soil erosion, fertilization, the age of land-use change, etc.) overwrites the role of land-use. Try to discuss citing some literature.

Table 3. Multiple comparisons of land-uses to find a significant difference based on the Duncan post-hoc test

Contrast	Sig.	Difference	+/- Limits
garden - forest		-0.412192	0.499356
garden - grassland		0.218303	0.499356
garden - orchard		0.221189	0.499356
forest - grassland	*	0.630496	0.507346
forest - orchard	*	0.633381	0.507346
grassland - orchard		0.00288582	0.507346

CONCLUSIONS AND RECOMMENDATIONS

The impact of different land-uses management on carbon content has been of great interest in recent years. In this study, the effect of four land-uses (garden, orchard, forest, grassland) on soil carbon content was investigated. According to the results, forest showed the highest value of soil organic matter compared to other land-uses, however, there were statistically significant differences between forest and grassland and also between forest and orchard (at the 95.0% confidence level). This may be a result of greater organic-matter accumulation due to increased (above- and below-ground) biomass input and reduced litter decomposition rates. Garden shows an overlapping category between the two groups of forest and grassland. Soil cultivation may not generally be associated with a strong decline of SOC, as tillage probably promotes the formation of organo-mineral associations, and relocation of SOC with depth may decrease it. Also, it could depend on the type of vegetation cover, management practices, soil type and specially fertilizer. Further research is needed to explore the specific explanation for this. The result of this study will help to develop a plan for land-use and soil management regarding soil carbon dynamics and climate change mitigation. However, we recommend investigating soil organic carbon in the subsoil as in this study we focused on just a 0-30 cm layer of soil.

ACKNOWLEDGEMENT

Supported by the Stipendium Hungaricum Scholarship (Tempus Public Foundation).

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Article submitted to the Proceedings Book of the VI[th]. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

MODELLING AN ATMOSPHERIC DISPERSION OF METHANE AND HYDROGEN SULFIDE ORIGINATIG FROM LANDFILLS

Drakulovic VESNA*, Marko JOVANOV, Una MARCETA, Bogdana VUJIC

Technical faculty "Mihajlo Pupin" Zrenjanin, University of Novi Sad, Serbia e-mail: vesna.drakulovic2@gmail.com

This study was carried out to estimate methane and hydrogen sulfide emission from Zrenjanin's waste landfill, dispersion of these gases in the atmosphere, and their impact on the nearby population. Mathematical model used in this study, LandGem 3.02, requires data regarding the size and the duration of use of landfills, volume of deposited waste, etc. Simulation of dispersion and determination of concentration levels in specific vulnerable sites was performed using ADMS URBAN dispersion software. The results show that, in selected scenarios, methane (24,1 mg/dm3) and hydrogen sulfide (0.38 mg/dm3) concentrations are highest at the landfill site, while modeled concentrations based on meteorological conditions with predominant winds for the selected period indicate no significant impact on the neighboring population.

Keywords: *landfill, emission, atmospheric modelling, methane, hydrogen sulfide*

INTRODUCTION

Globally, unsustainable waste management has been a significant problem for decades (1). Even though waste dumpsites exhibit the highest negative impact on the environment, they are still the most economical and convenient solution to waste management challenges (2). According to data in Waste Management Strategy, annual per capita waste production in Serbia is 318 kg. In the United States of America in 2006, approximately 55% of waste was deposited on landfills, 13% was incinerated, and 32% of waste was composted. In the European Union, 10-65% of waste is recycled and 10-90% deposited in the landfills (3).
Sites where waste is deposited can be classified as either sanitary or unsanitary landfills. Sanitary landfill is a planed and equipped area where waste is deposited so that it produces minimal impact on the environment and human health. Unsanitary landfills, on the other hand, are areas where waste is collected with no precautions to the environment (4).
One of the main problems originating in landfills is air pollution. Exposure to polluted air from landfills causes serious health issues. Hence, headaches and vertigo have been reported in many individuals in the surrounding communities (5). In Europe, during August of 1998, a study investigating prevalence of birth anomalies was conducted. The study was focused on the pregnancy outcome in women residing in the 21 km vicinity of the landfill, and the data shows increased prevalence of no chromosomal congenital anomalies i.e. artery and vein anomalies (6). Inhalation of significant quantities of pollutants leads to inflammation of mucosa tissue, blood coagulation causing blood vessel obstruction, myocardial infarction, and other diseases. Cancer and respiratory infections, cholera, malaria, cough, skin irritations, tuberculosis, and number of other illnesses are more common in people residing near waste landfills (7).
Type of pollutants contributing to air pollution are numerous, and the most common ones reported in studies are unpleasant odor, debris, and landfill gas which is a complex mixture of gaseous substances containing predominantly carbon dioxide, methane, volatile organic components, ammonia, as well as acidic compounds like nitrogen dioxide, sulfur dioxide, etc. Landfill gas is the most prominent contributor to air pollution, and it's generated by microbial activity under aerobic and anaerobic

conditions over several years. Quantity of the generated landfill gas is directly proportional to the decomposition period and waste deposition period (8).

Methane is a predominant component of the landfill gas in its late, anaerobic or methane phase of the waste decomposition. Due to its flammability when exposed to oxygen, it forms explosive mixture, and along with its greenhouse effect, it posses a great threat of explosion and fire. It is also asphyxiant gas since it exchanges blood oxygen for carbon dioxide. Population exposed to methane atmosphere can experience headaches, vertigo, nausea, lightheadedness, and even complete loss of all senses. Sever acute methane exposure can be fatal. Owing to its low specific weight compared to air, methane can be dispersed at great distances from the landfill where it originated, and elevated concentrations of methane can be detect at lower levels in residential areas. Studies have shown that methane distribution can span as far as 500m from the landfill site (5).

Health-threatening concentrations of methane are not yet fully defined since it is still generally considered to have no acute or chronic effect on human health. However, exposure to increased concentrations of methane (328000 mg/m3) can cause suffocation, and the recommended concentration during eight-hour exposure period in working environment is 650 – 7000 mg/m3 (9).

Decomposition of accumulated waste containing largely food remains produces gaseous compounds with a particularly unpleasant odor. The most prominent being hydrogen sulfide generated by anaerobic or aerobic decomposition of proteins and fats. Hydrogen sulfide is highly toxic gas with distinct smell of rotten eggs distinguishable at levels as low as 0.112 – 0.182 mg/m3. United States Environmental Protection Agency (US EPA) defines limiting hydrogen sulfide levels for various exposure periods for general population (*Acute exposure guideline levels – AEGLs*) (10,11) (Table 1).

Table 1. Acute exposure guideline levels for hydrogen-sulfide

Classification	**Hydrogen sulfide concentrations for different exposure periods**					**Symptoms**
	10min	30min	1h	4h	8h	
AEGL-1 (non-consequence)	0.75ppm (1.05mg/m^3)	0.60ppm (0.84mg/m^3)	0.51ppm (0.71mg/m^3)	0.36ppm (0.50mg/m^3)	0.33ppm (0.4605mg/m^3)	Population can feel: irritations, discomfort, certain asymptomatic not sensitive effects
AEGL-2 (with consequences)	41ppm (59mg/m^3)	32ppm (45mg/m^3)	27ppm (39mg/m^3)	20ppm (28mg/m^3)	17ppm (24mg/m^3)	Population can feel: irreversible or long term consequences for health
AEGL-3 (lethal)	76ppm (106mg/m^3)	59ppm (85mg/m^3)	50ppm (71mg/m^3)	37ppm (52mg/m^3)	31ppm (44mg/m^3)	Population can feel: effects dangerous to health or death

Conserning the fact that in Sebia, there are a huge number of non sanitary landfills emiting various types of pollutants, to access their influence on nearby population, a modelling of methane and hydrogen-sulfide concentration levels in air from landfill in Zrenjanin were provided.

METHODOLOGY

In order to acess population exposure to the methane and hydrogen-sulfide, this research it is necessery to conduct ine following phases:

1. Source emission caracteristic indentification (location and size of landfill, disposed waste amount)
2. Methane and hidrogen-sulfide emission estimation from the landfill
3. Simulation of methane and hydrogen-sulfide air dispersion in order of determination of concentration levels in specified points
4. Population exposure assessmenet

ADMS Urban, an modelling software

Mathematical models are useful tools for identifying the behaviour and fate of pollutions after emission. Also, in the lack of monitoring, models can be used to indicate the concentration levels of observed pollutants in a particular area. In order to obtain concentration levels at specific points in this study, the Gaussian model will be used, ADMS urban (The Atmospheric Dispersion Modelling System). ADMS urban has a wide application and simulates a large number of pollutants from various polluting sources (12). To simulate the distribution of pollution using the ADMS urban model, two groups of data are needed: source characteristics including emission rates and environmental characteristics, which includes outfield characteristics and meteorological data

Rate of pollution emission

For pollutants rate emission estimation a LandGem 3.02 mathematical model were used. Besides emission rate of two main pollutants, methane and carbon/dioxide, this mathematical model calculate other constituents of landfill gass as well (13):

$$Q_n = kL_0 \sum_i^n = 0 \sum_{0,0}^{0,9} \frac{\mathrm{M}_i}{10} e^{kt_{i,j}}$$

Where:
Qn – methane formation rate [m^3 year^{-1}]
n – year
K – first-order waste decay rate [year^{-1}]
L_0 – methane formation potential [m^3 Mg^{-1} wet waste]
M_i – waste mass placement in year (Mg)
j – intra-annual time increment used to calculate CH_4
t – time [year]

RESULTS AND DISSCUSSION

Research area

Zrenjanin is the largest city in the Banat district in the Autonomous Province of Vojvodina. According to data from the last census in 2011, the population was 170,013 (14). Annual production waste per capita is 341,4 kg/year. The collected waste is disposed of on landfills while PET is sorted. Zrenjanin landfill is located 5km southwest of the city centre. Landfill operates since 1984, occupies an area of 35ha and 50% of the landfill is covered with waste (15,16).

In order to simulate real landfill and its environment, data on location and landfill size are georereferenced and presentet trought the Google Earth (Figure 1)

Data on landfill caracteristisc are the starting point for emission rate of methane and hydrogen-sulfide estimation in *LanđGem* programm. In order to determine landfill influence on sourounding envinroment and population a specified points were selected. Selected points are vulnarable zones as welll because their position regarding dominant winds and distance from the landfill (Table 2).

