



VIIIth International Annual Symposium-2024

Proceedings Book

“Environmental Health and Biosecurity: Sciences, Engineering and Application”

May 9th – 10th, 2024

**Obuda University
Budapest - Hungary**



Proceedings Book

VIIIth International Annual Symposium-2024

“Environmental Health and Biosecurity: Sciences, Engineering and Application” with

Workshop Special Session: Environmental Health and Climatic Change (How humanity can solve climate change, alleviate poverty, and save biodiversity)

**May 9th – 10th, 2024
Budapest - Hungary**



2-DAY EVENT Online

VIIIth International Annual Symposium-2024 on
“Environmental Health and
Biosecurity: Sciences,
Engineering and
Application”

PROCEEDINGS BOOK
(PROGRAM, ABSTRACT & Full Papers)

Venue:
Obuda University
Budapest -Hungary

Date:
May 09 - 10, 2024

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



**VIIIth International Annual Symposium-2024 on
“Environmental Health and
Biosecurity: Sciences, Engineering and
Application”**



Considering 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 VIIIth Symposium virtually.

Online

May 09th – 10th, 2024
RKK – Obuda University
Budapest - Hungary



Content

Introduction	6
Bibliographic information	14
Acknowledgment	15
Impressum	17
Statistical Analysis	20
Symposium: Organization & Committees	22
Principal Publishing Partners	28
Symposium's Highlight Topics	29
Awards Ceremony of the Best Presentation & Manuscripts	30
Awards Ceremony	32
Scientific Program	42
Table of Publishing Contents	81
Abstracts	93
Manuscripts (oral and Posters) of the Accepted Papers	234
Invitation for the 15 th ICEEBS International Conference-2024	517



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. Environmental ecology 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.

Based on 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 VIIIth Symposium-2024 are mentioned below.

- Discusses a new environmental strategy based on the biosphere approach & considering 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-2024 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 VIIIth International Annual Symposium-2024 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 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 Artificial intelligence 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 Artificial intelligence 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, CO₂ 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 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 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. 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, most 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. 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 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 VIII.th International Annual Symposium-2024 will provide the newest innovate approaches & methods to prevent the environment & secure the environmental elements (Air, Soil, Water, Biodiversity, Food, Health, Wastes, etc.) based on research on life sciences, engineering, modern biotechnology & also provide the platform for all experts from academia, industry & research laboratory to discuss the latest hot research & achievements.

Based on the huge success of last events, I am strongly confident that the VIII.th Symposium-2024 will be a great success & meet our expectations.



Moreover, the VIII.th Symposium-2024 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, 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 Obuda University, Rejto Sandor 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 VIIIth. International Annual Symposium-2024 on **“Environmental Health and Biosecurity Strategy”** ONLINE event during 9th and 10th of May 2024 at Obuda University RKK, Budapest - Hungary.

Publication of the abstracts & full papers are published in the **ISBN Proceedings book** with the code: **ISBN 978-963-449-365-5**.

For more information, please visit the following websites:

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

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

Yours Sincerely,

rof. Dr. Hosam E.A.F. Bayoumi Hamuda
President of ICEEE
Chair, VIIIth International Symposium-2024
Editor, Proceedings Book
Chair of Organizing Committee
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	30 th of September 2024
Product Type	Proceedings Book of VIIIth International Annual Symposium-2024
Proceedings Book Title	“Environmental Health and Biosecurity Strategy”
ISBN	ISBN 978-963-449-365-5
Number of Pages	518 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



ACKNOWLEDGMENT

Dear Guests and Colleagues

Thank you very much for your attendance in the VIIIth International Annual Symposium-2024 which was in Budapest during May 9-10, 2024, online in Budapest at Obuda University, Hungary.

The VIIIth International Annual Symposium-2024 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 VIIIth International Symposium-2024 was to deals with „Environmental Safety and Biospheret”. Environmental Sustainability is projected to harm human health through adverse changes in security of the lifestyle.

The VIIIth International Annual Symposium-2024 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 VIIIth International Annual Symposium-2024 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 VIIIth International Annual Symposium-2024 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.

We, the editor, would like to thank the members of the organizing, scientific, and administrative committees and all the supporting staff for giving this opportunity.



We would also like to extend our sincere thanks to all the contributors and reviewers who have made this Proceedings Book possible. We hope that the papers in this Proceedings Book will inspire further research and innovation in this important field.

Sincerely,

At the end, the organizing committee of the VIIIth International Annual Symposium-2024 wish all the best for all the participants and thank their attendance.

Prof. Dr. Hosam E.A.F. Bayoumi Hamuda
President of ICEEE
Chair, VIIIth International Symposium-2024
Editor, Proceedings Book
Chair of Organizing Committee



IMPRESSUM

For the Program, Abstracts and the Proceedings Book of the papers of the VIIIth International Annual Symposium-2024

- The official language was English.
- The Program, Abstracts and Full papers of the VIIIth International Annual Symposium-2024 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 VIIIth International Annual Symposium-2024 are published in the Conference Proceedings Book with the ISBN 978-963-449-365-5. in CD-ROM format and online (electronic) on 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 shall be responsible for any possible errors
- The Publisher of the Program, Abstracts and the Proceedings Book of the VIIIth International Annual Symposium-2024, Institute of Environmental Engineering and Natural Sciences, Rejto Sandor Faculty of Light Industry and Environmental Engineering, Obuda University, Budapest, Hungary.
- Publication year of the Proceedings is **2024**.
- Important Website: www.iceee.hu

Attention:

- ✚ The VIII.th Symposium-2024 will be held through **Microsoft Teams**.
- ✚ To join the Symposium:
 - There is a short guide with useful information about how to use the Microsoft Teams during the Symposium
 - The participants will have the link of the Symposium
 - The time of the Symposium is related to the **Hungarian time**.
- ✚ Please check the time with your time at home

Time of Oral Presentations Online (Microsoft Teams)

Presentation Type:	Total Allotted Time:
• Plenary speaker	25 min
• Keynote speaker	20 min
• Featured speaker	10 min
• Poster	5 min



Please note that:

- ✚ The time is very limited
- ✚ The official language of all the presentations including oral or poster speaker is **English**

For Full paper:

The deadline to send the full paper is the end of June (30th of June 2024) in word document form.

30th of September 2024.

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



Statistical Analysis of the VIIIth International Symposium-2024

The International Council of Environmental Engineering Education (ICEEE) had the pleasure to announce about the **VIIIth International Symposium-2024 Online** (Microsoft Teams)

Topic: **Environmental Health and Biosecurity Strategy**

Date: **May 9th – 10th, 2024**

Total presentations: 88

The participants in this Symposium came from **29** countries covering as examples of Africa, Asia, Europe, N. and S. of America, Australia.

Nationalities: 29

Algeria, Australia, Benin, China, Ethiopia, Finland, France, Germany, Hungary, India, Italy, Iran, Iraq, Kuwait, Lebanon, Libya, Mexico, Morocco, Netherlands, Nigeria, Philippines, Portugal, Pakistan, Sweden, Syria, Tunisia, Turkey, Ukraine, and USA.

Total given scientific abstracts covering the following technical sessions were 88 classified as following:

Plenary Lectures: 7

Keynote Lectures: 6

Technical Sessions: 38 Lectures

- Agriculture and Soil Improvement, Food Security and Green Growth
- Water Security: Treatment and Management
- Air Quality, Climatic Changes, Energy Production and Industrial Pollution
- Environmental Risk and Human Health
- Resources and Wastes Management and Recycling
- Social-Ecological Systems Research for Monitoring Sustainable Development

POSTER SESSION: 30 Posters

Before closing the Symposium-2024, a workshop was carried out to discuss the topic: **The Future of our Biosphere.**

The full articles of the given abstracts will be published in the form of **ISBN Proceedings Book.**

Organizers: 11

Sessions: 5

(A): Healthcare: Risk & Management

(B): Soil Biology & Agricultural and Food Security, Ecosystems & Landscape Conservation

(C): Air, Water & Sediments Pollution and Waste Management

(D): Artificial intelligence, Bioinformatics, Circular Economy Strategy

(E): Energy Research & Applications

09th of May Program

09:30 – 11:00	Plenary Session A	Chair: Hosam BAYOUMI HAMUDA	3
11:00 – 12:20	Technical Session A	Chair: Ayan CHATTERJEE	7
	Technical Session B		
11:00 – 12:30	Sub-Session B1	Chair: Lyudmyla SYMOCHKO	9
11:00 – 12:20	Sub-Session B2	Chair: Salma LATIQUE	9
13:00 – 14:10	Sub-Session B3	Chair: Hosam BAYOUMI HAMUDA	4
	Technical Session C		
11:00 – 12:30	Sub-Session C1	Chair: Ágnes BÁLINT	8
13:00 – 16:10	Sub-Session C2	Chair: Hosam	18
11:00 – 12:20	Technical Session D	Chair: Ijaz Ahmad	6
11:00 – 11:50	Technical Session E	Chair: Emőke IMRE	4
16:30 – 18:00	POSTER SESSION	Chair: Hosam BAYOUMI HAMUDA	13

10th of May Program

09:00 – 10:30	Plenary Session B	Chair: Giuseppe CIABURRO	3
10:30 – 11:30	Technical Session All	Chair: Hosam BAYOUMI HAMUDA	3

11:20 – 12:00 Workshop Special Session:

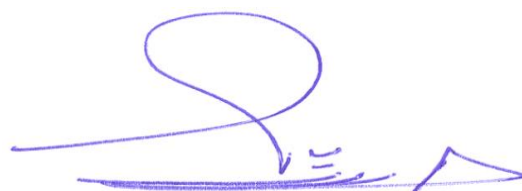
Environmental Health and Climatic Change (How humanity can solve climate change, alleviate poverty, and save biodiversity)

Keynote Speaker

Hosam E.A.F. BAYOUMI HAMUDA:

Organic Soil and Farming: As Climate Warming Adaptation And Mitigation Strategies

12:15 Closing the Symposium



Prof. Dr. Hosam E.A.F. Bayoumi Hamuda
President of ICEEE
Chair, VIIIth International Symposium-2024
Institute of Environmental Engineering &
Natural Sciences
Óbuda University
E-mail: bayoumi.hosam@uni-obuda.hu
WhatsApp/viber/messenger: +36-30-390-0813



VIIIth International Symposium-2024

Organization & Committees



VIII. International Symposium-2024

Organizers:

- International Council of Environmental Engineering Education (ICEEE), Hungary
- Obuda University (OU), Hungary
- International Society of Waste Management, Air and Water (ISWMAW), India
- Green India Clean Environment Society (GICES), India
- Azerbaijan Technological University, Azerbaijan
- University of Coimbra, Coimbra, Portugal,
- Uzhhorod National University, Uzhhorod, Ukraine
- Rejto Sandor Faculty of Light Industry and Environmental Engineering (RKK), Hungary
- Hungarian Soil Science Society, Soil Biology Department (MTT, TB), Hungary
- Sunwo Plc, Energy Expert, Hungary
- Institute of Environmental Engineering and Natural Sciences (KTI), Hungary



VIII. International Symposium-2024

The Symposium is carrying out under the patronage of:

- Prof. Dr. Levente KOVÁCS
Rector, Obuda University
- Dr. László KOLTAI
Dean, Rejto Sandor Faculty of Light Industry & Environmental Engineering
- Dr. Rita BODÁNE-KENDROVICS
Deputy Dean, Director, Institute of Environmental Engineering & Natural Sciences
- Dr. Edit CSANÁK
Deputy Dean, Director of the Product Design Institute
- Prof. Dr. Hosam BAYOUMI HAMUDA
President, International Council of Environmental Engineering Education
Chairman of the Symposium



Presidency of the Symposium-2024

VIIIth International Symposium on Environmental Health and Biosecurity Strategy with the following keywords:

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

is carrying out under the auspices of:

Prof. Dr. Levente KOVÁCS
Rector
Obuda University

Presidency of the Conference:

Dr. László KOLTAI
Dean

Rejto Sandor Faculty of Light Industry & Environmental Engineering

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

Prof. Dr. Hosam BAYOUMI HAMUDA
**President, International Council of Environmental Engineering Education
(ICEEE)**
Chair, VIIIth International Annual Symposium-2024



National Organising Committee

- Prof. Dr. Hosam BAYOUMI HAMUDA (Obuda University, Hungary)
- Dr. Rita BODÁNE-KENDROVICS (Obuda University, Hungary)
- Dr. Ágnes BÁLINT (Obuda University, Hungary)
- Dr. Krisztina DEMÉNY (Obuda University, Hungary)
- Dr. Lóránt SZABÓ (Obuda University, Hungary)
- Dr. Csaba ÁGOSTON (Obuda University, Hungary)
- Mr. András SZEDER (Obuda University, Hungary)
- Ms. Zsuzsa TAMÁSSY (Obuda University, Hungary)
- Ms. Júlia KASZÁS (Obuda University, Hungary)

International Scientific Committee

- Prof. Dr. Sadhan Kumar GHOSH (Jadavpur University, Kolkata, India)
- Prof. Dr.h.c. Miroslav BADIDA (Technical University of Košice, Slovakia)
- Prof. Dr. András MOLNÁR (Obuda University, Hungary)
- Prof. Dr. Nedjima BOUZIDI (University of Bejaia, Algeria)
- Prof. Dr. István PATKÓ (Obuda University, Hungary)
- Prof. Dr. Borbála BIRÓ (Hungarian University of Agriculture & Life Sciences, Hungary)
- Prof. Dr. Bogdana VUJIĆ (University of Novi Sad, Serbia)
- Prof. Dr. Mihály RÉGER (Obuda University, Hungary)
- Prof. Dr. Vasył LENDYEL (Uzhgorod National University, Ukraine)
- Prof. Dr. József STEIER (Sunwo Plc, Energy Expert, Hungary)
- Prof. Dr. Hosam BAYOUMI HAMUDA (Obuda University, Hungary)
- Prof. Dr. Maria WACLAWEK (University Opole, Poland)
- Prof. Dr. Ahmed M. MUFTAH (University of Benghazi, Libya)
- Prof. Dr. Lyudmila SYMOCHKO (Uzhgorod National University, Ukraine)
- Prof. Dr. Léocadie ODOULAMI (University of Abomey-Calavi, Republic of Benin)
- Prof. Dr. Faissal AZIZ (Cadi Ayyad University, Morocco)



- Dr. Nabil KHELIFI (Springer Nature, Germany)
- Dr. Enkhtuya OCHIRBAT (Mongolian Academy of Sciences, Mongolia)
- Dr. Abdelwahab TAHSIN (Cairo University, Egypt)
- Dr. Lýdia SOBOTOVÁ (Technical University of Košice, Slovakia)
- Dr. Ágnes BÁLINT (Obuda University, Hungary)
- Dr. Csaba CENTERI (Hungarian University of Agriculture & Life Sciences, Hungary)
- Dr. Ruslan MARIYCHUK (Presov University, Slovakia)
- Dr. Edmond HOXHA (Polytechnic University of Tirana, Albania)
- Dr. Zoltán NAÁR (Tokaj-Hegyalja University, Hungary)
- Dr. Edit CSANÁK (Obuda University, Hungary)
- Dr. Tünde TAKÁCS (HAS, Institute for Soil Sciences & Agricultural Chemistry, Hungary)
- Dr. Tibor SZILI-KOVÁCS (HAS, Institute for Soil Sciences & Agricultural Chemistry, Hungary)
- Dr. Rita BODÁNÉ-KENDROVICS (Obuda University, Hungary)
- Dr. Krisztina DEMÉNY (Obuda University, Hungary)



VIIIth International Annual Symposium-2024

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 (978-963-449-365-5)



SYMPOSIUM'S HIGHLIGHT TOPICS

Form the above-mentioned reasons, the special VIIIth. International Annual Symposium-2024 on **Environmental Health and Biosecurity Strategy** 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 for the special Symposium-2024. Most 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 VII.th Symposium-2024 provides leading forum for the presentation (plenary, keynote, oral & poster) of new advances & research results in the fields of on Environmental Health and Biosecurity Strategy. Accordingly, Topics of interest for paper submission include, but are not limited to:

- Session (A)
 - Healthcare: Risk & Management
- Session (B)
 - Soil Biology & Agricultural and Food Security, Ecosystems & Landscape Conservation
- Session (C)
 - Air, Water & Sediments Pollution and Waste Management
- Session (D)
 - Artificial intelligence, Bioinformatics, Circular Economy Strategy
- Session (E)
 - Energy Research & Applications



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 the Best Poster Presenter of the VIIIth International Annual Symposium-2024.