Figure 1. Research area: location of the landfill in Zrenjanin and selected specified points

Table 2. Specified points caracteristics

Name	Coordinates		Exposure height (m)	Distance form landfill (m)	Description
Village	449231.88	5024825.50	1.50	2700	Setllment at the dominant wind direction
Ranch	448696.50	5024005.00	1.50	2250	Isolated haous at the dominant wind direction
Lanadfill	450304.09	5022336.00	1.50	-	Pollution source
City beach	451682.16	5022156.50	1.50	1700	Lasure zone

For simulation of pollution distribution in the air, a meteorological data for July 2021. were used. Those data were selected because the landfill is very active concerning landfill gas prodution durng the summer period.

Distribution simulation was provided for three type of meterological scenarious. Scenario 1 (S1) represebt hourly meteorological data on wind speed and direction, air temperature and cloud cover. Scenario 2 (S2) and scnario 3 (S3), represents most unfavorable meteorological conditions, revailing conditions during dominant winds direction.

Hence, C2 represent conditons while prevailing south-east wind direction (Kosava), usualy reaching speed of 7 m/s. During theese days an air temperature were very high reaching 31-35ºC, whit high cloud cover (7 octas). Scenario C3 represents second dominant wind direction, nort-west with its maximum speed of 5m/s, relatevely low air temperatures for summer period (25ºC) and high cloud cover of 6 octas (Figure 2).

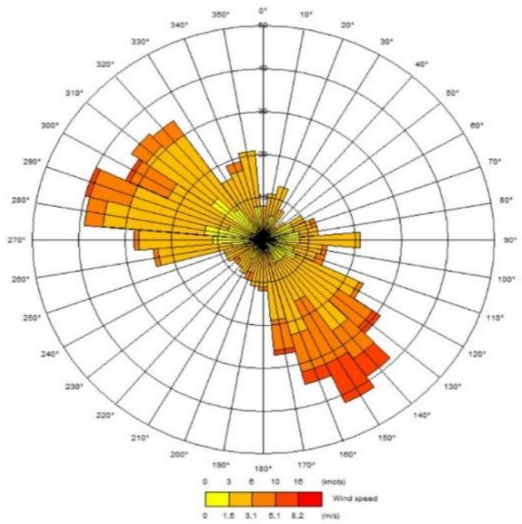


Figure 2.Wind rose for Jyly 2021 in Zrenjanin

Methane dispersion and concentration levels in specified points
Emission rate, meteorological data and data on terrain configuration as well are the starting point for pollution distribution modeling in ADMS urban software. According to the pollution rose obtainesd in S1 (Figure 3a), it could be concluded that significant dispersion does not exist and the higehst methane concentration were modeled on labdfill itself (Table 3). In comparasion to the C1, in case of pollution roses for S2 and S3, it could be noticed more intense pollution dispersion in direction of dominant winds (Figure 3b and Figure 3c). Hence, in S2 ans S3, higest methane concentration were modeled at the landfill location, and as espected, at the specified point (Panch and City beach) located on dominant wind directions (Table 3).

a – Methane dispersion in S1

Figure 3. Methane pollutionn roses in selected scenarios

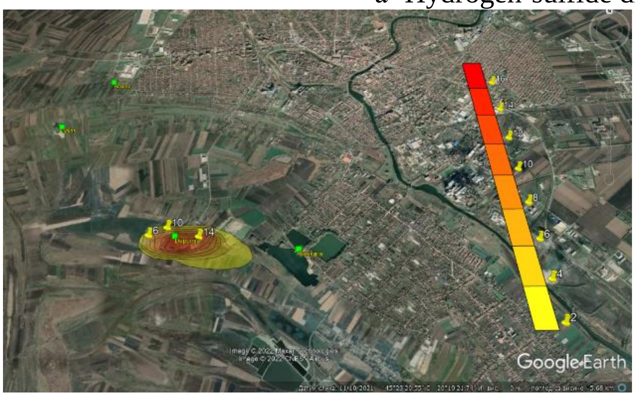
Table 3. Methane concentration in specified points for selected meteorological scenarios

Specified points	*Methane concentration (mg/m^3)*		
	C1	***C2***	***C3***
Village	0,12	0,52	0
Ranch	0,23	0,27	0
Landfill	25,1	0,61	0,99
City beach	0,56	0,00	0,43

Hydrogen-sulfide dispersion and concentration levels in specified points

Hydrogen-sulfide dispersion have showen simmilar pollution rose as in case of methane simulation. Namely, accoring to hydrogen-sulfide dispersion rose in S1 (Figure 4a), it could be concluded that the higest concentration were modeled at lanfill itself. Accoring to the S2 and S3 meteorological scenarios, more intense pollutant distribution in the wind direction were modeled (Figure 4b and Figure 4c). Simmilar to the methane distribution rose, higest concentrationlevels of hydrogen-sulfide were modeled at the landfill for all three scenarios, but in the case of dominant wind scenarios, elevated concentrations were modeled at the defined specified points (Ranch and City beach) (Table 4).

a- Hydrogen-sulfide dispersion in S1



b- Hydrogen-sulfide dispersion in S2

c-Hydrogen-sulfide dispersion in S3

Figure 4. Hydrogen-sulfide pollutionn roses in selected scenarios

Table 4. Hydrogen sulfide concentration in different meteorological scenarious

Specified point	*Hydrogen sulfide concentration* $\lvert mg/m^3 \rvert$		
	C1	***C2***	***C3***
Village	0,0018	0,0	0,00078
Ranch	0,0034	0,0	0,0041
Landfill	0,38	0,148	0,092
City beach	0,0084	0,0064	0,0

At the end it could be concluded that the highest modelled methane concentration (Table 3 and Table 4) was below the recommended concentration during eight-hour exposure period in working environment is 650 – 7000 mg/m^3. Hence, there is neither risk for the employees working every day on landfill site nor for the surrounding population. Concerning hydrogen-sulfide, modeled concentrations levels in S2 indicated possibility of rotten egg smell occurrence but there is no significant influence on employees because the modelled concentrations were below AEGL-1.

CONCLUSSION

The number of open, unregulated dumpsites is substantial and it increases daily posing serious health and environmental threat. Monitoring of the emission gas, as well as air quality, in the vicinity of waste landfills in Serbia is not yet established. Nearby communities are potentially exposed to this pollution and, additionally, largely uninformed regarding the impact on their health. Considering absent monitoring, estimation of pollutant concentration from both sanitary and unsanitary landfills can be done using mathematical models which provide approximate and indicative perspective concerning pollutant concentrations at landfills and their dispersion in the atmosphere. In this study, identification of methane and hydrogen sulfide concentration levels in the vicinity of Zrenjanin's city landfill was carried out using Gauss dispersion model ADMS urban. Based on predefined meteorological conditions scenarios characteristic for the summer months when generation and emission of gaseous pollutants is at its highest, concentrations were determined in specific vulnerable sites. Comparison of the modeled and recommended concentrations during specified exposure period, minimal impact on health of employees' at the landfill and the nearby population was confirmed. Since modeling is an approved method to estimate air quality with absent monitoring, thought no particular method has been specified in the Republic of Serbia, and approved deviation of modeled to real values can be as high 50% establishing a monitoring system surrounding waste landfills is an imperative in the Republic of Serbia.

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NEXUS BETWEEN FOREIGN DIRECT INVESTMENT AND ECONOMIC GROWTH IN OIL EXPORTING COUNTRIES OF CIS

Dina MALGAZHDAROVA

Management and Organization Sciences/Hungarian University of Agricultures and Life Sciences, Kaposvar, Hungary, dina.malgazhdarova@gmail.com, +36205187845

In the current article, the impact of foreign direct investments (FDI) on economic growth in large oil exporter countries of CIS is analyzed. Meanwhile, for the purposes of the study, open statistical databases of the World Bank, the United Nations Conference, statistical agencies of the considered group of countries for the period 1991-2020 were used. According to the intensity of FDI in the oil and gas industries of the studied CIS countries their vital importance for economic growth was confirmed, at the same time denoting the dependence of some of the countries under consideration on this type of FDI. It was also noted that the COVID-19 pandemic having negatively affected the economy of the whole world, led to a sharp drop in investment activity in the CIS countries.

***Keywords**: Foreign direct investments, FDI, CIS, oil exporters*

INTRODUCTION

No state can develop successfully without integrating into the world economy. One can say that Foreign Direct Investment (FDI) is one of the integral criteria for integration [16], [20]. Therefore, it is not surprising that in recent decades, developing countries, and in recent years the countries of the Commonwealth of Independent States (CIS) have paid great attention to attracting them [12]. The latter also for improving their investment climate due to the fact that investments have a significant impact on social – the economic development of the country both at the macro and micro levels [19], [21]. Thus, at the macro level, investments are fundamental for implementing a policy of expanded reproduction, restructuring the production sector and balanced development of all sectors of the economy, introducing innovations, and ensuring the competitiveness of the country's economy.

At the micro-level, investments are crucial for the development of production, increasing its technical and technological levels, reducing the moral and physical depreciation of fixed assets, improving the quality and competitiveness of products, as well as reducing the harmful environmental impact on the environment [15], [17]. According to the World Bank database, the highest level of global investment flows was recorded in 2007 at 3.13 trillion US dollars. At the same time, the total inward FDI flows in 2015 and 2016 were also relatively high and amounted to 2.68 and 2.74 trillion US dollars.

Despite the largely recognized positive effects of FDI in numerous studies on the impact of FDI on the economies of developing countries, one can still find diametrically opposed opinions about their consequences for the welfare of society. The indisputable fact that international companies through FDI give a certain impetus to the development of the economy of the recipient countries can hardly be disputed by anyone today.

At least the creation of new jobs speaks in favor of attracting foreign capital in this form. Whereas in other empirical studies, the positive impact of FDI on the economies of countries is not confirmed. In connection with the mentioned above, two questions are of major interest in the current paper. First, is there an effect of FDI on economic growth in the CIS countries, with the main emphasis being placed on CIS member countries that are oil exporters? Second, what is the sign of this effect, i.e. whether FDI affects economic growth in the countries under consideration in a positive or negative way?

VIEW OF RESEARCHERS

UIn the last decade, politicians in transition countries concluded that FDI is necessary to stimulate the growth of their economies. The example of some newly industrialized countries has demonstrated not only the possibility of economic development through FDI but also the possibility of modernizing the technological base, infrastructure, and public institutions. Meanwhile, many countries that are recipients of foreign investment not only do not show high rates of development but also face negative socio-economic effects of the activities of international companies.