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.

The VIIIth International Symposium-2024 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 VIIIth International Symposium-2024 were given to the most outstanding researchers of the symposium under below three categories.

SELECTION PROCESS

1. CRITERIA FOR THE SESSION'S BEST ORAI 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 VIIIth. International Annual Symposium-2024 in Budapest & contribute to these exciting debates on the Biosphere & Environmental Safety 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 VIIIth Symposium-2024 will be a great success & meet our expectations. Moreover, the VIIIth Symposium-2024 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 meeting you & your colleagues in this event.

Yours Sincerely, and Best regards,

Prof. Dr. Hosam Bayoumi Hamuda
President of ICEEE



AWARDS CEREMONY

**List of the Best presentations in VIIIth International Annual Symposium-
2024**

Environmental Health and Biosecurity Strategy

**Congratulations to all our participants and the
Awards winners in VIIIth International Annual Symposium-
2024**

PROFESSIONAL RESEARCHERS

ADVANCED SOUND EVENT DETECTION FOR SMART HOME SECURITY SYSTEMS

Giuseppe CIABURRO

Department of Architecture and Industrial Design Università degli Studi della Campania Luigi
Vanvitelli, AVERSA, ITALY.

IMPACT OF CLIMATE CHANGE ON CARDIAC PERFORMANCE

Ayan CHATTERJEE

Department of Allied Health, School of Health and Medical Sciences, Adamas
University, INDIA



EXPLORING THE POTENTIAL OF MICROALGAE-DERIVED BIOACTIVE COMPOUNDS FOR NUTRACEUTICAL AND PHARMACEUTICAL APPLICATIONS: CURRENT STATUS AND FUTURE DIRECTIONS

Salma LATIQUE

Biomedical and Translational Research Laboratory, Faculty of Medicine, Pharmacy
and Dentistry of Fez, Sidi Mohamed Ben Abdellah University, MOROCCO.

SUSTAINABILITY OF FOOD SUPPLY OF MIDDLE-EAST, NORTH- AFRICA AND INDIA BETWEEN 2010-2020 SUSTAINABILITY OF FOOD SUPPLY OF MIDDLE-EAST, NORTH-AFRICA AND INDIA BETWEEN 2010-2020

Sándor J. ZSARNÓCZAI, Hosam E.A.F. BAYOUMI HAMUDA

Óbuda University, Rejtő Sándor Faculty of Light industry and Environmental
Engineering, Institute of Environmental Engineering and Natural Sciences, Budapest,
HUNGARY

MITIGATION OF THE ENVIRONMENTAL EFFECTS OF FATTENING CATTLE BY USING BENTONITE CLAY MINERAL AS A FEED SUPPLEMENT

**Sándor KUKOVICS¹, Zoltán NAÁR², Attila SZAKÁCS³, Ferenc
KUKOVICS¹**

¹Hungarian Sheep and Goat Dairying Public Utility Association Érd, Hungary; ²University of
Tokaj, Sárospatak, Hungary; ³Angus Ltd, Adony, HUNGARY.



SECURING THE BIOSPHERE FOR FUTURE GENERATIONS USING ARTIFICIAL INTELLIGENCE

Neha Singh RAGHUVANSHI*, Arpita JOHARI, Mudit SAXENA

ABES Engineering College, Ghaziabad, Uttar Pradesh, INDIA.

LANDSCAPE SCALE STUDY OF HYDROMORPHOLOGICAL CHANGES OF BÜKKÖS STREAM (SZENTENDRE) AND THEIR EFFECTS ON NATURAL STATE

Igor DUKAY

Hungarian University of Agriculture and Life Sciences, Institute for Wildlife Management and
Nature Conservation, HUNGARY.

LEBANESE AGRO INDUSTRIES' KNOWLEDGE IN FOOD LOSS IS AN INITIAL STEP TOWARD THE SUSTAINABLE DEVELOPMENT GOAL 12.3

**Nathalie PANO¹, Nada NEHME², Jalal HALWANI^{1,3}, Kostas
KARANTININIS⁴, Najah TALEB²**

¹Lebanese University, Doctoral School of Science and Technology, Hadath, LEBANON.

²Lebanese University, Faculty of Agricultural Engineering and Veterinary Medicine, Dekwane,
LEBANON.

³Lebanese University, Water & Environment Science Lab, Tripoli, LEBANON.

⁴Swedish University of Agricultural Sciences, Alnarp, SWEDEN.
Beirut, LEBANON



GROUP METHOD OF DATA HANDLING-BASED MODELS FOR PREDICTING ARSENIC CONCENTRATION IN SEDIMENTARY PHOSPHATE ROCK

Mohamed DASSAMIOUR¹, Djamel SAMAI², Naima FAGHMOUS³, Rédha BOUSTILA⁴

¹Department of Geological Sciences, Faculty of Earth Sciences, Geography and Spatial Planning, Constantine 1 - Frères Mentouri University, Constantine, ALGERIA.

²Univ Ouargla, Fac. des nouvelles technologies de l'information et de la communication. Lab. de Génie Électrique, Ouargla, ALGERIA.

³Process Engineering Laboratory for Sustainable Development and Health Products, National Polytechnic School of Constantine, Constantine, ALGERIA.

⁴Département des Sciences de la Terre, Institut d'Architecture et des Sciences de la Terre, Université Ferhat Abbas Sétif 1, Sétif, ALGERIA.

OLIVE POMACE VALORIZATION

Meriem BENAMARA-BELLAGHA, Malika BARKAT¹, Rim Tinhinene MAOUGAL
Biotechnology and food quality laboratory (Bioqual,) INATAA, UPMC1, Constantine, ALGERIA.

YOUNG RESEARCHERS

ECOSYSTEMS & LANDSCAPE CONSERVATION

Iram MAJEED

The Government Sadiq College Women University, Bahawalpur, PAKISTAN.



UTILIZATION OF THE POULTRY INDUSTRY BY-PRODUCTS PAW WASTE FOR THE PRODUCTION OF AN ALTERNATE MATERIAL OF EXOTIC LIKE LEATHER: WASTE TO THE HEALTH

Zerihun TESHOME¹, Tamrat TESFAYE^{1,2}, Tsion BELAY¹

¹Leather Processing and Products Research and Innovation Centre, Ethiopian Institute of Textile and Fashion Technology, Bahir Dar, ETHIOPIA.

²Biorefinery Research Centre, Ethiopian Institute of Textile and Fashion Technology, Bahir Dar, ETHIOPIA.

EXPLORING THE PHENOLIC COMPOSITION AND SENSORY CHARACTERISTICS OF OLIVE OILS FROM MINOR CULTIVARS IN TUNISIA

Amal OMRI¹, Sofiane ABDELHAMID¹, Mohamed AYADI¹, Cinzia BENINCASA²

¹Olive Tree Institute, Rue de l'Aéroport, Sfax, TUNISIA.

²CREA Research Centre for Olive, Fruit and Citrus Crops - via Li Rocchi, Rende CS, ITALY.

BIOREMEDIATION OF WASTEWATER AND VALORIZATION OF MICROALGAE: A SUSTAINABLE SOLUTION FOR ENVIRONMENTAL AND ECONOMIC CHALLENGES

Imane EL-BAGGAR¹, Mohammed ALAOUI MHAMDI¹, Jamila BAHHOU¹, Salma LATIQUE^{1,2}

¹Laboratory of Biotechnology, Conservation and Valorization of Natural Resources, Faculty of Sciences Dhar El Mahraz, Sidi Mohamed Ben Abdellah University, Fez, MOROCCO.

²Biomedical and Translational Research Laboratory, Faculty of Medicine, Pharmacy and Dentistry of Fez, Sidi Mohamed Ben Abdellah University, MOROCCO.



INTERNATIONAL COOPERATION IN THE FIELD OF WATER SECURITY: KAZAKHSTAN ON THE WAYS TO STABILITY

Madina IGIBAYEVA

University of Public Service-Ludovika, Budapest, HUNGARY.

MUNICIPAL SOLID WASTE MANAGEMENT. ANALYSIS AND COMPARISON OF PRACTICES IN FINLAND AND THE REPUBLIC OF MOLDOVA

Eva Lota CIUGANSCHI

Tampere University of Applied Sciences, Tampere, FINLAND.

ENVIRONMENTALLY SAFE MAGNETIC NANOCATALYST FOR THE PRODUCTION OF BIODIESEL FROM PONGAMIA PINNATA OIL

Hafiza Qurat ul Ain SAMI

Nano and Biomaterials Lab, Department of Chemistry, University of Agriculture, Faisalabad 38040,
PAKISTAN.



PhD STUDENTS RESEARCHERS

HEPATIC EFFECTS OF GRAPHENE OXIDE (GO): A MACROSCOPIC AND HISTO-BIOCHEMICAL ANALYSIS

**Asmaa RHAZOUANI^{1,2,3}, Halima GAMRANI³, Lhoucine GEBRATI⁴,
Faissal AZIZ^{1,2}**

¹Laboratory of Water, Biodiversity & Climate Change, Cadi Ayyad University, Marrakech, MOROCCO.

²National Centre for Studies and Research on Water and Energy, Cadi Ayyad University, Marrakech, MOROCCO.

³Laboratory of Clinical, Experimental and Environmental Neurosciences, Cadi Ayyad University, Marrakech, MOROCCO.

⁴Laboratory of Materials, Processes, Environment and Quality, Cadi Ayyad University, Safi, MOROCCO.

AMELIORATIVE EFFECT OF ONONIS NATRIX AGAINST CHRONIC LEAD POISONING IN MICE: BIOCHEMICAL AND HISTOLOGICAL STUDY

Asmaa HAJ-KHLIFA, Faissal AZIZ, Maroua Ait TASTIFT, Souad SELLAMI, Hanane RAIS, Miloud HAMMOUD, Naima FDIL, Najib KISSANI, Halima GAMRANI, Moulay Mustapha BOUYATAS

Cadi Ayyad University, Faculty of sciences Semlalia, Marrakech, MOROCCO

CO-COMPOSTING OF SHRIMP SHELL WASTE AND OLIVE LEAVES: PHYSICO-CHEMICAL AND AGRONOMIC QUALITY ASSESSMENT

Hayet HFAIEDH, Emna BOUAZIZI, Yaakoub GHARBI, Mohamed Ali TRIKI

Laboratory of Olive Genetic Resources: characterization, valorization and phytosanitary protection, Olive Tree Institute, TUNISIA.



BIOBASED HYDROGELS AS A RESILIENT SOLUTION FOR WATER-EFFICIENT AGRICULTURE

Achraf BERRADI^{1,2}, Ahlam LAFDALI^{1,2,3}, Laila MANDI^{1,2}, Faissal AZIZ^{1,2}, Naaila OUZZANI^{1,2}, Abdelhaq EL ARRAM^{1,2}

¹Laboratory of Water, Biodiversity, and Climate Change, Faculty of Sciences Semlalia, Cadi Ayyad University, Marrakech, MOROCCO.

²National Center for Research and Studies on Water and Energy, Cadi Ayyad University, Marrakech, MOROCCO.

³Laboratory of Innovative Materials, Energy and Sustainable Development (IMED-Lab), Faculty of Science and Technology, Cadi Ayyad University, Marrakech, MOROCCO.

HYDROGEOCHEMICAL STUDY OF THE GROUNDWATER IN THE COASTAL AREA, NORTHEASTERN OF BENGHAZI CITY, NE LIBYA

Osama A. EL FALLAH¹, Ahmed ABUHARARA²

¹Department of Earth Sciences, Faculty of Science, Benghazi University, Benghazi, LIBYA.

²Department of Geology, Faculty of Science, Omar Al-Mukhtar University, Al Byada, LIBYA.

COMPARATIVE EVALUATION OF PHENOL REMOVAL BY MICROALGAE FROM VARIED ECOSYSTEMS

Sara ELHAMJI^{1,2}, Maryem MINHAI^{1,2}, Karim SBIHI^{1,3}, Jihen ELLEUCH⁴, Naaila OUZZANI^{1,2}, Faissal AZIZ^{1,2}

¹National Centre for Research and Study on Water and Energy (CNEREE), University Cadi Ayyad, Marrakech, MOROCCO.

²Laboratory of Water, Biodiversity and Climate Changes, Semlalia Faculty of Sciences, B.P.2390, 40000, Marrakech, MOROCCO.

³Laboratory Analysis, Modelling, Engineering, Natural Substances and Environment, Natural Substances, Health and Environment Team, Polydisciplinaire Faculty of Taroudant, University Ibn Zohr, MOROCCO.

⁴Laboratoire de Génie Enzymatique et Microbiologie, Equipe Biotechnologie des Algues, Ecole Nationale d'Ingénieurs de Sfax, Université de Sfax, Sfax, TUNISIA.



COMPREHENSIVE STUDY ON THE EFFICIENT ELIMINATION OF ALIZARIN RED S DYE IN WATER USING AN ECO-FRIENDLY CLAY-CHITOSAN COMPOSITE: EXPERIMENTAL AND THEORETICAL INVESTIGATION

**Mouhsine BELLAJ¹, Hicham YAZID², Abdelmajid REGTI²,
Mohammadine EL HADDAD², Abdelkrim ABOURRICHE¹, Lhoucine
GEBRATI¹, Faissal AZIZ^{3,4}**

¹Laboratory of Materials, Process, Environment, and Quality, National School of Applied Sciences, Cadi Ayyad University, Safi, MOROCCO.

²Laboratory of Analytical and Molecular Chemistry, Faculty Poly-disciplinary of Safi, Cadi Ayyad University, Safi, MOROCCO.

³Laboratory of Water, Biodiversity, and Climate Change, Faculty of Sciences Semlalia, Cadi Ayyad University, Marrakech, MOROCCO.

⁴National Center for Research and Studies on Water and Energy, Cadi Ayyad University, Marrakech, MOROCCO.

BURNER MODEL: EFFECTS OF EQUIVALENCE RATIO AND GEOMETRY MODIFICATION

Abdelkader HEMAIZIA¹, Dominique THEVENIN²

¹Faculty of Mechanical engineering and Processes engineering, USTHB, ALGERIA.

²Institute of Fluid Dynamics and Thermodynamics, OVGU, GERMANY.

ROLE OF MARINE ALGAE IN PLANT GROWTH AND PROTECTION FOR SUSTAINABLE AGRICULTURE

**Eetizez KAROUI, Karim ENNOURI, Mohammed Ali TRIKI, Monia
ENNOURI**

Olive Tree Institute, Sfax, TUNISIA.



THE ANTIFUNGAL ACTIVITY OF TWO-FERMENTED COMPOST TEAS AGAINST FUSARIUM CROWN AND ROOT ROT

Asma BEN AMARA^{1,2,3}, Manel CHEFFI², Monia EL HAJJI³, Emna AMMAR^{1,4}, Mohamed Ali TRIKI²

¹Laboratory of Environmental Sciences and Sustainable Development, University of Sfax, Preparatory Institute for Engineering Studies of Sfax, Sfax, TUNISIA.

²Laboratory of Improvement and Protection of Olive Tree Genetic Resources, Olive Tree Institute, University of Sfax, Sfax, TUNISIA.

³Laboratory of Advanced Research in Industrial and Logistic Engineering, Team OSIL, National High School of Electrical and Mechanical Engineering, University Hassan II, Casablanca, MOROCCO.

⁴Laboratory of Environment Sciences and Sustainable Development, University of Sfax, National Engineering School of Sfax, TUNISIA.

Budapest, 9th of May 2024.

Prof. Dr. Hosam E.A.F. Bayoumi Hamuda
President of ICEEE

Chair, VIIth International Symposium-2024
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 30th of September 2024. In case of non-receipt of the certificate, please write to us with your contact details to:
bayoumi.hosam@uni-obuda.hu



Online
Scientific Program of the
VIIIth International Annual
Symposium-2024

Environmental Health and
Biosecurity Strategy

May 9th – 10th, 2024

Obuda University
Budapest - Hungary



VIII. International Symposium-2024

VIIIth Symposium-2024 **International Annual Symposium**

on

“Environmental Health and Biosecurity: Sciences, Engineering and Application”

online

May 09 - 10, 2024
Budapest – Hungary

with

Workshop Special Session: **Environmental Health and Climatic Change** (How humanity can solve climate change, alleviate poverty, and save biodiversity)



VIII. International Symposium-2024

Online **Scientific Program of the** **VIIIth International** **Symposium-2024** **on**

Environmental Health and
Biosecurity: Sciences, Engineering
and Application

May 9th – 10th, 2024

Obuda University
Budapest - Hungary



VIII. International Symposium-2024

Attention:

- ✚ The VIII.th Symposium-2024 will be held through **Microsoft Teams**.
- ✚ To join the Symposium:
 - There is a short guide with useful information about how to use the Microsoft Teams during the Symposium
 - The participants will have the link of the Symposium.
 - The time of the Symposium is related to the **Hungarian time**.
- ✚ Please check the time with your time at home

Time of Presentations Online (Microsoft Teams)

Presentation Type:	Total Allotted Time:
• Plenary speaker	25 min
• Keynote speaker	20 min
• Featured speaker	10 min
• Poster	5 min

Please note that:

- ✚ The time is very limited.
- ✚ The official language of all the presentations including oral or poster speaker is **English**.

For Full paper:

The deadline to send the full paper is the end of June (30th of June 2024) in word document form.



VIII. International Symposium-2024

Acknowledgement

We, the editor, would like to thank the members of the organizing, scientific, and administrative committees and all the supporting staff for giving this opportunity. We would also like to extend our sincere thanks to all the contributors and reviewers who have made this Program Book possible. We hope that the papers in this Proceedings Book will inspire further research and innovation in this important field.

Sincerely,

Editor

Prof. Dr. Hosam Bayoumi Hamuda

President of ICEEE

Chairman of the Symposium

Obuda University

Budapest - Hungary

E-mail: bayoumi.hosam@uni-obuda.hu

WhatsApp/viber/messenger: +36303900813



9th of May 2024 (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 BODÁNE-KENDROVICS

Director, Institute of Environmental Engineering &
Natural Sciences

Dr. Edit CSANÁK

Deputy Dean, Rejtő Sándor Faculty of Light Industry &
Environmental Engineering



09:30 – 11:00

Plenary Session A

Chair of the Session:

Hosam BAYOUMI HAMUDA

PL1 09:30 – 10:00

Ratnesh DAS

Department of Chemistry, Dr Harisingh Gour Central University, Sagar,
470003 India. Email: ratneshdas1@gmail.com

**CARBON NANOTUBES AND NANOPARTICLES AS AN EFFICIENT
ELECTROCHEMICAL SENSOR FOR THE ANALYSIS OF CALCIUM
CHANNEL BLOCKERS**

PL2 10:00 – 10:30

Lyudmyla SYMOCHKO^{1,2,3,4}

¹Uzhhorod National University, Uzhhorod, Ukraine

²University of Coimbra, Calçada Martim de Freitas, Coimbra, Portugal

³Institute of Agroecology and Environmental Management NAAS,
Metrolohichna, Kyiv, Ukraine

⁴CERNAS - Research Centre for Natural Resources, Environment and
Society, Escola Superior Agrária de Coimbra, Coimbra, Portugal;
lyudmilassem@gmail.com

**ANTIBIOTIC POLLUTION IN THE ENVIRONMENT: FROM MICROBIAL
ECOLOGY TO PUBLIC HEALTH**

PL3 10:30 – 11:00

Giuseppe CIABURRO

Department of Architecture and Industrial Design Università degli Studi
della Campania Luigi Vanvitelli, AVERSA, ITALY,
giuseppe.ciaburro@unicampania.it

**ADVANCED SOUND EVENT DETECTION FOR SMART HOME
SECURITY SYSTEMS**



SYMPOSIUM'S SESSIONS

- Session (A)
 - Healthcare: Risk & Management
- Session (B)
 - Soil Biology & Agricultural and Food Security, Ecosystems & Landscape Conservation
- Session (C)
 - Air, Water & Sediments Pollution and Waste Management
- Session (D)
 - Artificial intelligence, Bioinformatics, Circular Economy Strategy
- Session (E)
 - Energy Research & Applications



11:00 – 12:20

Technical Session A

Healthcare: Risk & Management



Chair of the Session: **Ayan CHATTERJEE**

11:00 – 11:20

Keynote Speaker:

Rahul HAJARE

School of Pharmaceutical Sciences, Sandip University India

**QUALITATIVE AND QUANTITATIVE ANALYSIS OF PERSIMMON,
AN AMERICAN TOMATO**

11:20 – 11:30

**Asmaa RHAZOUANI^{1,2,3}, Halima GAMRANI³, Lhoucine GEBRATId⁴,
Faissal AZIZ^{1,2}**

¹Laboratory of Water, Biodiversity & Climate Change, Cadi Ayyad University, Marrakech, Morocco; ²National Centre for Studies and Research on Water and Energy, Cadi Ayyad University, Marrakech, Morocco; ³Laboratory of Clinical, Experimental and Environmental Neurosciences, Cadi Ayyad University, Marrakech, Morocco; ⁴Laboratory of Materials, Processes, Environment and Quality, Cadi Ayyad University, Safi, Morocco.

**HEPATIC EFFECTS OF GRAPHENE OXIDE (GO): A MACROSCOPIC
AND HISTO-BIOCHEMICAL ANALYSIS**

11:30 – 11:40

Henok ABEBE¹, Henok MULATU^{2*}, Samuel KELEMEWORK³

¹Hirna Regional Veterinary Laboratory, Oromiya Regional State, Hirna, Ethiopia; ²Habro District Livestock and Fisheries Development Office, Gelemso, Ethiopia; ³Guba Koricha District Livestock and Fisheries Development Office, Komona, Ethiopia.

**REVIEW ON EPIDEMIOLOGICAL INTERFACE OF FOOT AND
MOUTH DISEASES BETWEEN WILD ANIMALS, DOMESTIC
ANIMALS AND HUMAN**

11:40 – 11:50

Kenza IRINISLIMANE

Mechanical Engineering Department, M'Hamed Bougara University, Boumerdes, Algeria.

ANALYSIS OF THE MANAGEMENT SYSTEM ACCIDENT RISKS



11:50 – 12:00

Rahat SIRAJ

Hazara University sub-Campus Battagram, Battagram, Pakistan

THREATS TO WILDLIFE

12:00 – 12:10

Rahul KUMAR

Chaudhary Charan Singh Haryana Agricultural University, College of Agriculture, Bawal-123501, Rewari, Haryana, INDIA

ISOLATION OF PATHOGENIC BACTERIA FROM DISEASED HETEROPNEUSTES FOSSILIS

12:10 – 12:20

Asmaa HAJ-KHLIFA, Faissal AZIZ, Maroua Ait TASTIFT, Souad SELLAMI, Hanane RAIS, Miloud HAMMOUD, Naima FDIL, Najib KISSANI, Halima GAMRANI, Moulay Mustapha BOUYATAS

Cadi Ayyad University, Faculty of sciences Semlalia, Marrakech, Morocco

AMELIORATIVE EFFECT OF ONONIS NATRIX AGAINST CHRONIC LEAD POISONING IN MICE: BIOCHEMICAL AND HISTOLOGICAL STUDY

Lunch time.



11:00 – 12:30

Technical Session B

**Soil Biology & Agricultural and Food
Security, Ecosystems & Landscape
Conservation**

11:00 – 12:30

Sub-Session B1

Chair of the Session:

Lyudmyla SYMOCHKO

11:00 – 11:10

Iram MAJEED

The Government Sadiq College Women University, Bahawalpur,
Pakistan,

ECOSYSTEMS & LANDSCAPE CONSERVATION

11:10 – 11:20

Sana AHMED¹, Sufia ZAMAN¹, Abhijit MITRA²

¹Department of Oceanography, Techno India University, West Bengal,
Salt Lake, Sector V, Kolkata, India; ²Department of Marine Science,
University of Calcutta, Kolkata, India.

**EVALUATION OF STORED CARBON IN URBAN TREES OF
KOLKATA CITY USING EMERGING TECHNOLOGIES**

11:20 – 11:30

Lateefat Adeola BELLO

Ahmadu Bello University, Zaria, Kaduna State, Nigeria.

**NAVIGATING THE LEGAL LABYRINTH: BALANCING TOURISM,
ENVIRONMENTAL HEALTH, AND BIOSECURITY**



11:30 – 11:40

Igor DUKAY

Hungarian University of Agriculture and Life Sciences, Institute for Wildlife Management and Nature Conservation, Hungary.

LANDSCAPE SCALE STUDY OF HYDROMORPHOLOGICAL CHANGES OF BÜKKÖS STREAM (SZENTENDRE) AND THEIR EFFECTS ON NATUTAL STATE

11:40 – 11:50

Achraf BERRADI^{1,2}, Ahlam LAFDALI^{1,2,3}, Laila MANDI^{1,2}, Faissal AZIZ^{1,2}, Naaila OUZZANI^{1,2}, Abdelhaq EL ARRAM^{1,2}

¹Laboratory of Water, Biodiversity, and Climate Change, Faculty of Sciences Semlalia, Cadi Ayyad University, Marrakech, Morocco;

²National Center for Research and Studies on Water and Energy, Cadi Ayyad University, Marrakech, Morocco; ³Laboratory of Innovative Materials, Energy and Sustainable Development (IMED-Lab), Faculty of Science and Technology, Cadi Ayyad University, Marrakech, Morocco.

BIOBASED HYDROGELS AS A RESILIENT SOLUTION FOR WATER-EFFICIENT AGRICULTURE

11:50 – 12:00

Rashwan ALKENTAR, Tamás MANKOVITS

University of Debrecen, Faculty of Engineering, Debrecen, Hungary.

HIP IMPLANT OPTIMIZATION USING LATTICE STRUCTURES

12:00 – 12:10

Karim ENNOURI¹, Monia ENNOURI², Mohamed Ali TRIKI²

¹Digital Research Center of Sfax, Sfax, Tunisia; ²Olive tree institute, Sfax, Tunisia.

EXAMINING SOIL CHARACTERISTICS USING SATELLITE-BASED IMAGING TECHNIQUES



12:10 – 12:20

Zerihun TESHOME¹, Tamrat TESFAYE^{1,2}, Tsion BELAY¹

¹Leather Processing and Products Research and Innovation Centre, Ethiopian Institute of Textile and Fashion Technology, Bahir Dar, Ethiopia; ²Biorefinery Research Centre, Ethiopian Institute of Textile and Fashion Technology, Bahir Dar, Ethiopia.

UTILIZATION OF THE POULTRY INDUSTRY BY-PRODUCTS PAW WASTE FOR THE PRODUCTION OF AN ALTERNATE MATERIAL OF EXOTIC LIKE LEATHER: WASTE TO THE HEALTH

12:20 – 12:30

Belkasim KHAMEISS

Kansas Geological Survey, 1930 Constant Ave., Lawrence, USA

SEDIMENT ANALYSIS OF MIOCENE DEPOSITS IN THE RED BAY FORMATION, FLORIDA: INSIGHTS INTO NEARSHORE MARINE FACIES AND LITHOLOGICAL DISCREPANCIES

Lunch time.



11:00 – 12:30

Sub-Session B2

Chair of the Session: Salma LATIQUE

11:00 – 11:10

Olena DEMYANYUK, Dmitry SHATSMAN, Oleksander POLTAVA
Institute of Agroecology and Environmental Management of NAAS,
Kyiv, Ukraine

**AGROECOLOGICAL ASSESSMENT OF HERBICIDE APPLICATION
FOR MONOCULTURE MAIZE**

11:10 – 11:20

**Hayet HFAIEDH, Emna BOUAZIZI, Yaakoub GHARBI, Mohamed Ali
TRIKI**

Laboratory of Olive Genetic Resources: characterization, valorization and
phytosanitary protection, Olive Tree Institute, Tunisia.

**CO-COMPOSTING OF SHRIMP SHELL WASTE AND OLIVE LEAVES:
PHYSICO-CHEMICAL AND AGRONOMIC QUALITY ASSESSMENT**

11:20 – 11:30

**Eetizez KAROUI, Karim ENNOURI, Mohammed Ali TRIKI, Monia
ENNOURI**

Olive Tree Institute, Sfax, Tunisia.

**ROLE OF MARINE ALGAE IN PLANT GROWTH AND PROTECTION
FOR SUSTAINABLE AGRICULTURE**



11:30 – 11:40

Ghizlane AKHOUY^{1,2}, Lhoucine GEBRATI¹, Yasin AKGÜL³, Mehmet Durmus CALISIR⁴, Manal ZEFZOUFI², Salima ATLAS⁵, Majdoulène BELAQZIZ^{2,6}, Faissal AZIZ^{2,6}

¹Laboratory of Materials, Processes, Environment and Quality, Cadi Ayyad University Safi, Morocco; ²National Center for Research and Studies on Water and Energy, Cadi Ayyad University, Marrakech, Morocco; ³Karabuk University Iron and Steel Institute, KARABÜK, Turkey; ⁴Istanbul Technical University, Istanbul, Turkey; ⁵Polydisciplinary Faculty, Sultan Moulay Slimane University, Beni-Mellal, Morocco; ⁶Laboratory of Water, Biodiversity, and Climate Change, Faculty of Sciences Semlalia, Cadi Ayyad University, Marrakech, Morocco.

ELECTRO-BLOW SPUN HYBRID NANOFIBERS: A NEW PERSPECTIVE IN ACTIVE PACKAGING MATERIALS

11:40 – 11:50

Abdousalam AHMED ALGAIDI¹, Hosam E.A.F. BAYOUMI HAMODA², Ibrahim ISSA³, Yosof SALEH HAMID⁴

¹Department of Microbiology, Faculty of Science, Sabha University, Sabha, Libya; ²Óbuda University, Rejto Sandor Faculty of Light industry and Environmental Engineering, Institute of Environmental Engineering and Natural Sciences, Budapest, Hungary; ³Department of Soil Science, Faculty of Agriculture, Sirte University, Sirte Libya; ⁴Department of Soil Science, Faculty of Agriculture, Tripoli University, Tripoli, Libya.

THE EMISSION OF NITRIC OXIDE AND CARBON DIOXIDE FROM CULTIVATED SOIL

11:50 – 12:00

Izhar ULLAH, Shabir AHMAD, Sardar Azhar MAHMOOD, Said Nawaz KHAN, Asifa KHAN, Mohammad YOUSAF

Department of Zoology, Hazara University Mansehra, Pakistan

TAXONOMIC STUDY OF SPIDER (ARACHNIDA: ARANEAE) FAUNA IN DISTRICT BATTAGRAM KP, PAKISTAN



12:00 – 12:10

Zita ZSEMBERY¹, Dorottya PUJSZ²

¹Herman Otto Institute, Budapest, Hungary; ²Hungarian University of Agriculture and Life Sciences, Institute for Wildlife Management and Nature Conservation, Gödöllő, Hungary.

PEDOLOGICAL BACKGROUND FOR EARTHWORM RESEARCH IN THE GÖDÖLLŐ HILLSIDE

12:10 – 12:20

Amal OMRI¹, Sofiane ABDELHAMID¹, Mohamed AYADI¹, Cinzia BENINCASA²

¹Olive Tree Institute, Rue de l'Aéroport, Sfax, Tunisia; ²CREA Research Centre for Olive, Fruit and Citrus Crops - via Li Rocchi, Rende CS, Italy.

EXPLORING THE PHENOLIC COMPOSITION AND SENSORY CHARACTERISTICS OF OLIVE OILS FROM MINOR CULTIVARS IN TUNISIA

12:20 – 12:30

Hosam E.A.F. BAYOUMI HAMUDA

Obuda University, Rejto Sandor Faculty of Light Industry and Environmental Engineering, Institute of Environmental Engineering and Natural Sciences, Budapest, Hungary

AN INNOVATIVE APPROACH OF BIOREMEDIATION IN ENZYMATIC DEGRADATION OF XENOBIOTICS

Lunch time.