The analysis of studies in this direction showed that the assessment of the impact of FDI on the economy of the host country was carried out either in the context of individual countries or groups of countries, or in the context of individual factors of influence, or in the context of individual categories of FDI [1], [2], [4]-[7]. One of the most positive effects of FDI noted by researchers is technological exchange, and this phenomenon is not something fundamentally new [13], [22], [25], [26]. In the work of Blalock and Gertler, the effects of technological exchange on the welfare of society were assessed, FDI can be a source of new technologies in growing markets, which leads to an increase in wealth, and therefore can become the basis for government measures to stimulate investors. The analysis showed that one of the main channels of technological exchange is vertical production chains.

It should be noted that the positive effect of FDI inflows on the economy of the recipient country is achieved through a competent investment policy and is mainly achieved by attracting investments related to technology transfer [29].

At the same time, the most important indicator characterizing economic growth is the gross domestic product. In models that show a direct dependence of economic growth on FDI inflows, refinement is always made either by the category of investments attracted (more often associated with technology transfer) or by the degree of development of the country (presence of a sufficiently developed financial market, availability of skilled labor, etc.) [8]-[10], [27].

A fairly large number of researchers come forward with counterarguments to FDI. In particular, the work of D. Te Velde and O. Morissy assessed the impact of FDI on the degree of income differentiation in five East Asian countries. The authors conducted an empirical test of the model based on a multifactorial production function (the labor productivity of the skilled and unskilled sectors was separated). Using data from the International Labor Organization on wages and employment by occupation, no strong evidence was found that foreign investment has reduced wage inequality in the five East Asian countries. Moreover, investment found to be a direct source of increased income inequality in Thailand.

G. Hanson in his study argues that in most of the economies he studied, the impact of FDI turned out to be negative, and Görg generally claims that in most of the economies he studied, the impact of FDI turned out to be negative. Te Velde and Morissey's findings on the ability of an economy to benefit from the presence of international companies suggest a shift in focus from the impact of investment on development to the question of the right policy to use investment for development.

Kremer and Maskin (2007), analyzed the participation of transnational companies in international trade. Based on the extended Heckscher-Ohlin model, they concluded that inequality in developing countries may increase, in particular, due to the different content of the concepts of skilled and unskilled labor for developed and developing countries. All this suggests that the impact of foreign capital inflows on the well-being of the population is ambiguous [23], [24]. For at least a limited set of developing countries, researchers have identified a positive relationship between attracting foreign investors and increasing income differentiation.

Based on the econometric model proposed by A. Hanif and S. Jalaluddin who analyzed statistics on FDI in Malaysia from 1970 to 2011 and its impact on domestic investment, the influx of foreign investment can also have a negative impact on domestic producers..

ASSESSMENT OF THE ECONOMIC DEVELOPMENT OF THE CIS COUNTRIES

According to the 2020 indicators, the leader among all CIS partner countries in terms of GDP is Russia (1483 billion US dollars), which accounts for more than 75% of the total value of this indicator within the union and 1.8% already of the global indicator.

In the CIS, in terms of GDP, Kazakhstan ($171.08 billion) and Belarus ($60.258 billion) rank second and third respectively. The lowest figures were recorded in Kyrgyzstan ($7.736 billion), Tajikistan ($8.194 billion), and Moldova ($11.916 billion).
Meanwhile, Turkmenistan's data for 2020 are not available; however, in the previous 2018 and 2019, the volume of GDP was 40.765 and 45.231 billion US dollars, respectively. In the end of 2019, Belarus, Russia, and Azerbaijan recorded the lowest GDP growth rates (1.4% and 2.5%, respectively). According to the World Bank data in 2019 GDP per capita in Kazakhstan was at the level of - 9812.596 US dollars, in Russia - 10918.72 US dollars, while the value of this indicator in other CIS countries is lower (see Table 1).

Table 1. GDP per capita

Country Name	1991	1995	2000	2005	2010	2015	2019
Armenia	590,51	456,37	622,74	1643,76	3218,38	3607,29	4604,65
Azerbaijan	-	314,56	655,12	1578,40	5843,53	5500,31	4805,75
Belarus	-	1323,27	1276,49	3125,81	6033,69	5967,05	6837,72
Georgia	-	578,34	749,91	1642,76	3233,30	4014,19	4697,98
Kazakhstan	1514,92	1288,19	1229,00	3771,28	9070,49	10510,77	9812,60
Kyrgyzstan	575,64	364,23	279,62	476,55	880,04	1121,08	1374,03
Moldova	-	593,77	440,67	1034,71	2437,53	2732,46	4491,69
Russia	3490,45	2665,78	1771,59	5323,46	10675,00	9313,01	11497,65
Tajikistan	250,34	213,54	138,43	340,58	749,55	978,40	890,54
Turkmenistan	-	590,28	643,19	1704,42	4439,20	6432,69	7612,04
Ukraine	-	935,98	658,35	1894,47	3078,43	2124,66	3661,46
Uzbekistan	652,81	585,93	558,23	546,78	1742,35	2753,97	1784,01
OECD members	*17798,87*	*22178,11*	*22995,01*	*30180,98*	*34973,12*	*35612,51*	*39552,66*

Source: World Bank database

In general, the analysis of the available data allows us to understand that the CIS countries still differ significantly from each other, as well as from the OECD countries listed here for comparison, in terms of economic and investment indicators and development. For instance, as seen from table 1, Tajikistan and Kyrgyzstan are characterized by the problem of a low level of economic development (890.54 and 1374.03 US dollars, respectively). At the same time, geopolitical realities, growing tensions, and the pandemic of recent years have had a negative impact on economic growth and FDI flows. FDI inflows, both globally and in the CIS, have fallen sharply to levels almost 20 years ago. The rapid fall in oil prices that occurred in 2014 and more recently has strongly affected FDI inflows to oil-exporting CIS countries. The fuel and energy complex occupies a special place in the development of the CIS countries that export the relevant resources (see Table 2).

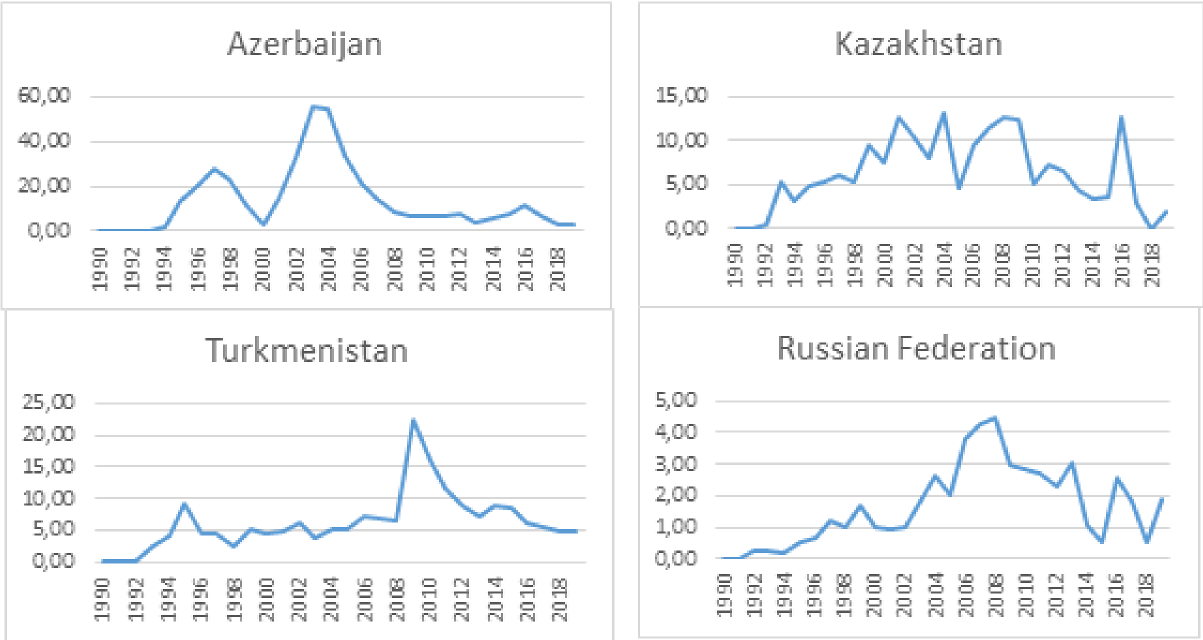
Table 2. The share of fuel and energy complex (FEC) in GDP of CIS countries biggest exporters of the oil

Country	2000	2005	2010	2015	2020
Azerbaijan	19,6	20,3	22,1	26,2	32,5
Kazakhstan	21,1	25,2	22,5	26,9	29,7
Russia	30,5	29,3	28,6	25,9	23,6
Turkmenistan	9,2	15,4	16,2	21,1	22,0

Source: World Bank database

The commonwealth countries considered in table 2 are characterized by a high level of fuel and energy complex in the formation of GDP. The list includes (in alphabetical order) Azerbaijan, Kazakhstan, Russia, and Turkmenistan. As seen in Table 2 the share of TEC in GDP grew over time, and supposedly continues to grow which might mean the growing dependency of the economy on the fossil fuel sector.
Compared with other groups of countries in the world, the CIS countries as a whole are distinguished by low FDI volumes, while having a positive net FDI indicator. In this regard, in the CIS countries with a

bigger share of FEC in GDP, flows have positive indicative FDI, however, with a different share in GDP (see Figure 1).



Source: World Bank database

Figure 1. FDI rates for selected CIS countries and global indicators, in USD

However, the link between FDI and fossil fuel production in Azerbaijan and Kazakhstan is weaker than expected, which also witnesses against conventional opinion. Meanwhile, the latter does preclude the need for closer study. The dynamics of indicators (in mln US dollars) is presented in charts compiled on the basis of data for the period 1990 to 2019. During the studied period, against the background of growing indicators in general, three out of four countries passed the peak of the rise in 2008-2009. There are also several periods of fall. For instance, the fall in 2009 was due to the trends in the development of the world economy, while the fall in 2014 was due to political factors, and in recent years, the Covid-19 pandemic. According to UNCTAD data, the Covid-19 pandemic has had a very negative impact on FDI, with global FDI flows falling to US$1 trillion in 2020, less than the level of the previous global crisis that took place 10 years ago. To study the relationship between indicators the analysis of correlation coefficients is used [30]. These coefficients for each country are presented in the Table 3 below. The strong connection evident from the considered correlation coefficients of Russia and Turkmenistan indicates the possible systemic attraction and use of FDI, as well as the large role of oil production in the economic growth of all the countries under consideration, especially Azerbaijan and Kazakhstan.

Table 3: Correlation coefficients for the considered macroeconomic indicators (GDP, oil production, FDI)

Azerbaijan	*lO*	*lGDP*	*lFDI*	*Kazakhstan*	*lO*	*lGDP*	*lFDI*
lO	1			lO	1		
lGDP	0,9799	1		lGDP	0,9107	1	
lFDI	0,6802	0,6934	1	lFDI	0,4776	0,5271	1
Russia	*lO*	*lGDP*	*lFDI*	*Turkmenistan*	*lO*	*lGDP*	*lFDI*
lO	1			lO	1		
lGDP	0,9088	1		lGDP	0,8261	1	
lFDI	0,8251	0,8782	1	lFDI	0,7396	0,9611	1

Source: The US Information Agency

CONCLUSION

There has been renewed interest in the analysis of the FDI growth nexus, specifically in emerging economies of CIS countries' biggest global exporters of fossil fuels. There is no doubt that natural resources, fossil fuels are an important source of national wealth around the world [28]. Meanwhile, the questions on the nexus of economic growth with the FDI in countries of CIS arise. According to the analysis results, there is some strong relation between the FDI attraction and economic growth in two of the four countries considered, while two others i.e. Azerbaijan and Kazakhstan do not strongly support such an opinion. Furthermore, there is a correlation between oil production and FDI strong for all four countries of CIS considered, meaning that the fossil fuel – oil production here plays a great role in total production. Thus, the role of the oil sector shall be studied more.

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Article submitted to the Proceedings Book of the VIth. International Symposium–2022, *Theme: "Biosphere & Environmental Safety"*	Biosphere and Environmental Safety VI.th International Symposium-2022	ISBN: 978-963-449-285-6 Online May 5-6, 2022 ICEEE, Óbuda University, Budapest, Hungary

IMPACT OF FLOODS ON SOIL MICROBIAL BIOMASS AND ACTIVITY AT A FLOODPLAIN CONTAMINATED BY FORMER METAL MINING

Tibor SZILI-KOVÁCS*, Tünde TAKÁCS

Department of Soil Biology, Institute for Soil Sciences, Centre for Agricultural Research, Budapest, Hungary Szili-Kovács T., e-mail: szili-kovacs.tibor@atk.hu

Mining and metal industry are the main sources of soil contamination by adverse metals causing environmental risk to human health and ecosystem. River floodplains near to metal mines or industrial centers are frequently flooded with heavy metal containing sediment that may exhibit toxic effects towards soil biota. The objectives were to study a metal contaminated site if there are differences in soil microbial properties; and if there are significant relationships between soil biological and chemical properties. The study site was located near Gyöngyösoroszi village at the floodplain of the river which were contaminated by heavy metals. Soil samples were taken from willow and maize plantation. Soil basal respiration, substrate-induced respiration, soil microbial biomass carbon (MBC) and acid phosphatase activities were measured together with soil chemical properties. As, Pb, Zn, Cu, Cd and Ca content in soil was significantly higher at polluted, while phosphorus and potassium was significantly higher at unpolluted site. The substrate-induced respiration was in positive correlation with MBC and negative correlation with respiration quotient (qCO_2). MBC was in positive correlation with plasticity index and phosphorus, while negative correlation with total salt and Cd, Pb, Zn, As, and Cu content. Acid phosphomonoesterase activity was in negative correlation with plant available phosphorus content, and with MBC, while positive correlation with toxic elements (Cd, Pb, Zn, As, and Cu). A strong positive correlation was found between qCO_2 and toxic element content, showing that the respiration quotient is a sensitive indicator for metal pollution at floodplain soil.

***Keywords**: heavy metal, lead zinc mine, pollution gradient, microbial activity, phosphatase activity, soil respiration*

INTRODUCTION

Mining and metal industry are the main sources of soil contamination by adverse metals causing environmental risk to human health and ecosystem. Mining areas contain large quantities of spoils, tailings and flotation sludge that characterized high content of heavy metals. Heavy metals could be mobilized from minerals by weathering and leaching. To mitigate the environmental problem caused by soil contamination by metals various remediation techniques are used. Probably the most economic way is the stabilization of pollutant elements by additives [1] and revegetation of the contaminated area. River floodplains near to metal mines or industrial centers are time and time again are flooded with heavy metal containing sediment along rivers e.g. as Rhine in Germany and Netherland, Meuse in Netherland or Tisza in Hungary [2-4].
Heavy metals exhibit toxic effects towards soil biota: they can affect key microbial processes ([5,6] and decrease the number and activity of soil microorganisms [7]. Thus, the biological properties of such soils are usually severely affected. Conversely, long-term heavy metal effects can increase

bacterial community tolerance [8] as well as the tolerance of fungi such as arbuscular mycorrhizal (AM) fungi; this can play an important role in the restoration of contaminated ecosystems [9-11]. Nevertheless, microorganisms respond quickly to changes and can rapidly adapt to environmental conditions. Extreme metal contamination in the vicinity of smelters caused clearly visible effects such as accumulation of deep layers of organic matter on the soil surface through inhibition of the activity of soil microorganisms and soil fauna [12, 13].

Microbial biomass C decreased with metal-enriched (Cu, Ni, Zn and Cd) sewage sludge by chloroform fumigation incubation and also microscopic investigations [14]. Fliessbach et al. [15] found that not only microbial biomass but the microbial biomass C to soil organic C ratio is also decreased after addition of metal enriched (Cr, Cu, Cd, Pb, Hg, Ni, Zn) sewage sludge to the soil. Other studies indicate that biomass-C per total organic-C [15-18], specific respiration activity (qCO_2) [15-19] and the formation of biomass-C from added C-source [20,21] can also be used as an indicator of soil pollution. Biomass specific respiration i.e. soil respiration per unit microbial biomass increased especially the fungal respiration increased in higher extent due to the treatments. Knight et al. [22] studied soils at the current UK limit values with Cu, Cd and Zn and found that Cd and Cu treatments decreased the microbial biomass C while Cu and Zn decreased the metabolic potential of the soil microbial community. Soil microbial biomass C was significantly lower even 6 years after the artificial contamination by Cd, Cu or Ni salts in field samples [23].

Sediment is originated from metal mine contains not only high concentration of heavy metals, but often contains in lower volume nutrient element, as nitrogen or phosphorus. The nutrient element content and theirs bioavailability, firstly nitrogen and phosphorus are determinant factors for microbial processes. Further effect of heavy metals on the available phosphorus content is direct, e.g. non-soluble inorganic compound with Pb, and indirect, determining hydrolysis of organic phosphorus sources by phosphatases, and so phosphorus cycle. Toxic metal decreases microbial biomass in soils [24,25] and can inhibit transformation of soil organic matter and increase the ratio of labile to total fraction [26].

The enzymes related to C-decomposition were less influenced by metals treatments, while arylsulphatase and phosphatase activities were among the most sensitive microbial properties. Phosphatase activity showed a sensitive response to metal contamination according to several studies [27,28]. Different phosphatase reaction affecting heavy metals determined by metal characters, concentration and soil properties e.g. pH value [12, 24].

The ore mining began during the middle-age, however the large-scale vein-type exploitation took place between 1954 and 1986 years at Gyöngyösoroszi in the Mátra Mountains, Hungary. The mining and ore-dressing was stopped when the significant contamination was proved at all length of the Toka Creek and vicinity streaming water to a reservoir at the edge of a town of Gyöngyös. Possible sources of metals included the mine dumps, the flotation waste dump, various water reservoirs and the mine water [29]. Metals were released from the mine site during filtering, storage and transportation of ore and waste material. Sometimes the flotation waste slurry was entered directly into the Toka Creek from the ore-dressing plant and moreover dams burst of the flotation reservoir resulted some 100,000 tons of mud release into the valley of Száraz Creek. Technological neglects and breakdowns were also contributed to the spread of the contamination. The total loss amounted to approximately 800 tons of galena–sphalerite concentrates. The maximum concentrations of heavy metals were always found in the so-called yellow sand horizon, which can be easily identified in the soil section. The gray color of the original flotation dump material was due to the presence of pyrite and marcasite. The latter were oxidized on the surface to give limonite and jarosite, which color the sand yellow. The flotation waste and the concentrates that reached the stream-bed were carried great distances by floods and distributed on the flood plain. The attenuation of high metal concentrations in soils is due in part to mixing of this material with the natural erosion products found on the flood-plain and in part to dissolution and transport of metals away from the yellow sand deposits [29].

The most severe contaminations were measured in the upper soil layer along the stream which can be explained by repeated floods [30]. In contrary, that floods significantly contaminated soils in many gardens of the village the calculated human health risk considering the homegrown vegetable consumption and soil ingestion was within the acceptable range [31]. Although many studies have investigated the effect of metal contamination on soil biological properties only very few of them studied the contamination caused by flooding originated from Pb/Zn ore, therefore more information

are needed especially for the planning and monitoring the success of phytoremediation of contaminated floodplain.
The objectives were to study a metal contaminated site resulted from historical and immediate flooding that contaminated by abandoned Pb/Zn mine tailings (i) if there are differences in the soil metal accumulation at the site under phytoremediation depending on plant and distance from the stream; (ii) there are differences in soil microbial properties depending on plant and the metal accumulation; (iii) there are significant relationships between soil biological properties, soil physical and chemical properties and metal accumulation.

MATERIALS AND METHODS

The study site was located approximately 300 meters south from Gyöngyösoroszi village between the village and the so-called agricultural water reservoir at the bank of Toka Creek in Northeast Hungary (47°49′ N, 19°54′ E; 211 m a.s.l., Figure 1).

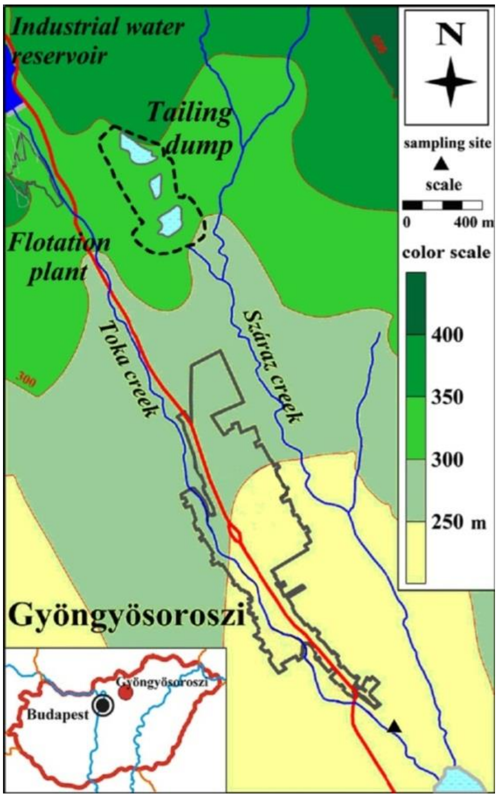

Figure 1. Soil sampling location at the Toka Creek, NE Hungary, redrawn after Sipter et al., (2008)[31].