13:00 – 14:10

Sub-Session B3

Chair of the Session:

Hosam E.A.F. BAYOUMI HAMUDA

13:00 – 13:20

Keynote Speaker

Hosam E.A.F. BAYOUMI HAMUDA

Obuda University, Rejto Sandor Faculty of Light Industry and
Environmental Engineering, Institute of Environmental Engineering and
Natural Sciences, Budapest, Hungary

**IMPACTS OF ZINC AND SILVER ENGINEERED NANOPARTICLES
ON PLANT GROWTH-PROMOTING BACTERIA IN AGRICULTURAL
SOIL**

13:20 – 13:30

Zita ZSEMBERY

Herman Otto Institute, Budapest, Hungary.

**COMPARING SOIL PROPERTIES OF NATURAL AND ARABLE
AREAS COMPARING SOIL PROPERTIES OF NATURAL AND
ARABLE AREAS**

13:30 – 13:40

REETU¹, Rahul KUMAR²

¹Department of Zoology, College of Basic Sciences & Humanities,
Chaudhary Charan Singh Haryana Agricultural University, Hisar,
Haryana, India; ²Zoology, Chaudhary Charan Singh Haryana Agricultural
University, College of Agriculture, Bawal, Rewari, Haryana, India.

**EFFECT MORINGA OLEIFERA LEAVES ON AEROMONAS
HYDROPHILA INFECTED COMMON CARP**



13:40 – 13:50

Malika BARKAT, Nassim ZOUAOUI

Department of Biotechnology, INATAA, UPMC1, Constantine, Algeria.

**DETERMINATION OF THE VOLATILE PROFILE OF SIX ENDEMIC
PLANTS FROM THE BISKRA REGION (ALGERIA)**



Technical Session C

Air, Water & Sediments Pollution and Waste Management

11:00 – 12:30

Sub-Session C1

Chair of the Session:

Ágnes BÁLINT

Keynote Speaker

11:00 – 11:20

Ágnes BÁLINT¹, Dávid CZEKMEISTER², Xuechu WANG², Csaba MÉSZÁROS²

¹Obuda University, Budapest, Hungary, ²Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary

**HEAVY METAL LOADS IN THE SLURRY AREA OF THE PAKS
NUCLEAR POWER PLANT**

11:20 – 11:30

Rahele Khosravi NESIANI¹, Meysam NASERI²

¹Sahand University of Technology, Tabriz, Iran; ²Amirkabir University of Technology, Tehran, Iran.

**ANALYSIS ON LOW TEMPERATURE SYNTHESIS OF NANO ALPHA
ALUMINA POWDER WITH TWO-STEP HYDROLYSIS**

11:30 – 11:40

Filipa Duque FONSECA^{1,2,3,4}, M. Nazaré Coelho PINHEIRO^{1,2,3,4}

¹Polytechnic Institute of Coimbra (IPC), Coimbra Institute of Engineering (ISEC), Department of Chemical and Biological Engineering, Coimbra, Portugal; ²CEFT - Transport Phenomena Research Center, Faculty of Engineering (FEUP), University of Porto, Porto, Portugal; ³SISus - Laboratory of Sustainable Industrial Systems, Instituto Superior de Engenharia de Coimbra, Coimbra, Portugal; ⁴CERNAS - Research Centre for Natural Resources, Environment and Society, Escola Superior Agrária de Coimbra, Coimbra, Portugal.

**DRIVING CIRCULAR ECONOMY THROUGH WASTE
VALORIZATION: A CASE STUDY OF TEXTILE (BIO)DYES**



11:40 – 11:50

Y.L. ROMERO¹, J. BESSEMBINDER, N.C. VAN DE GIESEN, F.H.M. VAN DE VEN

Beuningen, The Netherlands

A RELATION BETWEEN EXTREME DAILY PRECIPITATION AND EXTREME SHORT-TERM PRECIPITATION

11:50 – 12:00

Belkasim KHAMEISS¹, Makenna HARRIS²

¹Kansas Geological Survey, 1930 Constant Ave. Lawrence, USA; ²Ritchie Hall | Earth, Energy & Environment Center, Lawrence, USA

TAXONOMIC OBSERVATIONS AND ENVIRONMENTAL SIGNIFICANCE OF RECENT FORAMINIFERA FROM ANTHONY'S BAY, ROATAN, NORTHEAST HONDURAS

12:00 – 12:10

Imane EL-BAGGAR¹, Mohammed ALAOUI MHAMDI¹, Jamila BAHHO¹, Salma LATIQUE^{1,2}

¹Laboratory of Biotechnology, Conservation and Valorization of Natural Resources, Faculty of Sciences Dhar El Mahraz, Sidi Mohamed Ben Abdellah University, Fez, Morocco; ²Biomedical and Translational Research Laboratory, Faculty of Medicine, Pharmacy and Dentistry of Fez, Sidi Mohamed Ben Abdellah University, Morocco.

BIOREMEDIATION OF WASTEWATER AND VALORIZATION OF MICROALGAE: A SUSTAINABLE SOLUTION FOR ENVIRONMENTAL AND ECONOMIC CHALLENGES

12:10 – 12:20

Osama A. EL FALLAH¹, Ahmed ABUHARARA²

¹Department of Earth Sciences, Faculty of Science, Benghazi University, Benghazi, Libya; ²Department of Geology, Faculty of Science, Omar Al-Mukhtar University, Al Byada, Libya.

HYDROGEOCHEMICAL STUDY OF THE GROUNDWATER IN THE COASTAL AREA, NORTHEASTERN OF BENGHAZI CITY, NE LIBYA



12:20 – 12:30

Osamah J. AL-SAREJI^{1,2,3}, Mónika MEICZINGER¹, Ruqayah Ali GRMASHA^{2,4}, Viola SOMOGYI¹

¹Sustainability Solutions Research Lab, Faculty of Engineering, University of Pannonia, Veszprém, Hungary; ²Environmental Research and Studies Center, University of Babylon, Babylon, Iraq; ³Research Centre of Engineering Sciences, Department of Materials Sciences and Engineering, University of Pannonia, Veszprém, Hungary; ⁴Research Group of Limnology, Center for Natural Science, Faculty of Engineering, University of Pannonia, Veszprém, Hungary.

UTILIZING AGRICULTURAL WASTE FOR EFFICIENT REMOVAL OF ORGANIC MICRO-POLLUTANTS FROM WATER AND WASTEWATER

Lunch time.



13:00 – 16:10

Sub-Session C2

Chair of the Session:

Hosam BAYOUMI HAMUDA

13:00 – 13:10

Rahele Khosravi NESIANI¹, Meysam NASERI²

¹Sahand University of Technology, Tabriz, Iran; ²Amirkabir University of Technology, Tehran, Iran.

DETAILED ANALYSIS AND UNDERSTANDING OF CARBON/IRON COMPOSITE MICROFIBER CATALYSTS DERIVED FROM BLOOD HEMOGLOBIN PROTEIN FOR LITHIUM-OXYGEN BATTERIES

13:10 – 13:20

Madina IGIBAYEVA

University of Public Service-Ludovika, Budapest, Hungary

INTERNATIONAL COOPERATION IN THE FIELD OF WATER SECURITY: KAZAKHSTAN ON THE WAYS TO STABILITY

13:20 – 13:30

Sihe HEDJAL¹, Abdelwaheb BENAMARA²

¹Department of Geological Sciences, Frères Mentouri Constantine-1 University, Algeria; ²Faculty of Science and Technology, Department of Civil Engineering. Ziane Achour Djelfa University, Algeria.

THE IMPACT OF ANTHROPOGENIC ACTIVITY ON WATER QUALITY IN THE SANHADJA WETLAND COMPLEX (NORTHEASTERN ALGERIA)

13:30 – 13:40

Eva Lota CIUGANSCHI

Tampere University of Applied Sciences, Tampere, Finland.

MUNICIPAL SOLID WASTE MANAGEMENT. ANALYSIS AND COMPARISON OF PRACTICES IN FINLAND AND THE REPUBLIC OF MOLDOVA



13:40 – 13:50

Leocadie ODOULAMI, Rene AYEMAN ZODEKON

Laboratoire Pierre PAGNEY, Climat, Eau, Ecosystème et Développement
(LACEEDE) DGAT/FASHS/ Université d'Abomey-Calavi (UAC),
Cotonou, République du Bénin

**DELEGATED PUBLIC DRINKING WATER SERVICES IN THE
MUNICIPALITY OF DASSA-ZOUME (BENIN)**

13:50 – 14:00

**Ruqayah Ali GRMASHA^{1,2,3,4}, Osamah J. AL-SAREJI^{1,2,4}, Mónika
MEICZINGER¹, Csilla STENGER-KOVÁCS^{3,5}**

¹Sustainability Solutions Research Lab, Faculty of Engineering,
University of Pannonia, Veszprém, Hungary; ²Environmental Research
and Studies Center, University of Babylon, Babylon, Al-Hillah, Iraq;
³University of Pannonia, Faculty of Engineering, Center for Natural
Science, Research Group of Limnology, Veszprem, Hungary; ⁴The
School of Civil and Environmental Engineering graduate, University of
New South Wales, Sydney, Kensington, Australia; ⁵HUN-REN-PE
Limnoecology Research Group Veszprém, Hungary.

**THE CURRENT STATUS OF POLYCYCLIC AROMATIC
HYDROCARBONS (PAHS) POLLUTION IN LAKE BALATON
SEDIMENT, HUNGARY**

14:00 – 14:10

Olena MITRYASOVA, Oleksandra KOVALSKA

Petro Mohyla Black Sea National University, Mykolaiv, Ukraine.

**WATER INSECURITY IN THE CITY OF MYKOLAIV UNDER
WARTIME CONDITIONS**

14:10 – 14:20

Olena MITRYASOVA, Viktor SMYRNOV, Andrii MATS

Petro Mohyla Black Sea National University, Mykolaiv, Ukraine.

**THE STATUS OF THE SURFACE WATERS OF THE BUZKY ESTUARY
WITHIN MYKOLAIV CITY: PRE-WAR AND WARTIME PERIODS**



14:20 – 14:30

Afef SAI^{1,2}, Sonia BEN YOUNES^{1,3}, Ali ELLAFI^{1,4}, Amel MOULA^{1,2}, Juan Manuel SÁNCHEZ-YAÑEZ⁵, Mohamed Ali BORGHI²

¹Faculty of Sciences of Gafsa, University campus of Ahmed Zarroug, 2112, University of Gafsa, Gafsa, Tunisia; ²Laboratory of Biotechnology and Biomonitoring of the Environment and Oasis Ecosystems (LBEOE). Faculty of Sciences of Gafsa, University campus of Ahmed Zarroug, 2112, University of Gafsa, Gafsa, Tunisia; ³Unité de Recherches n°17/ES/13, Faculté de Médecine de Tunis, Université de Tunis El Manar, Tunisie; ⁴Laboratory of Analysis, treatment and valorisation of environment pollutants and products, Faculty of Pharmacy, Monastir University, Tunisia; ⁵Environmental Microbiology Laboratory, Research Institute in Chemistry and Biology Universidad Michoacana de San Nicolás de Hidalgo. Morelia, Michoacán, México.

ROCK PHOSPHATE AMENDMENT AND THE KEY ROLE OF SERRATIA PLYMUTHICA BMA1 STRAIN IN ENHANCING MINERAL NUTRITION AND HEAVY METAL RHIZO-ACCUMULATION IN VICIA FABA L.

14:30 – 14:40

Sara ELHAMJI^{1,2}, Maryem MINHAI^{1,2}, Karim SBIHI^{1,3}, Jihen ELLEUCH⁴, Naaila OUZZANI^{1,2}, Faissal AZIZ^{1,2}

¹National Centre for Research and Study on Water and Energy (CNEREE), University Cadi Ayyad, Marrakech, Morocco; ²Laboratory of Water, Biodiversity and Climate Changes, Semlalia Faculty of Sciences, B.P.2390, 40000, Marrakech, Morocco; ³Laboratory Analysis, Modelling, Engineering, Natural Substances and Environment, Natural, Substances, Health and Environment Team, Polydisciplinaire Faculty of Taroudant, University Ibn Zohr, Morocco; ⁴Laboratoire de Génie Enzymatique et Microbiologie, Equipe Biotechnologie des Algues, Ecole Nationale d'Ingénieurs de Sfax, Université de Sfax, Sfax, Tunisia.

COMPARATIVE EVALUATION OF PHENOL REMOVAL BY MICROALGAE FROM VARIED ECOSYSTEMS



14:40 – 14:50

Rainiel Brkryan V. DOMASIAN

Ilaguna State Polytechnic University Los Banos Campus, Philippines

**EVALUATION OF CONTAMINANT LEVELS IN WATER, SEDIMENTS,
AND FISH FOR HEALTH RISK ASSESSMENT IN AQUATIC
ECOSYSTEMS**

14:50 – 15:00

**Imane HAYDARI^{1,2}, Jamila SABYH^{1,2}, Jihen ELLEUCH³, Naaila
OUAZZANI^{1,2}, Laila MANDI^{1,2}, Faissal AZIZ^{1,2}**

¹Laboratory of Water, Biodiversity, and Climate Change, Faculty of
Sciences Semlalia, Cadi Ayyad University, Marrakech,
Morocco; ²National Center for Research and Studies on Water and Energy
(CNEREE), Cadi Ayyad University Marrakech, Morocco; ³Laboratory of
Enzymatic Engineering and Microbiology, National Engineering School
of Sfax, University of Sfax, Sfax, Tunisia.

**SUSTAINABLE NANOPARTICLE SYNTHESIS FOR EFFICIENT
PHENOL ELIMINATION IN OLIVE MILL EFFLUENTS**

15:10 – 15:20

**Maryem MINHAI^{1,2}, Sara ELHAMJI^{1,2}, Karim SBIHI^{1,3}, Jihen
ELLEUCH⁴, Naaila OUAZZANI^{1,2}, Faissal AZIZ^{1,2}**

¹National Centre for Research and Study on Water and Energy
(CNEREE), University Cadi Ayyad, Marrakech, Morocco; ²Laboratory of
Water, Biodiversity and Climate Changes, Semlalia Faculty of Sciences,
Marrakech, Morocco; ³Laboratory Analysis, Modelling, Engineering,
Natural Substances and Environment, Natural, Substances, Health and
Environment Team, Polydisciplinaire Faculty of Taroudant, University
Ibn Zohr, Morocco; ⁴Laboratoire de Génie Enzymatique et Microbiologie,
Equipe Biotechnologie des Algues, Ecole Nationale d'Ingénieurs de Sfax,
Université de Sfax, Sfax, Tunisia.

**DIATOM EFFICIENCY IN ORGANIC MICROPOLLUTANTS
REMOVAL: AN EVALUATION STUDY**



15:20 – 15:30

Mustafa HATHAL, Viola SOMOGYI

Sustainability Solutions Research Laboratory, Faculty of Engineering,
University of Pannonia, Veszprém, Hungary.

**NUMERICAL SIMULATION AND FLOW VISUALIZATION OF
BAGHDAD CITY TIGRIS RIVER USING COMSOL MULTIPHYSICS**

15:30 – 15:40

Abdelfettah GHERIB^{1,2}, Inês DOMINGUES³

¹Laboratory of Environmental Analysis, Biotechnology Research Centre (CRBt), Constantine, Algeria; ²Laboratory of Biology and Environment (LBE), Department of Biology and Plant Ecology, University of Brothers Mentouri Constantine 1, Constantine, Algeria; ³Department of Biology & Centro de Estudos do Ambiente e do Mar (CESAM), University of Aveiro, Campus Universitário de Santiago, Aveiro, Portugal.

**DEVELOPMENTAL, BEHAVIORAL AND BIOCHEMICAL EFFECTS
OF ANTHRACENE AND Pb²⁺ TO ZEBRAFISH EMBRYOS**

15:40 – 15:50

**Nathalie PANO¹, Nada NEHME², Jalal HALWANI^{1,3}, Kostas
KARANTININIS⁴, Najah TALEB²**

¹Lebanese University, Doctoral School of Science and Technology, Hadath, Lebanon; ²Lebanese University, Faculty of Agricultural Engineering and Veterinary Medicine, Dekwene, Lebanon; ³Lebanese University, Water & Environment Science Lab, Tripoli, Lebanon; ⁴Swedish University of Agricultural Sciences, Alnarp, Sweden.