Soil type was Fluvisol, organic C 2.32%, total N 0.15%, pH_{CaCl2} 7.1, lime content 0.9%, particle composition was sand 31%, loam 49% and clay 20%. Several floods polluted the soils along Toka Creek in the last decades. The last most severe flooding was caused by high summer precipitation in 2004 when river flooded the experiment site and newly transported sediment was laid. An approximately 5-10-meter wide zone along the stream was polluted by fresh sediment while that located more than 15 meters from the stream considered unpolluted according to soil analyses at this site. The sediment contained heavy metals as zinc (Zn), lead (Pb), cadmium (Cd), copper (Cu), mercury (Hg) and nonmetal elements arsenic (As) and sulfur (S) in excess concentration. The pollution distribution was quite unequal resulted from the microtopography of the site, but generally the zone closest to stream was the most polluted [30].

Dominant plant species at the site, prior a phytoremediation experiment establishment, were *Calamagrostis epigeios* L., *Salix* and *Populus* sp. At the nearby site was dominated by mainly orchards (*Prunus domestica* L., *Malus domestica* Borkh.) and shrubs as Common Blackberry (*Rubus fruticosus* L.) and vegetable as potato (*Solanum tuberosum L),* and tomato *(Lycopersicum aesculentum L.).*
A phytoremediation experiment was set up from 2003 by planting willow (*Salix* sp.) and corn (*Zea mays* L.) in three lines perpendicular to the streamline. Before plantation all vegetation were removed from the site.
Soil samples were taken at 18 points along the planted three lines, normal to the stream in the fall of 2004 year after a severe flood. 3-3 sampling points along two planted willows and one corn lines from both polluted and unpolluted zones were sampled from the rooting zone. Each sample was a composite of six individual soil core (0–20 cm) around a plant.
Soil samples after thorough mixing in the lab were divided for soil moisture, soil chemical and microbiological analyses. Gravimetric moisture content (GWC %) of the soil samples was measured after drying at 105°C. Soil plasticity index (K_A) was used as a texture characteristic of the soil samples. Soil chemical analyses were performed from air-dried, thoroughly mixed, sieved (< 2mm) soil samples such as soil organic carbon (SOC) by Walkley-Black wet oxidation; lime ($CaCO_3$ %) content with calcimeter; soil pH_{H2O} and pH_{KCl} with pH-meter and glass electrodes in 1:2.5 soil to water or 1N KCl ratio suspension, total salt percent from the saturated paste. Total element content of soils for Cd, Hg, Pb, Zn, As, Cu, P, K and Ca was determined according to MSZ 21470-50:1998 [32], after soil extraction by hydrochloric acid/nitric acid and microwave-assisted digestion. Potentially bioavailable fraction of the elements was measured from the LE-extract [33]; 0.5 M ammonium-acetate + 0.02 M EDTA + acetic acid 0.5 M, buffered at pH 4.65, 1 h shaking). The element content for both aqua regia and LE-extract was measured by inductively coupled plasma atomic emission spectrometry (ICP-AES: JY Ultima2, Jobin Yvon, Villeneuve d'Ascq, France).
Soil samples for biological analyses were sieved at their original moisture (<2mm) and stored at 4 °C until the analyses were performed.
Soil basal respiration (BRESP) and substrate-induced respiration (SIR) measurements were based on CO_2 evolution by gas chromatography [34]. 2.0 g of moist soil was weighted into a 25 cm^3 vessel. Evolved CO_2 was measured 4 and 24 hours after closure and the difference between them gives the rate of CO_2 production (i.e. basal respiration). The incubation was performed in shaking water bath (22°C ±0.1°C). After finishing basal respiration assay, substrate-induced respiration was measured from the same samples. 200 µl glucose solutions were added to a sample (8 mg glucose g^{-1} soil) and the evolved CO_2 was measured after 180 minutes.
The CO_2 was measured by a gas chromatograph (FISONS GC 8000) from 250 µl gas sample. Soil microbial biomass C was measured by chloroform fumigation extraction from 15 g of soil [35]. From the filtered soil extract, organic C was measured with a combustion TOC analyzer (Apollo 9000, Teledyne Tekmar, Mason, Ohio, USA). The equation used for microbial biomass calculation was $MBC = (Cfum - Cnfum)/K_{EC}$ where: *MBC* is the microbial biomass C, *Cfum* is the organic C from the fumigated extract, *Cnfum* is the organic C in the nonfumigated extract, K_{EC} is the conversion factor (k_{EC}= 0.45; [36]). Respiration quotient (qCO_2), i.e. the basal respiration per unit microbial biomass C (BRESP/MBC) and the ratio of microbial biomass C per soil organic C (MBC/SOC) were also calculated. Acid phosphatase activities (APA) were determined according to Tabatabai and Bremner [37] from 1 g of moist fresh soil after adjustment of soil pH 5.5. After the addition of a buffered p-nitrophenyl phosphate solution, soil samples were incubated for 1 h at 37°C. The nitrophenol released by phosphomonoesterase activity was extracted and colored with sodium hydroxide, and determined photometrically at 400 nm. All analyses have performed in three replicates.

STATISTICAL ANALYSIS

Statistical analysis was carried out with the statistical package SPSS v9.0 provided by SPSS Inc (Chicago, IL, USA). Two-way analysis of variance (ANOVA) considering the plantation lines as factor 1 (willow1, willow2, and corn) and pollution as factor 2 (unpolluted and polluted), after normality (Kolmogorov-Smirnov test) and homogeneity of variances (Levene-test) check was used to evaluate experimental data, and Tukey HSD or Dunnett's C posthoc test used if they were applicable. Spearman's non-linear correlation between variables was calculated.

RESULTS

SOC and pH was marginally significantly higher at unpolluted zone ($p=0.097$ and $p=0.070$). Soil moisture ($p=0.014$) and total salt content was significantly higher at polluted than unpolluted zone, the plasticity index was significantly lower at polluted zone (Table 1).

Table 1. Main properties of soil samples collected from the polluted and unpolluted floodplain of Toka creek near Gyöngyösoroszi village

Sampling point	Organic C %	pH_{H2O}	pH_{KCl}	$CaCO_3$ %	K_A	Salt %	GWC %	Ca^a	P^a	K^a
	Willow-1 unpolluted									
1	1.46	7.46	6.86	0.57	51	0.09	19.55	8391	1106	**13327**
2	2.39	7.20	6.50	traces	49	0.09	18.90	10233	1245	**10853**
3	1.92	7.30	6.55	traces	47	0.07	19.17	8867	1005	**9435**
	Willow-1 polluted									
4	2.04	6.75	6.47	0	44	0.12	22.05	20205	838	**3958**
5	1.79	6.70	6.32	0	44	0.13	17.41	9810	847	**6528**
6	2.01	6.77	6.46	0	46	0.13	22.62	19794	815	**5656**
	Willow-2 unpolluted									
7	2.34	7.28	6.59	0.53	51	0.08	18.89	9603	1162	**10748**
8	1.75	7.35	6.59	traces	46	0.09	17.52	9822	1083	**10957**
9	2.08	7.39	6.51	traces	47	0.06	18.40	9639	1071	**11516**
	Willow-2 polluted									
10	1.86	7.08	6.86	traces	42	0.13	19.14	25118	481	**3657**
11	2.10	6.86	6.53	0	48	0.13	22.60	19443	998	**4866**
12	1.48	6.57	6.28	0	44	0.13	21.46	19118	720	**5148**
	Corn unpolluted									
13	2.00	7.45	6.68	traces	46	0.08	20.15	9608	1062	**10765**
14	2.10	7.46	6.59	traces	46	0.07	17.91	10913	1153	**13287**
15	2.04	7.40	6.63	traces	46	0.07	18.79	9874	1096	**9581**
	Corn polluted									
16	1.56	6.53	6.31	0	33	0.10	23.62	17183	686	**5142**
17	1.72	6.47	5.91	0	33	0.11	19.20	17107	720	**4736**
18	**1.08**	**6.95**	**6.65**	**0**	**34**	**0.11**	**22.81**	**17287**	**679**	4076

GWC%= gravimetric water content (g water/100 g soil);
[a] Concentration are presented as mg kg^{-1}

The As, Pb, Zn, Cu, Cd and Ca content in soil was significantly higher at polluted, while phosphorus and potassium was significantly higher at unpolluted zone (Table 2).
The mercury content was in the range of 0.9-1.8, 1.3-3.1 and 1.3-6 ppm for willow-1, willow-2 and corn lines in polluted zone, while it was under the detection limit (0.12 ppm) in all lines at unpolluted zone.
In LE-extract the Hg was under the detection limit in all samples (Table 3).
The sulfur content was also significantly higher in polluted zone (data not shown). Soil characteristics differed in the three lines. Although the soil As, Pb, Zn, Cu, Cd, P, content in both aqua regia and LE extracts were not differed among sampling lines, but the ratio of the LE-soluble per aqua regia soluble Cd and Zn content were significantly different between the willow lines and corn line. The total salt content was significantly higher at willow-1 than corn while willow-2 was between and did not differ

from them. The plasticity index (K_A) at corn line was significantly lower than at willow-1 and willow-2. The soil pH and SOC was not differed among sampling lines.

Table 2. Pollutant element content of soils samples (aqua regia extract) collected from the polluted and unpolluted site of the floodplain of Toka creek near Gyöngyösoroszi village

Sampling point	Cd	Hg	Pb	Zn	As	Cu
Willow-1 unpolluted						
1	0.360	<0.12	35	141	21.3	**62.3**
2	0.932	<0.12	65	274	25.4	**100**
3	0.575	<0.12	47	199	22.6	**87.6**
Willow-1 polluted						
4	19.7	1.77	1409	3181	216	**325**
5	11.9	0.947	724	2190	147	**197**
6	16.9	1.79	1620	2873	204	**315**
Willow-2 unpolluted						
7	0.618	<0.12	47	211	23.1	**84.5**
8	1.05	<0.12	64	285	24.4	**90.4**
9	0.698	<0.12	56	221	21.6	**105**
Willow-2 polluted						
10	28.8	3.11	2827	4417	341	**494**
11	18.9	1.29	1183	3185	190	**298**
12	15.4	2.08	1974	2650	240	**365**
Corn unpolluted						
13	0.524	<0.12	47	188	22.3	**93.0**
14	0.625	<0.12	53	240	22.9	**107**
15	0.635	<0.12	56	213	22.2	**103**
Corn polluted						
16	19.8	2.66	1047	3544	253	**297**
17	18.4	5.98	1097	3370	308	**306**
18	**15.7**	**1.36**	**722**	**2933**	**196**	**226**

All values are presented as mg kg^{-1}

Basal respiration was marginally (p=0.079) higher at polluted than unpolluted zone. Substrate induced respiration and microbial biomass C was significantly higher in unpolluted than polluted zone, while APA was significantly higher at polluted zone. The two calculated indices, qCO_2 was significantly higher, while MBC/SOC was significantly lower at polluted zone (Table 4).