**LEBANESE AGRO INDUSTRIES' KNOWLEDGE IN FOOD LOSS IS AN
INITIAL STEP TOWARD THE SUSTAINABLE DEVELOPMENT GOAL
12.3**



15:50 – 16:00

Abdelhaq EL ARRAM¹, Achraf BERRADI^{1,2}, Ahlam LAFDALI^{1,2,3}, Faissal AZIZ^{1,2}

¹National Center for Research and Studies on Water and Energy (CNEREE), Cadi Ayyad University, Marrakech, Morocco; ²Laboratory of Water, Biodiversity, and Climate Change, Faculty of Sciences Semlalia, Cadi Ayyad University, Marrakech, Morocco; ³Laboratory of Innovative Materials, Energy and Sustainable Development (IMED-Lab), Faculty of Science and Technology, Cadi Ayyad University, Marrakech, Morocco.

ECO-FRIENDLY POLYSACCHARIDE-BASED HYDROGELS FOR SUSTAINABLE IRRIGATION

16:00 – 16:10

Mouhsine BELLAJ¹, Hicham YAZID², Abdelmajid REGTI², Mohammadine EL HADDAD², Abdelkrim ABOURRICHE¹, Lhoucine GEBRATI¹, Faissal AZIZ^{3,4}

¹Laboratory of Materials, Process, Environment, and Quality, National School of Applied Sciences, Cadi Ayyad University, Safi, Morocco; ²Laboratory of Analytical and Molecular Chemistry, Faculty Poly-disciplinary of Safi, Cadi Ayyad University, Safi, Morocco; ³Laboratory of Water, Biodiversity, and Climate Change, Faculty of Sciences Semlalia, Cadi Ayyad University, Marrakech, Morocco; ⁴National Center for Research and Studies on Water and Energy, Cadi Ayyad University, Marrakech, Morocco.

COMPREHENSIVE STUDY ON THE EFFICIENT ELIMINATION OF ALIZARIN RED S DYE IN WATER USING AN ECO-FRIENDLY CLAY-CHITOSAN COMPOSITE: EXPERIMENTAL AND THEORETICAL INVESTIGATION



11:00 – 12:30

Technical Session D

**Artificial intelligence, Bioinformatics,
Circular Economy Strategy**

Chair of the Session:

Ijaz Ahmad TATLAH

11:00 – 11:20

Keynote speaker:

Ijaz Ahmad TATLAH¹, Durr-e-SHAHWAR²

¹University of Education, Lahore, Pakistan; ²Lahore University of
Management Sciences, Lahore, Pakistan

**ARTIFICIAL INTELLIGENCE REVOLUTION IN EDUCATION AND
WAY FORWARD ARTIFICIAL INTELLIGENCE REVOLUTION IN
EDUCATION AND WAY FORWARD**

11:20 – 11:40

Invited Speaker

Rashmi RATHORE

B.H. Medical College Medicine. Image consulting. Soft skills training
Jaipur, Rajasthan, India

SUSTAINABLE FASHION -THE ONLY REMEDY FOR FAST FASHION

Invited Speaker

11:40 – 12:00

Neha Singh RAGHUVANSHI, Arpita JOHARI, Mudit SAXENA

ABES Engineering College, Ghaziabad, Uttar Pradesh, India.

**SECURING THE BIOSPHERE FOR FUTURE GENERATIONS USING
ARTIFICIAL INTELLIGENCE**



12:00 – 12:10

Mohamed Sabri BENSaad

Department of Biology of Organisms, Faculty of Natural and Life Sciences, University Batna 2, Fesdis, Batna, Algeria.

COMPUTATIONAL ESTIMATION OF THE ECO-TOXICITY RISKS, BIODEGRADABILITY, PERSISTENCE AND BIOACCUMULATION FACTOR OF FOUR BIO-COMPOUNDS

12:10 – 12:20

Mohamed DASSAMIOUR¹, Djamel SAMAI², Naima FAGHMOUS³, Rédha BOUSTILA⁴

¹Department of Geological Sciences, Faculty of Earth Sciences, Geography and Spatial Planning, Constantine 1 - Frères Mentouri University, Constantine, Algeria; ²Univ Ouargla, Fac. des nouvelles technologies de l'information et de la communication. Lab. de Génie Électrique, Ouargla, Algeria; ³Process Engineering Laboratory for Sustainable Development and Health Products, National Polytechnic School of Constantine, Constantine, Algeria; ⁴Département des Sciences de la Terre, Institut d'Architecture et des Sciences de la Terre, Université Ferhat Abbas Sétif 1, Sétif, Algeria.

GROUP METHOD OF DATA HANDLING-BASED MODELS FOR PREDICTING ARSENIC CONCENTRATION IN SEDIMENTARY PHOSPHATE ROCK

12:20 – 12:30

Akeel BDRANY¹, Sattar B. SADKHAN²

¹Department of field crops, College of Agriculture, University of Diyala, Iraq; ²College of Information Technology, University of Babylon, Al-Mustaqbal University, Babylon, Iraq.

CHANNEL SELECTION ENHANCEMENT IN COGNITIVE RADIO NETWORKS BASED ON FUZZY APPROACH

Lunch time.



11:00 – 11:50

Technical Session E

Energy Research & Applications

Chair of the Session:

Emőke IMRE

11:00 – 11:20

Invited Speaker

**Emőke IMRE^{1,2}, László TÓTH², Péter FELKER¹, Ákos NEMCSICS^{2,5},
Antal ÜRMÖS^{2,5}, Tamás WEIDINGER⁶, Martin MAYER³, Tibor
PÁLINKÁS¹, Gábor MILE⁴, Lily TANUI⁷, Ulsbold AYURZANA⁷, Delphin
KABEY², Habaguhirwa VEDASTE¹, Ágnes BÁLINT^{2,8}, Ervin RÁCZ^{2,5},
Zoltán KAPROS¹⁰**

¹Bánki Donát Faculty, Óbuda University, Budapest, Hungary; ²Hydro-Bio-Mechanical Systems Research Center, Óbuda University;

³Department of Energy Engineering, Faculty of Mechanical Engineering, Budapest University of Technology and Economics, Hungary; ⁴FKF Zrt., Budapest, Hungary; ⁵Kandó Kálmán Faculty, Óbuda University, Budapest, Hungary; ⁶Faculty of Social Sciences, Eötvös Loránd University, Budapest, Hungary; ⁷Doctoral School of Applied Informatics and Applied Mathematics, Óbuda University; ⁸Rejtő Sándor Faculty, Óbuda University, Budapest, Hungary; ⁹Faculty of Engineering and Information Technology, University of Pécs, Hungary; ¹⁰Ministry of Construction and Transport, Hungary.

ENERGY UTILISATION OF MSW LANDFILL HILLS SITES OF HUNGARY

11:20 – 11:30

Amberbir WONDIMU, Yang CHAOJUN, Guo YAFE, Ebenezer OMARI
School of Mechanical Engineering, Jiangsu University, Zhenjiang, China
**DESIGN OF NOVEL COAXIAL MAGNETIC FOR HIGH POWER
DENSITY APPLICATIONS**



11:30 – 11:40

Abdelkader HEMAIZIA¹, Dominique THEVENIN²

¹Faculty of Mechanical engineering and Processes engineering, USTHB, Algeria; ²Institute of Fluid Dynamics and Thermodynamics, OVGU, Germany.

STUDY OF POLLUTANT EMISSIONS FORMATION IN A PREMIXED BURNER MODEL: EFFECTS OF EQUIVALENCE RATIO AND GEOMETRY MODIFICATION

11:40 – 11:50

Mathapelo Kgolomela MOTIMELE

Széchenyi Istvan University, Gyor, Hungary

ENERGY CRISIS IN SOUTH AFRICA: ASSESSMENT OF THE EFFECTS OF LOAD SHEDDING ON THE LOGISTICS CONTEXT

Lunch time.



POSTER SESSION (ALL SESSIONS: A, B, C, D AND E)

16:30 – 17:40

Chair of the Session: Hosam BAYOUMI HAMUDA

16:30 – 16:35

Asad ULLAH

Khayaban-e-Jinnah Road, Johar Town, Lahore, Pakistan,

GRAPHENE, A GAME-CHANGER IN SCIENCE AND TECHNOLOGY

16:35 – 16:40

Hafiza Qurat ul Ain SAMI

Nano and Biomaterials Lab, Department of Chemistry, University of
Agriculture, Faisalabad 38040, Pakistan

**ENVIRONMENTALLY SAFE MAGNETIC NANOCATALYST FOR THE
PRODUCTION OF BIODIESEL FROM PONGAMIA PINNATA OIL**

16:40 – 16:45

Evan DAYOUB, Jihad IBRAHIM, Samar HASAN, Ola KAJO

Tishreen University, Latakia, Syria.

**THE EFFECT OF WOODY BIOCHAR ON SOIL BULK DENSITY AND
PORE SIZE DISTRIBUTION**

16:45 – 16:50

Lara Rúbia BORGES SILVA, Levente KARDOS

Institute of Environmental Sciences, Department of Agro-Environmental
Studies, Hungarian University of Agriculture and Life Sciences,
Budapest, Hungary.

**PROMOTING ENVIRONMENTAL HEALTH THROUGH PÁLINKA
SPENT WASH COMPOSTING**



16:50 – 16:55

Sara MOGHNIE^{1,2}, Jalal HALWANI¹, Khaled YOUNES², Grasset LAURENT³

¹Water and Environment Sciences Laboratory, Lebanese University, Tripoli, Lebanon; ²College of Engineering and Technology, American University of the Middle East, Kuwait; ³Université de Poitiers, Institut de Chimie des Milieux et Matériaux de Poitiers IC2MP CNRS UMR 7285, Equipe Eaux, Biomarqueurs, Contaminants Organiques, Milieux, France.

THE APPLICATION OF HMDS THERMOCHEMOLYSIS FOR THE MOLECULAR CHARACTERIZATION OF AN OMBROTROPHIC PEAT BOG: A PRINCIPAL COMPONENT ANALYSIS APPROACH

16:55 – 17:00

Karima DRICI^{1,2}, Cherifa ABDELBAKI³, Yamina EL MEDDAHI^{1,2}

¹Department of Hydraulics, Faculty of Civil Engineering and Architecture, University of Hassiba Benbouali Chlef, Algeria; ²Vegetal Chemistry -Water-Energy Laboratory, University of Chlef, Algeria; ³EOLE laboratory, Faculty of Technology, University of Tlemcen, Algeria.

A HIERARCHICAL ANALYTICAL PROCESS TO ASSESS THE LONG-TERM BEHAVIOR OF THE WATER SUPPLY SYSTEM – CASE OF KHEMIS MILIANA, AIN DEFLA, ALGERIA

17:00 – 17:05

Iryna GUMENIUK, Alla LEVISHKO

Department of Agroecology and Biosafety, Institute of Agroecology and Environmental Management of NAAS, Kyiv, Ukraine.

SOIL MICROBIOCENOSIS IN THE CURRENT STATE

17:05 – 17:10

Alyona BUNAS, V. DVORETSKYI

Institute of Agroecology and Environmental Management of NAAS, Metrologichna, Kyiv, Ukraine.

THE STATE OF THE SOIL MICROORGANISM COMMUNITY UNDER THE INFLUENCE OF THE ORGANO-MINERAL FERTILISER DIAMOND GROW



17:10 – 17:15

Anatolii ORLOVSKYI¹, Nazarii SUS², Iryna GUMENIUK³, Viktoriia TSVIHUN⁴

¹Institute of Horticulture of the National Academy of Agrarian Sciences of Ukraine, Novosilky, Ukraine; ²Institute of Agroecology and Environmental Management of the National Academy of Agrarian Sciences of Ukraine, Kyiv, Ukraine; ³Institute of Agroecology and Environmental Management of the National Academy of Agrarian Sciences of Ukraine, Kyiv, Ukraine; ⁴Institute of Agroecology and Environmental Management of the National Academy of Agrarian Sciences of Ukraine, Kyiv, Ukraine.

WHY IS IT IMPORTANT TO MONITOR PESTS AND PATHOGENS OF THE COMMON HOP IN URBAN ECOSYSTEMS?

17:15 – 17:20

Nazarii SUS¹, Liliya JANSE², Anatolii ORLOVSKYI³, Viktoriia TSVIHUN⁴

¹Institute of Agroecology and Environmental Management of the National Academy of Agrarian Sciences of Ukraine, Kyiv, Ukraine; ²National Academy of Agrarian Sciences of Ukraine, Kyiv, Ukraine; ³Institute of Horticulture of the National Academy of Agrarian Sciences of Ukraine, Novosilky, Ukraine; ⁴Institute of Agroecology and Environmental Management of the National Academy of Agrarian Sciences of Ukraine, Kyiv, Ukraine.

FACTORS EFFECTING HOST PREFERENCES OF METCALFA PRUINOSA (SAY, 1830)

17:20 – 17:25

Yeuheniia TKACH, I. MOVCHAN

Institute of Agroecology and Environmental Management of NAAS, Metrologichna, Kyiv, Ukraine

ALTERNATIVE CARBON IN AGRICULTURAL PRODUCTION



17:25 – 17:30

Viktoriia STARODUB, Yevheniia TKACH, Andrii KRYZHANIVSKYJ

Department of Agroecology and Biosafety, Institute of Agroecology and Environmental Management of NAAS, Kyiv, Ukraine.

FREQUENCY OF OCCURRENCE, ABUNDANCE OF ADVENTIVE PLANT SPECIES IN AGROCENOSSES (ON THE EXAMPLE OF ODESA REGION)

17:30 – 17:35

Viktoriia TSVIHUN, Iryna GUMENIUK

Department of Agroecology and Biosafety, Institute of Agroecology and Environmental Management of NAAS, Kyiv, Ukraine

VIRAL AND BACTERIAL DISEASES OF PLANTS IN FOREST ECOSYSTEMS OF UKRAINE

17:35 – 17:40

Danara SMAIL^{1,2}

¹Licensed Expert on “green building”, Kazakhstan, ²University of Pécs, Hungary

IMPACT OF WASTE MANAGEMENT ON CLIMATE CHANGE ON THE EXAMPLE OF KAZAKHSTAN

17:40 – 17:45

Felicia Itunu WOLE-ALO*, Bosede Olufunmilayo AKINWALERE, Gbolade Evelyn AGBOMUSERIN, Abosede ADESOLA

Department of Agricultural Extension and Communication Technology, Federal University of Technology, Akure, Nigeria

FACTORS AFFECTING MARKET ORIENTATION OF RICE FARMERS IN EKITI STATE, NIGERIA

17:45 – 17:50

Felicia Itunu WOLE-ALO*, Gbolade Evelyn AGBOMUSERIN, Matthew Olalekan IYANDA

Department of Agricultural Extension and Communication Technology, Federal University of Technology, Akure, Nigeria

FACTORS AFFECTING CONSUMERS ATTITUDE TOWARDS LOCAL RICE PRODUCTION AND CONSUMPTION IN OGUN STATE, NIGERIA



17:50 – 17:55

Bekalu Melis ALEHEGN¹, Dagnenet Sultan ALEMU²

¹Assosa University, college of Agriculture, Department of Soil Resource and Watershed Management, Ethiopia.

²Bahir Dar university faculty of civil and Water Resource Engineering, Ethiopia

EFFECT OF DEFICIT IRRIGATION ON BARLEY YIELD AND WATER PRODUCTIVITY THROUGH FIELD EXPERIMENT AND MODELING AT KOGA IRRIGATION SCHEME, AMHARA REGION, ETHIOPIA

17:55 – 18:00

Sahel HAGHIGHI, Forood SHARIFI

Soil Conservation and Watershed Management Research Institute, Tehran, Iran.

EVALUATION OF THE PERFORMANCE AND QUALITY OF VETIVER PLANT UNDER THE INFLUENCE OF SOME ENVIRONMENTAL FACTORS (CASE STUDY: SIDE AREA OF SANGAR DAM RESERVOIR - IRAN)



10^h of May 2024 (Friday)

09:00 – 10:30

Plenary Session B

Chair of the Session:

Giuseppe CIABURRO

PI4: 09:00 – 09:30

Ayan CHATTERJEE

Department of Allied Health, School of Health and Medical Sciences,
Adamas University, India

**IMPACT OF CLIMATE CHANGE ON CARDIAC
PERFORMANCE**

PI5 09:30 – 10:00

Salma LATIQUE

Biomedical and Translational Research Laboratory, Faculty of Medicine,
Pharmacy and Dentistry of Fez, Sidi Mohamed Ben Abdellah University,
Morocco.