Table 3. Pollutant element content of soil samples (LE-extract) collected from the polluted and unpolluted site of the floodplain of Toka creek near Gyöngyösoroszi village

Sampling point	Cd	Hg	Pb	Zn	As	Cu
Willow-1 unpolluted						
1	0.304	<dl	17	36	1.8	**38.5**
2	0.705	<dl	28	100	1.4	**48.5**
3	0.506	<dl	21	69	0.8	**45.1**
Willow-1 polluted						
4	11.524	<dl	491	1855	2.16	**125.7**
5	7.706	<dl	226	1100	1.97	**74.5**
6	9.825	<dl	457	1603	1.58	**116.4**
Willow-2 unpolluted						

7	0.519	<dl	22	76	1.1	**43.1**
8	0.857	<dl	31	108	1.4	**47.4**
9	0.517	<dl	22	72	0.7	**47.2**
Willow-2 polluted						
10	14.8	<dl	888	2896	2.1	**128.1**
11	11.3	<dl	444	1879	2.7	**103.5**
12	9.25	<dl	403	1450	0.9	**110.7**
Corn unpolluted						
13	0.436	<dl	20	62	0.8	**42.9**
14	0.461	<dl	21	67	0.9	**46.1**
15	0.509	<dl	28	73	0.9	**51.1**
Corn polluted						
16	7.48	<dl	339	1083	1.6	**93.5**
17	7.27	<dl	329	961	1.8	**94.2**
18	**6.50**	**<dl**	**267**	**977**	**1.9**	**66.7**

*dl – detection limit
All values are presented as mg kg^{-1}.

Total salt content was in positive correlation with toxic metal concentration of Cd, Pb, Zn, As, and Cu (Table 6). The phosphorous content was in negative correlation with total salt content. There were significant positive correlations (near to 1:1 lines) between the decisive pollutants, e.g Zn and Cd, Zn and Pb, and positive, but lower b value was in the linear correlation between the As and Zn or Cd or Pb content. The substrate-induced respiration (SIR) was in positive correlation with soil microbial biomass C (MBC), MBC/SOC and negative correlation with qCO_2 and was also correlated with SOC and LE-P content, pH, and plasticity index (Table 5) Soil microbial biomass C (MBC) was in negative correlation with qCO_2 and also with acid phosphatase activity. SIR was in negative correlation with total salt content and also with Cd, Pb, Zn, As, and Cu (Table 6). MBC was in positive correlation with plasticity index and phosphorus, while negative correlation with total salt and Cd, Pb, Zn, As, and Cu content (Table 7).

Table 4. Means±SD values of soil microbial properties collected from polluted and unpolluted floodplain of Toka creek near Gyöngyösoroszi village

Sampling point	**Basal respiration (µg CO_2-C g^{-1} soil h^{-1})**	**Substrate induced respiration (µg CO_2-C g^{-1} soil h^{-1})**	**Soil microbial biomass C (µg C g^{-1} soil)**	**qCO_2 (µg CO_2-C hour^{-1} mg biomass C^{-1})**	**MBC/SOC %**	**Acid phosphatase activity (µmol g^{-1} soil h^{-1})**
Willow-1 unpolluted						
1	0.872±0.19	4.13±0.09	197±53	4.42±0.96	0.97±0.26	**0.781±0.02**
2	n.d.	n.d.	121±22	n.d.	0.68±0.12	**0.962±0.03**
3	1.257±0.30	3.59±0.34	160±24	7.86±1.91	0.80±0.12	**0.779±0.02**
Willow-1 polluted						
4	2.059±0.45	2.42±0.26	53.5±13	38.5±8.35	0.37±0.09	**1.455±0.02**
5	1.047±0.16	1.92±0.48	31.2±11	33.6±5.14	0.13±0.05	**1.120±0.05**
6	2.356±0.59	2.54±0.18	54.7±11	43.1±10.94	0.28±0.05	**1.721±0.05**
Willow-2 unpolluted						
7	0.952±0.52	5.55±0.67	168±99	5.67±3.07	1.45±0.85	**0.969±0.03**
8	0.878±0.05	4.02±0.43	218±100	4.03±0.21	1.04±0.48	**0.777±0.02**
9	2.117±0.42	4.55±0.51	253±33	8.36±1.67	1.71±0.22	**0.821±0.03**
Willow-2 polluted						
10	1.952±0.18	2.45±0.21	50.4±16	38.7±3.49	0.22±0.07	**0.878±0.01**
11	2.655±0.48	2.66±0.32	117±5	22.6±4.10	0.67±0.03	**1.585±0.08**
12	1.598±0.46	2.73±0.12	121±45	13.2±3.85	0.58±0.22	**1.186±0.02**

Corn unpolluted						
13	0.348±0.02	7.53±0.27	143±32	2.43±0.17	0.72±0.16	**1.163±0.07**
14	0.596±0.21	8.22±0.73	147±38	4.07±1.40	0.70±0.18	**1.358±0.06**
15	0.494±0.13	7.55±0.25	112±32	4.41±1.19	0.55±0.16	**1.304±0.07**
Corn polluted						
16	0.352±0.04	2.38±0.15	18.8±12	18.7±2.29	0.12±0.01	**1.516±0.08**
17	0.488±0.05	2.31±0.12	21.9±29	22.2±2.18	0.13±0.17	**1.537±0.08**
18	**0.241±0.03**	**2.47±1.71**	**35.4±14**	**6.81±0.96**	**0.33±0.13**	**1.444±0.09**

n.d.= not determined

Basal respiration was significantly lower at corn than willow-1 and willow-2 lines. Substrate induced respiration significantly differed among all the three lines, corn had the highest, higher than willow-2 and the lowest was at willow-1. Microbial biomass C was the highest at willow-2, while willow-1 and corn did not differ. The significantly highest APA was at corn, the lowest at willow-2 while willow-1 was between the two others and did not differ significantly from them. Respiration quotient (qCO_2) was significantly higher at willow-1 than corn, while willow-2 did not differ from corn and willow-1.

MBC/SOC was significantly higher at willow-2 than willow-1 and corn; these later had no significant difference. The result of rank-correlation analysis has shown many significant relationships among the investigated soil physical, chemical and biological properties (Table 5-7). The plasticity index (K_A) was in negative correlation with toxic metal concentration of Cd, Pb, Zn, As and Cu, but in positive correlation with phosphorus, SOC and pH.

Table 5. Spearman's rank correlation between variables

	SIR	**qCO_2**	**MBC/SOC**	**APA**	**SOC**	**pH_{H2O}**	**K_A**	**salt**
Cmic	0.777***	-0.586 *	0.979 ***	-0.668 **	0.361 NS	0.755 ***	0.789 ***	**-0.621 ****
SIR		-0.779 ***	0.776 ***	-0.370 NS	0.485 *	0.862 ***	0.678 **	**-0.733 *****
qCO_2			-0.625 **	0.458 NS	-0.117 NS	-0.728 ***	-0.368 NS	**0.739 *****
MBC/SOC				-0.637 **	0.416 NS	0.747 ***	0.804 ***	**-0.664 ****
APA					0.084 NS	-0.555 *	-0.440 NS	**0.453 +**
SOC						0.272 NS	0.610 **	**-0.390 NS**
pH_{H2O}							0.632 **	**-0.738 *****
K_A								**-0.448 NS**

K_A=plasticity index

The upper rows show correlation coefficients, the lower show the level of significance (2-tailed),

Acid phosphomonoesterase activity (APA) was in negative correlation with LE-P content, and with MBC, MBC/SOC, while positive correlation with toxic elements (Cd, Pb, Zn, As, and Cu) (Table 7). A marginal negative correlation was found with soil "total" phosphorus content (p=0.076) and plasticity index (p=0.068), not shown in Table.

Table 6. Spearman's rank correlation between aqua regia element content and soil physical and chemical properties

	SOC	**pH_{H2O}**	**K_A**	**salt**	**moisture**	**LE-P**
Cd-Tot	-0.274 NS	-0.786 ***	-0.675 **	0.735 ***	0.439 NS	-0.764 ***

Pb-Tot	-0.259 NS	-0.781 ***	-0.608 **	0.837 ***	0.389 NS	-0.738 ***
Zn-Tot	-0.312 NS	-0.786 ***	-0.716 ***	0.723 ***	0.418 NS	-0.77 ***
As-Tot	-0.377 NS	-0.861 ***	-0.732 ***	0.779 ***	0.457 NS	-0.784 ***
Cu-Tot	-0.269 NS	-0.707 ***	-0.692 ***	0.735 ***	0.426 NS	-0.781 ***

The upper rows show correlation coefficients, the lower show the level of significance (2-tailed)

Table 7. Spearman's rank correlation between aqua regia (X-Tot) or LE-extractable (X-LE) element content and soil microbial properties

	BRESP	SIR	MBC	qCO_2	MBC/SOC	APA
Cd-Tot	0.279 NS	-0.757 ***	-0.735 ***	0.770 ***	-0.744 ***	0.556 *
Cd-LE	0.539 *	-0.728 ***	-0.616 **	0.858 ***	-0.637 **	0.465 +
Pb-Tot	0.443 NS	-0.667 **	-0.649 **	0.793 ***	-0.703 ***	0.526 *
Pb-LE	0.45 NS	-0.692 **	-0.661 **	0.82 ***	-0.688 **	0.545 *
Zn-Tot	0.174 NS	-0.757 ***	-0.758 ***	0.713 ***	-0.765 ***	0.573 *
Zn-LE	0.515 *	-0.701 ***	-0.627 **	0.828 ***	-0.644 **	0.48 *
As-Tot	0.108 NS	-0.77 ***	-0.759 ***	0.684 **	-0.772 ***	0.523 *
As-LE	0.182 NS	-0.70 **	-0.61 **	0.60 *	-0.583 *	0.392 NS
Cu-Tot	0.348 NS	-0.623 **	-0.677 **	0.765 ***	-0.724 ***	0.624 **
Cu-LE	0.453 NS	-0.686 **	-0.696 ***	0.831 ***	-0.74 ***	0.564 *