**EXPLORING THE POTENTIAL OF MICROALGAE-DERIVED
BIOACTIVE COMPOUNDS FOR NUTRACEUTICAL AND
PHARMACEUTICAL APPLICATIONS: CURRENT STATUS AND
FUTURE DIRECTIONS**

PI6 10:00 – 10:30

Sándor J. Zsarnóczai, Hosam E.A.F. BAYOUMI HAMUDA

Óbuda University, Rejtő Sándor Faculty of Light industry and
Environmental Engineering, Institute of Environmental Engineering and
Natural Sciences, Budapest, Hungary

**SUSTAINABILITY OF FOOD SUPPLY OF MIDDLE-EAST, NORTH-
AFRICA AND INDIA BETWEEN 2010-2020**



10:30 – 11:30 Technical Session, All Sessions: A, B, C, D, and E

Chair of the Session: Hosam BAYOUMI HAMUDA

10:30 – 10:50

Keynote Speaker:

Sándor KUKOVICS¹, Zoltán NAÁR², Attila SZAKÁCS³, Ferenc KUKOVICS¹

¹Hungarian Sheep and Goat Dairying Public Utility Association Érd, Hungary; ²University of Tokaj, Sárospatak, Hungary; ³Angus Ltd, Adony, Hungary.

MITIGATION OF THE ENVIRONMENTAL EFFECTS OF FATTENING CATTLE BY USING BENTONITE CLAY MINERAL AS A FEED SUPPLEMENT

10:50 – 11:00

Asma BEN AMARA^{1,2,3}, Manel CHEFFI², Monia EL HAJJI³, Emna AMMAR^{1,4}, Mohamed Ali TRIKI²

¹Laboratory of Environmental Sciences and Sustainable Development, University of Sfax, Preparatory Institute for Engineering Studies of Sfax, Sfax, Tunisia; ²Laboratory of Improvement and Protection of Olive Tree Genetic Resources, Olive Tree Institute, University of Sfax, Sfax, Tunisia; ³Laboratory of Advanced Research in Industrial and Logistic Engineering, Team OSIL, National High School of Electrical and Mechanical Engineering, University Hassan II, Casablanca, Morocco; ⁴Laboratory of Environment Sciences and Sustainable Development, University of Sfax, National Engineering School of Sfax, Tunisia.

THE ANTIFUNGAL ACTIVITY OF TWO-FERMENTED COMPOST TEAS AGAINST FUSARIUM CROWN AND ROOT ROT



11:00 – 11:10

Meriem BENAMARA-BELLAGHA, Malika BARKAT1, Rim Tinhinene MAOUGAL

Biotechnology and food quality laboratory (Bioqual,) INATAA, UFMCI,
Constantine, Algeria.

OLIVE POMACE VALORIZATION

11:20 – 12:00

Workshop Special Session: Environmental Health and Climatic Change (How humanity can solve climate change, alleviate poverty, and save biodiversity)

Keynote Speaker

Hosam E.A.F. BAYOUMI HAMUDA

Obuda University, Rejto Sandor Faculty of Light Industry and
Environmental Engineering, Institute of Environmental Engineering and
Natural Sciences, Budapest, Hungary.

**ORGANIC SOIL AND FARMING: AS CLIMATE WARMING
ADAPTATION AND MITIGATION STRATEGIES**

12:15

Closing the Symposium



Table of Publishing Contents



Author(S)	Presentation Title	Page Number	
		Abstract	Full Paper
Plenary Lectures			
Ratnesh DAS	CARBON NANOTUBES AND NANOPARTICLES AS AN EFFICIENT ELECTROCHEMICAL SENSOR FOR THE ANALYSIS OF CALCIUM CHANNEL BLOCKERS	95	
Lyudmyla SYMOCHKO	ANTIBIOTIC POLLUTION IN THE ENVIRONMENT: FROM MICROBIAL ECOLOGY TO PUBLIC HEALTH	96	
Giuseppe CIABURRO	ADVANCED SOUND EVENT DETECTION FOR SMART HOME SECURITY SYSTEMS	98	
Ayan CHATTERJEE	IMPACT OF CLIMATE CHANGE ON CARDIAC PERFORMANCE	99	
Salma LATIQUE	EXPLORING THE POTENTIAL OF MICROALGAE-DERIVED BIOACTIVE COMPOUNDS FOR NUTRACEUTICAL AND PHARMACEUTICAL APPLICATIONS: CURRENT STATUS AND FUTURE DIRECTIONS	101	
Sándor J. ZSARNÓCZAI, Hosam E.A.F. BAYOUMI HAMUDA	SUSTAINABILITY OF FOOD SUPPLY OF MIDDLE-EAST, NORTH-AFRICA AND INDIA BETWEEN 2010-2020	103	235
Keynote Lectures			
Rahul HAJARE	QUALITATIVE AND QUANTITATIVE ANALYSIS OF PERSIMMON, AN AMERICAN TOMATO	106	
Hosam E.A.F. BAYOUMI HAMUDA	IMPACTS OF ZINC AND SILVAR ENGINEERED NANOPARTICLES ON PLANT	107	

	GROWTH-PROMOTING BACTERIA IN AGRICULTURAL SOIL		
Ágnes BÁLINT, Dávid CZEKMEISTER, Xuechu WANG, Csaba MÉSZÁROS	HEAVY METAL LOADS IN THE SLURRY AREA OF THE PAKS NUCLEAR POWER PLANT	110	251
Ijaz Ahmad TATLAH, Durr-e-SHAHWAR	ARTIFICIAL INTELLIGENCE REVOLUTION IN EDUCATION AND WAY FORWARD	112	
Sándor KUKOVICS, Zoltán NAÁR, Attila SZAKÁCS, Ferenc KUKOVICS	MITIGATION OF THE ENVIRONMENTAL EFFECTS OF FATTENING CATTLE BY USING BENTONITE CLAY MINERAL AS A FEED SUPPLEMENT	114	
Oral Presentation Sessions			
Technical Session (A)	Agriculture and Soil Improvement, Food Security and Green Growth		
Asmaa RHAZOUANI, Halima GAMRANI, Lhoucine GEBRATId, Faissal AZIZ	HEPATIC EFFECTS OF GRAPHENE OXIDE (GO): A MACROSCOPIC AND HISTO-BIOCHEMICAL ANALYSIS	126	
Henok ABEBE, Henok MULATU, Samuel KELEMEWORK	REVIEW ON EPIDEMIOLOGICAL INTERFACE OF FOOT AND MOUTH DISEASES BETWEEN WILD ANIMALS, DOMESTIC ANIMALS AND HUMAN	127	
Kenza IRINISLIMANE	ANALYSIS OF THE MANAGEMENT SYSTEM ACCIDENT RISKS	128	
Rahat SIRAJ	THREATS TO WILDLIFE	129	
Rahul KUMAR	ISOLATION OF PATHOGENIC BACTERIA FROM DISEASED HETEROPNEUSTES FOSSILIS	130	
Asmaa HAJ-KHLIFA, Faissal AZIZ, Maroua Ait TASTIFT, Souad SELLAMI, Hanane RAIS, Miloud HAMMOUD, Naima FDIL, Najib KISSANI, Halima GAMRANI, Moulay Mustapha BOUYATAS	AMELIORATIVE EFFECT OF ONONIS NATRIX AGAINST CHRONIC LEAD POISONING IN MICE: BIOCHEMICAL AND HISTOLOGICAL STUDY	131	
Technical Session (B)	Agriculture and Soil Improvement, Food Security and Green Growth		
Session (B1)			

Iram MAJEED	ECOSYSTEMS & LANDSCAPE CONSERVATION	133	
Sana AHMED, Sufia ZAMAN, Abhijit MITRA	EVALUATION OF STORED CARBON IN URBAN TREES OF KOLKATA CITY USING EMERGING TECHNOLOGIES	134	
Lateefat Adeola BELLO	NAVIGATING THE LEGAL LABYRINTH: BALANCING TOURISM, ENVIRONMENTAL HEALTH, AND BIOSECURITY	136	
Igor DUKAY	LANDSCAPE SCALE STUDY OF HYDROMORPHOLOGICAL CHANGES OF BÜKKÖS STREAM (SZENTENDRE) AND THEIR EFFECTS ON NATUTAL STATE	137	278
Achraf BERRADI, Ahlam LAFDALI, Laila Mandi, Faissal AZIZ, Naaila OUZZANI, Abdelhaq EL ARRAM	BIOBASED HYDROGELS AS A RESILIENT SOLUTION FOR WATER-EFFICIENT AGRICULTURE	139	
Rashwan ALKENTAR, Tamás MANKOVITS	HIP IMPLANT OPTIMIZATION USING LATTICE STRUCTURES	141	286
Karim ENNOURI, Monia ENNOURI, Mohamed Ali TRIKI	EXAMINING SOIL CHARACTERISTICS USING SATELLITE-BASED IMAGING TECHNIQUES	142	
Zerihun TESHOME, Tamrat TESFAYE, Tsion BELAY	UTILIZATION OF THE POULTRY INDUSTRY BY-PRODUCTS PAW WASTE FOR THE PRODUCTION OF AN ALTERNATE MATERIAL OF EXOTIC LIKE LEATHER: WASTE TO THE HEALTH	143	289
Belkasim KHAMEISS	SEDIMENT ANALYSIS OF MIOCENE DEPOSITS IN THE RED BAY FORMATION, FLORIDA: INSIGHTS INTO NEARSHORE MARINE FACIES AND LITHOLOGICAL DISCREPANCIES	145	303
Technical Session (B2)			
Olena DEMYANYUK, Dmitry SHATSMAN, Oleksander POLTAVA	AGROECOLOGICAL ASSESSMENT OF HERBICIDE APPLICATION FOR MONOCULTURE MAIZE	146	
Hayet HFAIEDH, Emna BOUAZIZI, Yaakoub GHARBI, Mohamed Ali TRIKI	CO-COMPOSTING OF SHRIMP SHELL WASTE AND OLIVE LEAVES: PHYSICO-CHEMICAL AND	148	

	AGRONOMIC QUALITY ASSESSMENT		
Eetizez KAROUI, Karim ENNOURI, Mohammed Ali TRIKI, Monia ENNOURI	ROLE OF MARINE ALGAE IN PLANT GROWTH AND PROTECTION FOR SUSTAINABLE AGRICULTURE	150	315
Ghizlane AKHOUI, Lhoucine GEBRATI, Yasin AKGÜL, Mehmet Durmus CALISIR, Manal ZEFZOUFI, Salima ATLAS, Majdouline BELAQZIZ, Faissal AZIZ	ELECTRO-BLOW SPUN HYBRID NANOFIBERS: A NEW PERSPECTIVE IN ACTIVE PACKAGING MATERIALS	151	
Abdousalam AHMED ALGAIDI, Hosam E.A.F. BAYOUMI HAMODA, Ibrahim ISSA, Yosof SALEH HAMID	THE EMISSION OF NITRIC OXIDE AND CARBON DIOXIDE FROM CULTIVATED SOIL	153	326
Izhar ULLAH, Shabir AHMAD, Sardar Azhar MAHMOOD, Said Nawaz KHAN, Asifa KHAN, Mohammad YOUSAF	TAXONOMIC STUDY OF SPIDER (ARACHNIDA: ARANEAE) FAUNA IN DISTRICT BATTAGRAM KP, PAKISTAN	154	332
Zita ZSEMBERY, Dorottya PUJSZ	PEDOLOGICAL BACKGROUND FOR EARTHWORM RESEARCH IN THE GÖDÖLLŐ HILLSIDE	155	351
Amal OMRI, Sofiane ABDELHAMID, Mohamed AYADI, Cinzia BENINCASA	EXPLORING THE PHENOLIC COMPOSITION AND SENSORY CHARACTERISTICS OF OLIVE OILS FROM MINOR CULTIVARS IN TUNISIA	156	
Hosam E.A.F. BAYOUMI HAMUDA	AN INNOVATIVE APPROACH OF BIOREMEDIATION IN ENZYMATIC DEGRADATION OF XENOBIOTICS	157	
Technical Session (B3)			
Zita ZSEMBERY	COMPARING SOIL PROPERTIES OF NATURAL AND ARABLE AREAS	159	358
REETU, Rahul KUMAR	EFFECT MORINGA OLEIFERA LEAVES ON AEROMONAS HYDROPHILA INFECTED COMMON CARP	160	
Malika BARKAT, Nassim ZOUAOUI	DETERMINATION OF THE VOLATILE PROFILE OF SIX ENDEMIC PLANTS FROM THE BISKRA REGION (ALGERIA)	161	

Technical Session (C)	Air, Water & Sediments Pollution and Waste Management		
Technical Session (C1)			
Rahele Khosravi NESIANI, Meysam NASERI	ANALYSIS ON LOW TEMPERATURE SYNTHESIS OF NANO ALPHA ALUMINA POWDER WITH TWO-STEP HYDROLYSIS	163	363
Filipa Duque FONSECA, M. Nazaré Coelho PINHEIRO	DRIVING CIRCULAR ECONOMY THROUGH WASTE VALORIZATION: A CASE STUDY OF TEXTILE (BIO)DYES	164	
Y.L. ROMERO, J. BESSEMBINDER, N.C. VAN DE GIESEN, F.H.M. VAN DE VEN	A RELATION BETWEEN EXTREME DAILY PRECIPITATION AND EXTREME SHORT-TERM PRECIPITATION	166	388
Belkasim KHAMEISS, Makenna HARRIS	TAXONOMIC OBSERVATIONS AND ENVIRONMENTAL SIGNIFICANCE OF RECENT FORAMINIFERA FROM ANTHONY'S BAY, ROATAN, NORTHEAST HONDURAS	167	400
Imane EL-BAGGAR, Mohammed ALAOUI MHAMDI, Jamila BAHHOU, Salma LATIQUE	BIOREMEDIATION OF WASTEWATER AND VALORIZATION OF MICROALGAE: A SUSTAINABLE SOLUTION FOR ENVIRONMENTAL AND ECONOMIC CHALLENGES	168	
Osama A. EL FALLAH, Ahmed ABUHARARA	HYDROGEOCHEMICAL STUDY OF THE GROUNDWATER IN THE COASTAL AREA, NORTHEASTERN OF BENGHAZI CITY, NE LIBYA	170	377
Osamah J. AL-SAREJI, Mónica MEICZINGER, Ruqayah Ali GRMASHA, Viola SOMOGYI	UTILIZING AGRICULTURAL WASTE FOR EFFICIENT REMOVAL OF ORGANIC MICRO-POLLUTANTS FROM WATER AND WASTEWATER	171	
Technical Session (C2)			
Rahele Khosravi NESIANI, Meysam NASERI	DETAILED ANALYSIS AND UNDERSTANDING OF CARBON/IRON COMPOSITE MICROFIBER CATALYSTS DERIVED FROM BLOOD HEMOGLOBIN PROTEIN FOR LITHIUM-OXYGEN BATTERIES	173	411

Madina IGIBAYEVA	INTERNATIONAL COOPERATION IN THE FIELD OF WATER SECURITY: KAZAKHSTAN ON THE WAYS TO STABILITY	174	420
Siheem HEDJAL, Abdelwaheb BENAMARA	THE IMPACT OF ANTHROPOGENIC ACTIVITY ON WATER QUALITY IN THE SANHADJA WETLAND COMPLEX (NORTHEASTERN ALGERIA)	176	
Eva Lota CIUGANSCHI	MUNICIPAL SOLID WASTE MANAGEMENT. ANALYSIS AND COMPARISON OF PRACTICES IN FINLAND AND THE REPUBLIC OF MOLDOVA	179	
Leocadie ODOULAMI, Rene AYEMAN ZODEKON	DELEGATED PUBLIC DRINKING WATER SERVICES IN THE MUNICIPALITY OF DASSA-ZOUME (BENIN)	180	429
Ruqayah Ali GRMASHA, Osamah J. AL-SAREJI, Mónika MEICZINGER, Csilla STENGER-KOVÁCS	THE CURRENT STATUS OF POLYCYCLIC AROMATIC HYDROCARBONS (PAHS) POLLUTION IN LAKE BALATON SEDIMENT, HUNGARY	180	
Olena MITRYASOVA, Oleksandra KOVALSKA	WATER INSECURITY IN THE CITY OF MYKOLAIV UNDER WARTIME CONDITIONS	181	
Olena MITRYASOVA, Viktor SMYRNOV, Andrii MATS	THE STATUS OF THE SURFACE WATERS OF THE BUZKY ESTUARY WITHIN MYKOLAIV CITY: PRE-WAR AND WARTIME PERIODS	183	
Afef SAI, Sonia BEN YOUNES, Ali ELLAFI, Amel MOULA, Juan Manuel SÁNCHEZ-YAÑEZ, Mohamed Ali BORGİ	ROCK PHOSPHATE AMENDMENT AND THE KEY ROLE OF SERRATIA PLYMUTHICA BMA1 STRAIN IN ENHANCING MINERAL NUTRITION AND HEAVY METAL RHIZO-ACCUMULATION IN VICIA FABAL	185	
Sara ELHAMJI, Maryem MINHAJ, Karim SBIHI, Jihen ELLEUCH, Naaila OUAZZANI, Faissal AZIZ	COMPARATIVE EVALUATION OF PHENOL REMOVAL BY MICROALGAE FROM VARIED ECOSYSTEMS	187	
Rainiel Brkryan V. DOMASIAN	EVALUATION OF CONTAMINANT LEVELS IN WATER, SEDIMENTS, AND FISH FOR HEALTH RISK ASSESSMENT IN AQUATIC ECOSYSTEMS	189	

Imane HAYDARI, Jamila SABYH, Jihen ELLEUCH, Naaila OUAZZANI, Laila MANDI, Faissal AZIZ	SUSTAINABLE NANOPARTICLE SYNTHESIS FOR EFFICIENT PHENOL ELIMINATION IN OLIVE MILL EFFLUENTS	190	
Maryem MINHAJ, Sara ELHAMJI, Karim SBIHI, Jihen ELLEUCH, Naaila OUAZZANI, Faissal AZIZ	DIATOM EFFICIENCY IN ORGANIC MICROPOLLUTANTS REMOVAL: AN EVALUATION STUDY	191	
Mustafa HATHAL, Viola SOMOGYI	NUMERICAL SIMULATION AND FLOW VISUALIZATION OF BAGHDAD CITY TIGRIS RIVER USING COMSOL MULTIPHYSICS	192	
Abdelfettah GHERIB, Inês DOMINGUES	DEVELOPMENTAL, BEHAVIORAL AND BIOCHEMICAL EFFECTS OF ANTHRACENE AND Pb ²⁺ TO ZEBRAFISH EMBRYOS	193	438
Nathalie PANO, Nada NEHME, Jalal HALWANI, Kostas KARANTININIS, Najah TALEB	LEBANESE AGRO INDUSTRIES' KNOWLEDGE IN FOOD LOSS IS AN INITIAL STEP TOWARD THE SUSTAINABLE DEVELOPMENT GOAL 12.3	194	450
Abdelhaq EL ARRAM, Achraf BERRADI, Ahlam LAFDALI, Faissal AZIZ	ECO-FRIENDLY POLYSACCHARIDE-BASED HYDROGELS FOR SUSTAINABLE IRRIGATION	196	
Mouhsine BELLAJ, Hicham YAZID, Abdelmajid REGTI, Mohammadine EL HADDAD, Abdelkrim ABOURRICHE, Lhoucine GEBRATI, Faissal AZIZ	COMPREHENSIVE STUDY ON THE EFFICIENT ELIMINATION OF ALIZARIN RED S DYE IN WATER USING AN ECO-FRIENDLY CLAY-CHITOSAN COMPOSITE: EXPERIMENTAL AND THEORETICAL INVESTIGATION	197	
Session (D)	Artificial intelligence, Bioinformatics, Circular Economy Strategy		
Invited Speaker			
Neha Singh RAGHUVANSHI, Arpita JOHARI, Mudit SAXENA	SECURING THE BIOSPHERE FOR FUTURE GENERATIONS USING ARTIFICIAL INTELLIGENCE	117	271
Rashmi RATHORE	SUSTAINABLE FASHION - THE ONLY REMEDY FOR FAST FASHION	118	
Oral Speaker			
Mohamed Sabri BENSaad	COMPUTATIONAL ESTIMATION OF THE ECO-	200	

	TOXICITY RISKS, BIODEGRADABILITY, PERSISTENCE AND BIOACCUMULATION FACTOR OF FOUR BIO- COMPOUNDS		
Mohamed DASSAMIOUR, Djamel SAMAI, Naima FAGHMOUS, Rédha BOUSTILA	GROUP METHOD OF DATA HANDLING-BASED MODELS FOR PREDICTING ARSENIC CONCENTRATION IN SEDIMENTARY PHOSPHATE ROCK	201	
Akeel BDRANY, Sattar B. SADKHAN	CHANNEL SELECTION ENHANCEMENT IN COGNITIVE RADIO NETWORKS BASED ON FUZZY APPROACH	203	457
Session (E)	Energy Research & Application		
Emőke IMRE, László TÓTH, Péter FELKER, Ákos NEMCSICS, Antal ÜRMÖS, Tamás WEIDINGER, Martin MAYER, Tibor PÁLINKÁS, Gábor MILE, Lily TANUI, Ulsbold AYURZANA, Delphin KABEY, Habaguhirwa VEDASTE, Ágnes BÁLINT, Ervin RÁCZ, Zoltán KAPROS	ENERGY UTILISATION OF MSW LANDFILL HILLS SITES OF HUNGARY	120	
Amberbir WONDIMU, Yang CHAOJUN, Guo YAFE, Ebenezer OMARI	DESIGN OF NOVEL COAXIAL MAGNETIC FOR HIGH POWER DENSITY APPLICATIONS	205	
Abdelkader HEMAIZIA, Dominique THEVENIN	STUDY OF POLLUTANT EMISSIONS FORMATION IN A PREMIXED BURNER MODEL: EFFECTS OF EQUIVALENCE RATIO AND GEOMETRY MODIFICATION	206	
Mathapelo Kgolomela MOTIMELE	ENERGY CRISIS IN SOUTH AFRICA: ASSESSMENT OF THE EFFECTS OF LOAD SHEDDING ON THE LOGISTICS CONTEXT	208	478
Asma BEN AMARA, Manel CHEFFI, Monia EL HAJJI, Emna AMMAR, Mohamed Ali TRIKI	THE ANTIFUNGAL ACTIVITY OF TWO-FERMENTED COMPOST TEAS AGAINST FUSARIUM CROWN AND ROOT ROT	210	

Meriem BENAMARA-BELLAGHA, Malika BARKAT, Rim Tinhinene MAOUGAL	OLIVE POMACE VALORIZATION	212	
POSTER SESSION (A, B, C, D, E and F)			
Asad ULLAH	GRAPHENE, A GAME-CHANGER IN SCIENCE AND TECHNOLOGY	215	
Hafiza Qurat ul Ain SAMI	ENVIRONMENTALLY SAFE MAGNETIC NANOCATALYST FOR THE PRODUCTION OF BIODIESEL FROM PONGAMIA PINNATA OIL	216	
Evan DAYOUB, Jihad IBRAHIM, Samar HASAN, Ola KAJO	THE EFFECT OF WOODY BIOCHAR ON SOIL BULK DENSITY AND PORE SIZE DISTRIBUTION	217	
Lara Rúbia BORGES SILVA, Levente KARDOS	PROMOTING ENVIRONMENTAL HEALTH THROUGH PÁLINKA SPENT WASH COMPOSTING	218	
Sara MOGHNIE, Jalal HALWANI, Khaled YOUNES, Grasset LAURENT	THE APPLICATION OF HMDS THERMOCHEMOLYSIS FOR THE MOLECULAR CHARACTERIZATION OF AN OMBROTROPHIC PEAT BOG: A PRINCIPAL COMPONENT ANALYSIS APPROACH	219	
Karima DRICI, Cherifa ABDELBAKI, Yamina EL MEDDAHI	A HIERARCHICAL ANALYTICAL PROCESS TO ASSESS THE LONG-TERM BEHAVIOR OF THE WATER SUPPLY SYSTEM – CASE OF KHEMIS MILIANA, AIN DEFLA, ALGERIA	221	
Iryna GUMENIUK, Alla LEVISHKO	SOIL MICROBIOCENOSIS IN THE CURRENT STATE	222	
Alyona BUNAS, V. DVORETSKYI	THE STATE OF THE SOIL MICROORGANISM COMMUNITY UNDER THE INFLUENCE OF THE ORGANO-MINERAL FERTILISER DIAMOND GROW	224	
Anatolii ORLOVSKYI, Nazarii SUS, Iryna GUMENIUK, Viktoriia TSVIHUN	WHY IS IT IMPORTANT TO MONITOR PESTS AND PATHOGENS OF THE COMMON HOP IN URBAN ECOSYSTEMS?	225	

Nazarii SUS, Liliya JANSE, Anatolii ORLOVSKYI, Viktoriia TSVIHUN	FACTORS EFFECTING HOST PREFERENCES OF METCALFA PRUINOSA (SAY, 1830)	226	
Yeuheniia TKACH, I. MOVCHAN	ALTERNATIVE CARBON IN AGRICULTURAL PRODUCTION	227	
Viktoriya STARODUB, Yevheniia TKACH, Andrii KRYZHANIVSKYJ	FREQUENCY OF OCCURRENCE, ABUNDANCE OF ADVENTIVE PLANT SPECIES IN AGROCENOSSES (ON THE EXAMPLE OF ODESA REGION)	228	
Viktoriya TSVIHUN, Iryna GUMENIUK	VIRAL AND BACTERIAL DISEASES OF PLANTS IN FOREST ECOSYSTEMS OF UKRAINE	229	
Danara SMAIL	IMPACT OF WASTE MANAGEMENT ON CLIMATE CHANGE ON THE EXAMPLE OF KAZAKHSTAN	231	
Bekalu Melis ALEHEGN, Dagnenet Sultan ALEMU	EFFECT OF DEFICIT IRRIGATION ON BARLEY YIELD AND WATER PRODUCTIVITY THROUGH FIELD EXPERIMENT AND MODELING AT KOGA IRRIGATION SCHEME, AMHARA REGION, ETHIOPIA	232	503
Sahel HAGHIGHI, Forood SHARIFI	EVALUATION OF THE PERFORMANCE AND QUALITY OF VETIVER PLANT UNDER THE INFLUENCE OF SOME ENVIRONMENTAL FACTORS (CASE STUDY: SIDE AREA OF SANGAR DAM RESERVOIR - IRAN)	233	
Felicia Itunu WOLE-ALO, Bosede Olufunmilayo AKINWALERE, Gbolade Evelyn AGBOMUSERIN, Abosede ADESOLA	FACTORS AFFECTING MARKET ORIENTATION OF RICE FARMERS IN EKITI STATE, NIGERIA	178	489
Felicia Itunu WOLE-ALO, Gbolade Evelyn AGBOMUSERIN, Matthew Olalekan IYANDA	FACTORS AFFECTING CONSUMERS ATTITUDE TOWARDS LOCAL RICE PRODUCTION AND CONSUMPTION IN OGUN STATE, NIGERIA	178	495
Workshop Special Session:			

Environmental Health and Climatic Change (How humanity can solve climate change, alleviate poverty, and save biodiversity)			
Hosam E.A.F. BAYOUMI HAMUDA	ORGANIC SOIL AND FARMING: AS CLIMATE WARMING ADAPTATION AND MITIGATION STRATEGIES	116	



ABSTRACTS



Plenary Session



VIII. International Symposium-2024

CARBON NANOTUBES AND NANOPARTICLES AS AN EFFICIENT ELECTROCHEMICAL SENSOR FOR THE ANALYSIS OF CALCIUM CHANNEL BLOCKERS

Ratnesh DAS

Department of Chemistry, Dr Harisingh Gour Central University, Sagar, India.

E-mail: ratneshdas1@gmail.com

The electrochemically functionalized multiwalled carbon nanotubes/copper nanoparticles (fMWCNT/CuNPs) carbon paste electrode (fMWCNT/CuNPs-CPE) was successfully modified by silver nanoparticles (AgNPs) via electrocatalytic process. The formation of modified electrode (AgNPs/fMWCNT/Cu NP-CPE) was observed by Field Emission Scanning Electron Microscopy and X-ray diffraction techniques. The as-prepared electrodes were explored for the trace recognition of calcium channel blocker drug amlodipine besylate (ADB) using cyclic voltammetry and electrochemical impedance spectroscopy measurements. Kinetic parameters like electron transfer coefficient (α), charge due to adsorption (Q_{ads}), surface coverage (Γ), charge transfer coefficient (R_{ct}), and apparent electron-transfer rate constant (k_{app}) for the designed electrodes were evaluated. The nanoparticles based electrochemical sensor displayed high sensitivity, good selectivity and favorable catalytic ability for the oxidation of calcium channel blocker drug.

Keywords: *carbon nanotubes and nanoparticles as an efficient electrochemical sensor*



VIII. International Symposium-2024

ANTIBIOTIC POLLUTION IN THE ENVIRONMENT: FROM MICROBIAL ECOLOGY TO PUBLIC HEALTH

Lyudmyla SYMOCHKO^{1,2,3,4}

¹*Uzhhorod National University, Uzhhorod, Ukraine*

²*University of Coimbra, Calçada Martim de Freitas, Coimbra, Portugal*

³*Institute of Agroecology and Environmental Management NAAS, Metrolohichna, Kyiv, Ukraine*

⁴*CERNAS - Research Centre for Natural Resources, Environment and Society, Escola Superior Agrária de Coimbra, Coimbra, Portugal.*

E-mail: lyudmilasse@gmail.com

The World Health Organization has classified antimicrobial resistance (AMR) as a major global health concern. With soils providing nearly 98.8% of the world's food, the soil microbiome plays a critical role in the transmission of AMR to humans. Our research reveals that the systematic use of organic fertilizers containing antibiotic residues disrupts the structure of the soil microbiome. This disruption alters both the functional and taxonomic biodiversity, leading to an increase in the population of oligotrophic and pedotrophic microbiota, while significantly reducing the presence of nitrogen-fixing microbiota. Furthermore, pharmaceutical contamination of agroecosystems has led to a rise in the population of antibiotic-resistant microorganisms. Monitoring studies have indicated that external factors contribute to the formation of an environmental resistome and the spread of antibiotic-resistant microorganisms. Over a 5-year period, the number of antibiotic-resistant bacteria increased by 2.28 times, with ESKAPE pathogens experiencing a 2.21-fold increase. Modern agroecosystems are a significant source of pathogenic and opportunistic microorganisms, including ESKAPE pathogens with multiple antibiotic resistances, posing a serious threat to public health.

Keywords: *antibiotic contamination; soil microbiome; ESKAPE pathogens, public health.*

Biography:



Lyudmyla Symochko is an Ecologist and Environmental Microbiologist currently serving as an Invited Professor at the University of Coimbra, Portugal. She holds a Doctorate in Ecology and specializes in exploring the environmental resistome and the role of natural and transformed ecosystems as reservoirs of antibiotic-resistant microorganisms. Her research focuses on detecting antibiotic-resistant opportunistic pathogens in the environment

and providing risk assessments for ecosystems and human health. Author of over 250 scientific publications, including 5 books.



VIII. International Symposium-2024

ADVANCED SOUND EVENT DETECTION FOR SMART HOME SECURITY SYSTEMS

Giuseppe CIABURRO

*Department of Architecture and Industrial Design Università degli Studi della Campania Luigi Vanvitelli, AVERSA, ITALY,
E-mail: giuseppe.ciaburro@unicampania.it*

In safeguarding home environments, prioritizing safety stands paramount, given that domestic mishaps often stem from neglect or oversight. In response, an innovative Automated Home Security (AHS) system has emerged to proactively detect potential risks within unattended residences. Employing cost-efficient acoustic sensors, this system captures and analyzes common auditory occurrences found in household settings. Through the extraction of pertinent characteristics from audio recordings and the creation of spectrograms, valuable insights are gleaned. Subsequently, this data undergoes processing within a convolutional neural network (CNN), enabling the identification of sound events that may pose threats to both individuals and property in unattended homes. Impressively, the model exhibits exceptional accuracy, affirming the system's efficacy in pinpointing potentially hazardous sound events within domestic environments left unattended.