The upper rows show correlation coefficients, the lower show the level of significance (2-tailed),

DISCUSSION

Elevated heavy metals, arsenic and sulfur contents of soil samples in all three planted lines compared to that taken from longer distances proving that floods significantly contaminated a part of the floodplain close to the stream. The content of inorganic contaminants was more than one order of magnitude higher in polluted than unpolluted zone of the floodplain in this study. This observation was well fit the previous survey [30] related to soil analyses of many sites along Toka Creek. The laid sediment had sandy characteristics, which resulted lower plasticity index, lower phosphorus and potassium content of soils at contaminated zone. Soil pH was higher at this site than other sites along the Toka Creek according to previous data, which indicated sulfur oxidation [30] resulted from the use of liming technology for water cleaning.
Compared to the control, mining soils were polluted by heavy metals, Cu, Zn, Pb and Cd, resulting in decreases of sucrase activities, urease activities, acid phosphatase activities, MBC, MBN, MBP, and N mineralization, and increases of basal respiration and qCO_2 have been well documented in previous reports [38-44]. We also found a decreased soil microbial biomass C in metal contaminated zone compared to uncontaminated.
There is now a considerable amount of evidence documenting a decrease in the soil microbial biomass as a result of heavy metal contamination [40,41,43,44]. The reasons are possibly due to

microorganisms in soil under heavy metal stress diverting energy from growth to cell maintenance functions [45]. Moreover, in contaminated soils, microorganisms need more energy to survive in unfavorable conditions. Therefore, a higher percentage of energy is lost, and less C, N and P are built into organic components [46].
The results were inconsistent with the reports of Wang et al. [47], who found that soil microbial biomass C did not correlate with heavy metals and is not proposed as sensitive indicator for evaluating the environmental effects of heavy metal pollution. Only the oligotrophic bacteria had significant negative correlation with soil heavy metal content, as the most sensitive group of bacteria to metal contamination, but the ratio of available to total Pb and Cu also had negative correlation with substrate induced respiration [48].
The ratio of biomass C-to-soil organic C is an indicator of the relative availability of substrate for soil microorganisms [49] and the ratio respiration-to-biomass C is an important indicator of the efficiency of substrate use and thus of microbial stress were proposed [50,51].
A high respiration rate might indicate either an ecological disorder, or a high level of productivity in the ecosystem [52]. The respiration rate per unit of microbial biomass or metabolic quotient is a variable of easier interpretation. The qCO_2 has been utilized as a microbial stress indicator and interpreted as ‘‘microbial efficiency’’[53], since it is a measurement of the energy necessary to maintain metabolic activity in relation to the energy necessary for synthesizing biomass ([17]. Thus, soils under stress would present higher qCO_2 values than non-stressed soils. However, this qCO_2 increase may indicate an increase in microbial activity as agreed with our results.
Biochemical parameters of soil samples indicated the co-influences of the high heavy metal contents and low phosphorus content of soil. The adverse effect was explained by Ekenler and Tabatabai [54] that metal ions may inactivate enzymes by reacting with sulfhydryl groups of enzymes to forming metal sulfides. Sulfhydryl groups in enzymes may serve as integral parts of the catalytic active sites or as groups involved in maintaining correct structural relationship of enzyme protein. Metal may also inhibit enzymes by complexing the substrate, or by reacting with the enzyme–substrate complex [55]. The activation may attribute to a shift to dominant microbial composition structure after the long-term soil stress. Lower enzyme activities may be also due to energy diversion into physiological adaptations necessary to tolerate heavy metals, such as synthesis of intra- and extracellular metal-sequestering proteins or saccharides, and biochemical reactions to precipitate or trap metals onto microbial surfaces [39]. Effects of heavy metals on soil enzyme activities are generally related to main soil characteristics such as clay content, SOC and pH [56]. APA was a weak negative correlation with plasticity index as a proxy variable for clay content (higher clay content results higher plasticity index), no correlation with SOC and a weak negative correlation with pH in this study. Virtually the high metal content significantly stimulated the APA, but it could be speculated that the lower soil available P in contaminated soil could be provoked an increase in APA. Renella et al. [38] reported that alkaline phosphatase was more susceptible in the acid soil whereas acid phosphatase was more susceptible in the alkaline soil.
It is well known that microbial biomass and activities depend on SOC, clay content and pH [51]. In our study positive correlation was found between MBC and plasticity index as a proxy for clay and with soil pH, but not or a very weak with SOC. In addition, a negative correlation with total salt content was found, probably because the metal contaminated soils have higher salt content. As a long term effect of Pb and Zn accumulation in soil can show positive correlation between microbial biomass and metal content, because of the depleted rate of organic matter decomposition result accumulation of organic matter [57,58] which was not observed in this study.

CONCLUSIONS

The flooding caused by the metal contaminated stream caused a significant metal contamination in soil, which decreased from the edge with the distance. We found significant differences between polluted and unpolluted zones in microbial biomass C, qCO_2, MBC/SOC, APA, the pollution decreasing order in the three remediation lines was willow-2, willow-1 and corn. Corn line had the lowest basal but the highest substrate induced soil respiration. Soil microbial biomass was in positive correlation with plasticity index and phosphorus, while negative correlation with total salt and Cd, Pb, Zn, As, and Cu content. Acid phosphomonoesterase activity was in negative correlation with plant available phosphorus content. A strong positive correlation was found between respiration quotient (qCO_2) and toxic element content, suggesting that the respiration quotient could be a sensitive indicator for metal pollution at floodplain soils. The metal accumulation in soil was in negative correlation with pH, plasticity and soil phosphorus content, and positive correlation with salt content, while no correlation was found with soil organic carbon.

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PROMOTING PHYTOREMEDIATION BY ARBUSCULAR MYCORRHIZAL FUNGI

Tünde TAKÁCS *, Anna FÜZY

Department of Soil Biology, Institute for Soil Sciences, Centre for Agricultural Research, Budapest, Hungary Takács T., e-mail: takacs.tunde@atk.hu

Phytoremediation techniques are environmental-friendly methods for biological restoration. A small-plot field experiment was set up to examine the applicability of metal-tolerant arbuscular mycorrhizal fungi inoculants to improve the efficiency of phytostabilisation technologies. The experiments were performed on a field belonging to the Tatai Környezetvédelmi Zrt. (Environment Protection Company in Tata) using three different soil cover systems that were set up on the surface of red mud. The experiments were aimed at comparing the covering technique currently employed with possible alternative solutions. The vegetation was planted in four types of cover forming a 1 m layer on top of the red mud: I. compost, soil composite in a homogeneous order of layers; II. humified sewage sludge in a heterogeneous order of layers; III. soil cover (III/A without lignite and III/B with lignite). To test their effect maiden grass (Miscanthus sinensis 'Gracillimus') were planted with or without inoculation with selected AM fungi. There were no differences found in the element concentrations between the shoot of plants grown in plots I and II, while lower concentrations were recorded at plots III/A and III/B. The lignite had little influence on the plant element contents. Due to the substantial differences in toxic element content in the soils, the effect of AMF inoculation on element uptake exhibited different tendencies for each plot depending on the quantity and quality of the element in concern. The inoculation with selected AM fungi could be an efficient integrated technique for use on soils with high contents of toxic metals.

***Keywords**: heavy metal, phytostabilization, arbuscular mycorrhizal fungi, red mud, maiden grass*

INTRODUCTION

Among the soil degradation processes that reduce soil fertility and limit soil functions, soil contamination, caused primarily by human activities, is affecting increasingly large areas. The contamination of the soil with potentially toxic metals and non-metals represents a major threat to the environment and to human health. Soil pollution of this type is extremely expensive to eliminate and in many cases the environmental damage is irreversible. Conventional remediation technologies are not only expensive, but in many cases are unable to cope with the whole problem (Cunningham et al., 1995). The aim of bioremediation technologies is to stimulate biological soil functions using plants and/or microbial inoculants or their enzymes in order to promote biodegradation and/or the growth and tolerance of plants (Bollag & Bollag, 1995). Plants have been used to purify sewage and to decompose household waste for hundreds of years.

Phytoremediation methods can be grouped chiefly on the basis of how they neutralise or remove contaminants: (1) removal of the contaminant by extraction: (i) phytoextraction, (ii) phytofiltration, (2) stabilisation or neutralisation of the contaminant by immobilisation: (i) phytostabilization, and (3) conversion of the contaminant to less toxic or non-toxic compounds (primarily organic compounds): (i) phytovolatilisation, (ii) phytodegradation (EPA, 2001; Pulford & Watson, 2003). The technology

to be applied must be chosen site-specifically based on the nature of the polluted area, the risk to the environment and human health, and economic analysis (Wuana & Okieimen, 2011).
The latest developments in phytoremediation involve complex technologies integrating physical, chemical and biological techniques. Due to public interest in environment protection, increasing attention is given to the use of microorganisms (e.g. mycorrhizal fungi, plant growth-promoting bacteria – PGPB) that improve the efficiency of remediation processes through symbiosis or by closely cooperating with the plants (Ali and Glick 2019; Gaur & Adholeya, 2004; Khan, 2005; Takács 2001; 2003; 2008; 2012, 2014; Vosatka et al., 2001; 2006).
Most publications dealing with the use of AMF for phytostabilization purposes are based on pot experiments, while few data are available on field experiments. Very few experiments involved multicontamination, and in most cases only the total metal content of the polluted medium is reported, not the biologically available (reactive) content. It is therefore difficult to compare data from the literature.
A small-plot field experiment was therefore set up to examine the applicability of metal-tolerant AMF inoculants to improve the efficiency of phytostabilization technologies. The experiments were performed on land belonging to the Tatai Környezetvédelmi Zrt. (Environment Protection Company) in three soil cover systems set up on the surface of red mud. The aim was to compare the covering technique currently employed with possible alternative solutions in terms of both cover and vegetation.

MATERIALS AND METHODS

The experiment was laid out on 300 m² plots divided into subplots measuring approx 25 m². The vegetation was planted in four types of cover forming a 1 m layer on top of the red mud: I. compost, soil composite in a homogeneous order of layers (covering mode currently employed); II. humified sewage sludge in a heterogeneous order of layers; III. soil cover (III/A without lignite and III/B with lignite). Soil analysis was performed on the physical and chemical properties (nutrient content, potentially toxic element content) of dried samples taken from several points of the plots at a depth of 0–30 cm.
The soil of each plot was sandy loam with a light texture, containing large quantities of $CaCO_3$ (11–23%) and with very similar $pH_{(H2O)}$ values (7–8). There were considerable differences, however, in the humus content (I: 9.3, II: 6.9, III/A: 2.8, III/B: 1.9 %). The total element content was determined according to the Hungarian standard MSZ 21470-50:1998 (MSZ, 1998) and the potentially available (reactive or plant available) content from LE extract (Lakanen and Erviö, 1971) using an ICP analyser (Table 1).
On each type of cover the test plants were planted maiden grass (*Miscanthus sinensis* 'Gracillimus'), with or without inoculation with selected AM fungi. Two types of AMF inoculants were used for the microbiological treatment: *Funneliformis mosseae* **((Nicol. & Gerd.) Gerd. & Trappe;** synonym *Glomus mosseae*) adapted to metal pollution, and a mixture of *F. mosseae* and *Rhizophagus intraradices* (Biermann **&** Linderman; synonym *Glomus intraradices*) isolates. The efficiency of the AMF inoculation in terms of phytostabilization was evaluated on the basis of toxic element concentrations in the plants. The potentially toxic metal content of the shoots was determined by means of ICP analysis.
The AMF root colonisation indices were evaluated after microscopic analysis based on the method of Trouvelot *et al*. (1986) (data not shown).
Results were analysed using two-way analysis of variance (ANOVA). Data were tested for homogenity of variance by Bartlett's test. The comparisons between means were performed at significance levels of $p < 0.05$ (*), 0.01 (**) and 0.001 (***).

RESULTS AND DISCUSSION

All the soil samples from the plots were analysed for total (aqua regia, 1 HNO_3: 3 HCl) and reactive element contents, and the results are given in Table 1 for all the potentially toxic metals and non-

metals where the concentrations exceeded the B soil pollution limit (threshold value) in any of the plots. Among the elements tested: arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), mercury (Hg), nickel (Ni), lead (Pb) and zinc (Zn), the total and reactive contents of all but Cd, Cu and Hg were significantly higher in plots treated with the currently applied technology (plot I), than in those where alternative covering techniques were used.
In the case of maiden grass, there was no difference between the shoot element concentrations of plants in plots I and II, while lower concentrations were recorded for plots III/A and III/B (Table 2). Within plot III, the use of lignite as a chemical stabiliser had little influence on the plant element contents for maiden grass.
Due to the substantial differences in toxic element content in the soils of the plots, the effect of AMF inoculation on element uptake exhibited different tendencies for each plot depending on the quantity and quality of the element in question.

Table 1. Total and reactive contents of pollutants in the soil samples (*, **, ***: significantly different from the currently employed technology, plot I, at the $p < 0.05$, 0.01 and 0.001 levels, respectively)

Total concentrations of toxic metals and non-metals in the 0–30 cm soil layer [Digestion with aqua regia (mg kg^{-1})]								
	As	**Cd**	**Cr**	**Cu**	**Hg**	**Ni**	**Pb**	**Zn**
Plots	**mg kg^{-1}**	**mg kg^{-1}**	**mg kg^{-1}**	**mg kg^{-1}**	**mg kg^{-1}**	**mg kg^{-1}**	**mg kg^{-1}**	**mg kg^{-1}**
I.	61.7	12.7	305	701	5.8	124	478	1842
II.	41.3***	9.35**	235***	510***	2.5***	86***	298***	1247***
III./A	9.10***	6.53	52***	160***	0.6	35***	45***	221***
III./B	6.90***	5.66	39***	89***	0.50	30***	32***	130***
Reactive concentrations of toxic metals and non-metals in the 0–30 cm soil layer [Lakanen and Erviö (mg kg^{-1})]								
I.	3.24	6.86	8.83	204	<n.d.	31	210	881
II.	2.35	5.185	6.93*	139	<n.d.	22*	156**	564***
III./A	1.17**	5.00	1.77***	68***	<n.d.	7.83***	24***	107***
III./B	0.71***	4.38	1.15***	48***	<n.d.	5.19***	19***	64.6***
B soil pollution limit values (Joint decree 6/2009.(IV.14.) issued by the Ministries of Environment, Health and Agriculture) [Total soluble quantity (mg kg^{-1})]								
	15	1.0	75	75	0.5	40	100	200

(n.d.: Below the detection limit; As: 0.4 mg kg^{-1}; Hg: 0.12 mg kg^{-1}); I: currently employed soil covering technology – soil composite in a homogeneous order of layers; II: humified sewage sludge in a heterogeneous order of layers; III/A: soil cover in a homogeneous order of layers; III/B: soil cover in a heterogeneous order of layers with lignite.

As a C4 plant, Miscanthus species is one of the candidate species for phytoremedial purposes and its potential use as a biofuel material. *Miscanthus sinensis* × *giganteus* plants are high productivity and longevity even under extreme environmental conditions, and these plants low N fertilization requirements compared to other. Furthermore *Miscanthus plants tolerate and* can be grown on highly heavy metal polluted soils (Pavel et al. 2014). Similarly other grass hosts, the arbuscular mycorrhizal inoculation can be used as a bioaugmentation technology, promoting Miscanthus cultivation, plant vitality and fitness on highly heavy metal polluted soils (Firmin et al. 2015, Takács et al. 2001; 2003; 2012; 2014). *Funneliformis mosseae* and *Rhizophagus intraradices*-like fungi are the most intensely studied arbuscular mycorrhizal (AM) fungi.
Miscanthus grown well in the contaminated soils, tolerating high soil concentration of heavy metals. The significant effect of AMF on plant element contents could be detected even in the case of low

root colonisation values. Two-way analysis of variance indicated that the element concentrations in the maiden grass shoot were higher in the AMF1 treatment, than in AMF2 treatments (Table 2).

Table 2. Concentrations of toxic metals and non-metals in sward plants and in maiden grass shoots as a function of soil cover type and AMF treatment (*: significantly different from the data of the currently used covering technology, plot I, and from the control treatment, C, without AMF inoculation)

MAIDEN GRASS Group means		As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
		mg kg^{-1}	**mg kg^{-1}**	**mg kg^{-1}**	**mg kg^{-1}**	**mg kg^{-1}**	**mg kg^{-1}**	**mg kg^{-1}**	**mg kg^{-1}**
Factor A	**I.**	2.55	1.47	7.44	52.11	<n.d.	4.73	21.91	136
	II.	2.67	1.50	7.49	48.12	<n.d.	5.43	18.92	171
	III./A	0.82*	0.54*	1.32*	7.59*	<n.d.	1.60*	1.56*	24.5*
	III./B	0.83*	0.62*	1.56*	8.04*	<n.d.	1.17*	1.69*	21.7*
Factor B	**C**	2.21	0.95	5.43	37.42	<n.d.	3.57	14.55	95.6
	AMF1	1.57*	1.14	4.11*	28.82	<n.d.	3.14	10.23*	76.0
	AMF2	1.38*	1.01	3.82*	20.65*	<n.d.	2.98	8.28*	93.8

(n.d.: Below the detection limit; As: 0.4 mg kg^{-1}; Hg: 0.12 mg kg^{-1}); I: currently employed soil covering technology – soil composite in a homogeneous order of layers; II: humified sewage sludge in a heterogeneous order of layers; III/A: soil cover in a homogeneous order of layers; III/B: soil cover in a heterogeneous order of layers with lignite; C: control plots; AMF1: plots treated with *Funneliformis mosseae* inoculant; AMF2: plots treated with a 1:1 mixture of *F. mosseae* and *Rhizophagus intraradices* inoculant)

In all of the cases the shoot Hg concentrations were below the detection limit. In the shoots of maiden grass a significant reduction in the concentrations of As, Cr and Pb could be observed after both AMF treatments (Table 2).

The concentration of Cu was only lower than in the control plants after treatment with AMF2. With the exception of Cu, no significant difference in the metal and non-metal concentrations could be detected between the two AMF treatments for either host plant. AMF inoculation had no effect on the Cd, Ni and Zn concentrations recorded in the shoots.

As regards the individual plots, there were considerable differences both in the element concentrations measured in the leaves of the maiden grass and in the response given to inoculation with AM fungi. Plants belonging to the grass family are frequently used for phytoremediation and stabilisation purposes due to their drought and disturbance tolerance, their extensive root systems and their low metal accumulation ability (EPA, 2001). In terms of phytostabilization potential (Schmidt, 2003), the joint use of maiden grass and inoculation with selected arbuscular mycorrhizal fungi could be an efficient integrated technique for use on soils with high contents of toxic metals in comparison with conventional techniques.

Pavel et al. (2014) investigated the bioremediation potential of *Miscanthus sinensis* × *giganteus* in a long-term field experiment in Copşa Mică (Romania), an area heavily polluted with toxic metals, especially Cd and Pb, originating smelter activity. The low bioconcentration factor and transport factor values were found and the aboveground biomass contained small concentrations of Zn, Cd and Pb. *M. sinensis* × *giganteus* can be considered a heavy metal excluder plant, especially in case of Pb. In a pot experiment established with *Miscanthus sacchariflorus* and *Miscanthus sinensis* the higher contents of Cd and As in root were found than in stem and leaf, indicating that Miscanthus species is a root accumulator (Jiang et al. 2018).

CONCLUSIONS

As energy plants, investigations on the *Miscanthus* species concentrate not only on the possibility of using them for phytoremediation purposes to reduce the environmental and human health risks represented by pollutants, but also consider their production as biomass-based sources of renewable energy (Stewart *et al*., 2009). In a similar manner, dendroremediation is another alternative technology for the dual-purpose production of green energy (González-Oreja *et al*., 2008). The use of selected inocula of arbuscular mycorrhizal fungi plays an important role in supporting and optimising both aims: to increase biomass production and to reduce the uptake of toxic elements.
The environmental and human health risks arising from metal-polluted soils determine both the aim of phytoremediation and the technology to be applied. The integrated application of physical, chemical and particularly biological methods is a step towards improving the efficiency of phytoremediation methods and towards making remediation systems sustainable. The outstanding role of AM fungi in phytoremediation systems is indisputable. The plant response to AMF colonization and the efficiency of symbiosis, however, depend not only on the genotypes of the partners, but also on numerous other environmental factors. In order to maximise the effectiveness of site-specific phytoremediation and targeted mycorrhization, it will be essential to establish artificial selection systems for the identification of compatible combinations of symbiotic partners.

ACKNOWLEDGEMENT

The present study was supported by the Hungarian National Scientific Research Fund (MOKKA) NKFP 3/020/2005 and Eötvös Loránd Research Network (ELKH - SA-26/2021).

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