Keywords: *sound event detection, smart home, security systems*

Biography:



Giuseppe Ciaburro holds a PhD in environmental technical physics a master's degree in chemical engineering, and a master's degree in acoustic and noise control. He works at the Built Environment Control Laboratory - Università degli Studi della Campania "Luigi Vanvitelli". He has over 20 years of work experience in programming, first in the field of combustion and then in acoustics and noise control. His core programming knowledge is in Python and R, and he has extensive experience of working with MATLAB. An expert in acoustics and noise control, Giuseppe has wide experience in teaching professional computer courses (about 20 years), dealing with e-learning as an author. He has several publications to his credit: monographs, scientific journals, and thematic conferences. He is currently researching machine learning applications in acoustics and noise control.



VIII. International Symposium-2024

IMPACT OF CLIMATE CHANGE ON CARDIAC PERFORMANCE

Ayan CHATTERJEE

Department of Allied Health, School of Health and Medical Sciences, Adamas University, India

On a global scale, there is an alarming trend of increase in ambient temperatures, erratic weather patterns, and the escalation of greenhouse gas emissions. In the Indian context, a nation highly susceptible to climate shifts, these effects are particularly pronounced due to its varied geography and dense population. The present study has been undertaken to assess impact of climate change on cardiac performance among male agricultural workers occupationally engaged in different type of tasks during paddy cultivation time. On the other hand, rice cultivation is an important sector of earning opportunity for the human resources engaged in agricultural task. Moreover, in the agricultural task, cultivators often spend long hours under direct sun, in intense heat. In view of climate change becoming a reality due to global warming, and reports of adverse health consequences including performances getting affected in different occupational settings in different parts of world, a study has been undertaken to assess the impact of climate change on cardiac performance among the crop cultivators of a southern district of west Bengal primarily engaged in manual transplanting during paddy cultivating time. Thermal environmental condition was assessed in terms of Wet Bulb Globe Temperature Index, Corrected Effective Temperature, Discomfort Index and Physiological Strain Index. To assess the effect of workplace heat exposure, workload and posture being adopted in their likely impact on performance, cardiac strain indicators like net cardiac cost, estimated energy expenditure, absolute cardiac cost and human physical drudgery index were estimated in male paddy cultivators involved primarily in manual straight row paddy transplanting task in southern parts of West Bengal. The result of the study indicated that human resources are indeed subjected to strains, albeit to different degree, as adjudged by the indicators of cardiac strain.

Keywords: *occupational health, environment, heat indices, mitigation, public health*

Biography:



Dr. Ayan Chatterjee is currently working as Assistant Professor of Department of Allied Health, School of Health and Medical Sciences of Adamas University, West Bengal, India. He completed his PhD degree from University of Calcutta. He has a 6-month Diploma in Social Work and Community Service from School of Social Work and Community Service, National Council of Education, Bengal. Dr. Ayan successfully completed a Certificate course in Science Communication and Media Practice conducted by Indian Science News Association, Kolkata; the course is supported by DST, Government of India, and Vigyan Prasar. He authored 98 full length research papers; among them 43 as first author in Peer Reviewed Journals, Conference Proceedings and as Book Chapters and also presented papers in International and National Conferences held at IIT Bombay, IIT Guwahati, ISI Kolkata, ISI Giridih, Jadavpur University, University of Calcutta, Vidyasagar University, Indian Institute of Social Welfare and Business Management Kolkata, NIT Jalandhar, Aligarh Muslim University, University of North Bengal, College of Engineering Trivandrum, Diamond Harbour Womens' University, University of Gour Banga. Dr. Ayan also authored of Dr. Ayan also authored of two Books. Dr. Ayan also received Springer Sponsored Young Researcher Award for presentation of Papers at the 16th International Conference on Humanizing Work and Work Environment (HWWE 2018), Trivandrum, India. Dr. Ayan also received Young Scientist Best Oral Presentation award for the presentation of paper at the second international conference on Environmental, Agricultural, Chemical and Biological Sciences (ICEACBS 2021). Dr. Ayan supervised sixteen dissertations for Post Graduate students and fifteen dissertations for Undergraduate students. He also has teaching experience in Human Physiology, Biochemistry and allied subjects at Undergraduate, Postgraduate and Diploma level for 10 years 06 months. He also served as Member of Editorial Board of three UGC CARE listed journals and Reviewer of three Scopus indexed and three UGC CARE listed journals. Dr. Ayan also served as Editor of Four Books of different publication house. Recently Dr. Ayan appointed as an International Adviser in Research Publication for the organization of 1PHYSED.PH Training and Development Services, Philippines.



VIII. International Symposium-2024

EXPLORING THE POTENTIAL OF MICROALGAE-DERIVED BIOACTIVE COMPOUNDS FOR NUTRACEUTICAL AND PHARMACEUTICAL APPLICATIONS: CURRENT STATUS AND FUTURE DIRECTIONS

Salma LATIQUE

*Biomedical and Translational Research Laboratory, Faculty of Medicine, Pharmacy
and Dentistry of Fez, Sidi Mohamed Ben Abdellah University, Morocco.*

E-mail: salma.latique@uit.ac.ma

Microalgae are a promising source of bioactive compounds for the nutraceutical and pharmaceutical sectors, with various bioactivities including antioxidant, anti-inflammatory, antimicrobial, anticarcinogenic, antihypertensive, antihyperlipidemic, and antidiabetic activities. These bioactive metabolites possess significant potential for developing new products in the food, nutraceuticals, and pharmaceuticals industries. However, their utilization in these sectors has been limited due to challenges in cultivation, harvesting, extraction, and purification of bioactive metabolites from microalgae biomass. Currently, research is focused on overcoming these challenges by developing more efficient and cost-effective methods for microalgae cultivation, harvesting, and extraction. The use of closed systems, such as photobioreactors, and the optimization of light and temperature conditions can significantly improve microalgae growth and biomass production. Additionally, the development of novel extraction methods, such as supercritical fluid extraction and enzyme-assisted extraction, can enhance the yield and purity of bioactive metabolites. The future directions of research in this field include the identification and characterization of single bioactive compounds from microalgae biomass, the enhancement of microalgae growth for sufficient biomass production annually under a sterile environment, and the examination of food safety during microalgae technology and advancement. The regulations on production, exploitation, and consumption of microalgae-based bioactive compounds must also be taken as a vital concern. In conclusion, microalgae-derived bioactive compounds have significant potential in the nutraceutical and pharmaceuticals industries. Implementing these compounds into food products could lead to possible health benefits for humans, and the use of microalgae as a sustainable and cost-effective source of bioactive compounds could have significant implications for the future of these industries.

Keywords: *Microalgae, bioactive compounds, nutraceutical, pharmaceutical, health benefit.*

Biography:



I am an Assistant Professor at the Faculty of Medicine, Pharmacy and Dentistry of Fez, Sidi Mohamed Ben Abdellah University. I am also a Researcher in Marine Biotechnology, specializing in plant physiology and seaweed valorization. Additionally, I am an Engineer in Industry and Safety Food and an Engineer in Biotechnology Applied to Plant Improvement at the Faculty of Sciences and Techniques, Cadi Ayyad University. My research expertise lies in seaweed and microalgae valorization, with a focus on unlocking the potential of algae biomass for various applications, including wastewater treatment, sustainable agriculture, and the development of bioactive compounds for the pharmaceutical industry. I investigate the use of seaweed liquid extracts to enhance the agronomic performance of crops, particularly beans and wheat. This includes exploring their effectiveness in both soil and hydroponic systems, as well as under abiotic stress conditions. My research also involves studying plant physiology and stress tolerance, with a focus on understanding the mechanisms of abiotic stress tolerance in plants and the potential of seaweed extracts to enhance stress tolerance.



VIII. International Symposium-2024

SUSTAINABILITY OF FOOD SUPPLY OF MIDDLE-EAST, NORTH- AFRICA AND INDIA BETWEEN 2010-2020 SUSTAINABILITY OF FOOD SUPPLY OF MIDDLE-EAST, NORTH-AFRICA AND INDIA BETWEEN 2010-2020

Sándor J. ZSARNÓCZAI, Hosam E.A.F. BAYOUMI HAMUDA

*Óbuda University, Rejtő Sándor Faculty of Light industry and Environmental
Engineering, Institute of Environmental Engineering and Natural Sciences, Budapest,
Hungary*

E-mail: zsarnoczaisandorjozsef@gmail.com; bayoumi.hosam@uni-obuda.hu

The study overviews the possible balanced food demand-supply ratio in the MENA region and India during the researched period of 2010-2020. The sustainability of food supply of selected countries is very sensitivity accompanying with income-able agricultural production based on the advanced innovative technology. The food self-sufficient ratio mostly needs for setting up increasing agricultural production and not food import. To obtain wide-side overview for the food balance of selected countries, the study needs for the working out the SPSS as statistical program for social science system. Very strong correlations were between agriculture, value added in percent of GDP and value of food imports over total merchandise exports in period of 2010-2020. The food import also could increase food self-sufficiency of these selected countries, but this did not decrease their food import dependence coming abroad. For the researched period this MENA region and India have sharply increased their food import dependence. To solve food import issue for decreasing food dependence is to develop the innovation of agricultural and food production mostly in fields of mechanization, irrigation system and chemical materials included in input, as pesticide and fertilizer accompanying with possible less increasing trend of populations of these selected countries.

Keywords: *Advanced innovative technology, agricultural gross value-added, agricultural production, import dependence, irrigated agriculture, self-sufficient ratio*

Biography:



Sándor J. Zsarnóczai CSc, in 1991 economic sciences, Hungarian Academy of Sciences, Budapest and Dr. of University, World Economics, Budapest Corvinus University of Economics. In 2017 Habilitate Doctor, in social sciences, in Management and Business Administration, Kaposvár University. From 1987 work at Szent István University in Gödöllő. From 2017 work at Óbuda University. Participation

at Doctoral School. Research areas: Economics, EU Study, Regional economics, Environmental economics. He published 220 publications with 260 independent citations, of which 200 foreign language citations. His publications were published in Arab, English, Spanish, Russian languages. International scientific conferences in Turkey, Canada, Moldavia, Czech Republic, Slovakia, Lithuania, Romania. Research project in Finland, Sweden, Denmark, Italy, Spain, France.



Prof. Dr. habil. Hosam Bayoumi Hamuda has CSc, in 1994 Biological sciences, Hungarian Academy of Sciences, Budapest and Dr. of University, Agricultural Sciences, Gödöllő, 1987 from Gödöllő University of Agricultural Sciences, Gödöllő, Dr. of University, in 1995 Natural Sciences, ELTE Budapest, PhD in Biological Sciences from GATE, Gödöllő. In 2007 Habilitate Doctor, in Environmental Sciences, Szent István University in Gödöllő. He was the director of PhD Program (2007-2015), MSc (2000-2008) at Sant István University, Gödöllő. He is working at Obuda University since 2008. He is Environmental Microbiologist and Soil Biotechnologist dealing with the interactions between the microbiomes and the environmental factors for increasing soil quality and saving the soil from pollutants and secure the soil health in 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 especially the soil. Research Interest: Waste Management; Soil Biotechnology; Environmental Protection; Sustainable; PGPR; Microbial Inoculants; Gut Microbiota and human health as well as Environmental and Modern Biology



Keynote Session



VIII. International Symposium-2024

QUALITATIVE AND QUANTITATIVE ANALYSIS OF PERSIMMON, AN AMERICAN TOMATO

Rahul HAJARE

School of Pharmaceutical Sciences, Sandip University India

Defatted persimmon flour with n-hexane, it was steeped in distilled water. The starch's morphological Persimmons are good sources of heart health. The purpose of this study was to assess the starch extract from defatted persimmon seeds in terms of its physicochemical, function, and morphological properties. The process involved washing, hand-shelling, oven-drying, and milling persimmon seeds. After extracting the, functional, and physiochemical characteristics were all examined. The starch's physicochemical analysis revealed that it contains 7.26 percent carbohydrates, 12.10 percent moisture, 4.46 percent protein, 1.99% fat, 1.20 % fiber, and 2.99% ash. It also contains calcium (194.17 mg/g), copper (0.05 mg/g), manganese (0.42 mg/g), magnesium (4.26 mg/g), iron (0.34 mg/g), zinc (1.59 mg/g), phosphorus (26.1 mg/g), sodium (23.20 mg/g), potassium (37.13 mg/g), Na/K (0.62), and Ca/P (7.44) and the functional analysis revealed the following: swelling index (246.67%), gelation capacity (12.00m/v), amylose (20.5%), amylopectin (79.5%), in-vitro digestibility (63.68%), foaming capacity (12.69%), foaming stability (3.26%), emulsion capacity (45.48%), emulsion stability (50.00%), and starch bulk density (0.42g/ml). This finding demonstrated that the defatted persimmon starch is particularly rich in nutrients and can therefore be used as a meal supplement.

Keywords: *Persimmon, defatted, potassium, sodium, phosphorus*

Biography:



Dr. Rahul Hajare is a student of **Vedanta Institute Kolkata**; he has completed his M. Pharm in Distinction from Nagpur University. Professor Rahul Hajare obtained his PhD from the University of Vinayaka Mission Research Foundation, Deemed University. He has been a research fellow at KLE University, Bengaluru, **for two years**. He served as a group leader at Pune University, USA, before joining Hindu University of America, where he has been a scholar, studied with excellent grades. He has served on several professional panels and editorial boards and is the recipient of many awards. He has served as an associate professor at G H Raison University. He is a student intern at the Institute of Indic Wisdom in Hyderabad, Telangana, India. In 2020, he will be an honorary Rosalind member of the London Journals Press. He is a postdoctoral fellow of the world renowned and highly respected Dr. Ramesh S. Paranjape National AIDS Research Institute, Indian Council of Medical Research



VIII. International Symposium-2024

IMPACTS OF ZINC AND SILVER ENGINEERED NANOPARTICLES ON PLANT GROWTH-PROMOTING BACTERIA IN AGRICULTURAL SOIL

Hosam E.A.F. BAYOUMI HAMUDA

Obuda University, Rejto Sandor Faculty of Light Industry and Environmental Engineering, Institute of Environmental Engineering and Natural Sciences, Budapest, Hungary

Email.: Bayoumi.hosam@uni-obuda.hu, mobil: +36303900813

Orcid: <http://orcid.org/0000-0001-7358-4260>

The field of nanotechnology is being explored as a new source of key improvements in the agricultural sector. Silver oxide (AgO) and zinc oxide (ZnO) engineered nanoparticles (ENPs) have been reported to have anti-phytopathogenic activity, increase germination of seeds, and improve plant growth. Engineered nanoparticles will thereby enter soil directly through nanoparticulate agrochemicals, and indirectly via the use of consumer and industrial products. Plant growth is brought about when these useful PGP bacteria use any of the following mechanisms: nitrogen (N₂)-fixation, phosphate solubilization, and synthesis of phytohormones, siderophores, and antibiotics. Due to these properties, plant growth-promoting bacteria (PGPB) are used as soil inoculants to increase agricultural productivity. Few studies have used pure cultures of ecologically important isolates to study the effects of AgO and ZnO ENPs. Similar disturbances in soil bacterial communities caused by the same metal oxide ENPs have been reported. These disturbances were monitored by determining changes in the rates of microbial activity, microbial biomass, or microbial community composition. The use of ENPs in a wide range of consumer and industrial products is increasing globally. The antibacterial effect of NPs is mainly studied on the ensembles of the useful agricultural soil bacteria. The use of ENPs in a wide range of consumer and industrial products is increasing globally. For example, Ag NPs are being utilized for their antimicrobial properties in textiles, food packaging, wound dressings, medical devices like catheters, paints, water treatment processes, etc. With the global production of NPs expected to grow to over half a million tons by 2020, the release of NPs into the environment is bound to increase. The useful agricultural soil bacteria are some of the key players affecting plant productivity. Soil today is exposed to emerging pollutants like metal ENPs. The objective of this study was to evaluate the toxicological impacts of AgO and ZnO ENPs on agricultural soil bacteria classified as PGPB. Three types of bacteria: N₂-fixers, phosphate solubilizers, and biofilm formers were exposed to ENPs. Initially, the impact of AgO and ZnO ENPs at various concentrations was determined on pure cultures of the tested bacteria. These metal oxides ENPs were then applied to soil (Pot experiment) to assess changes in composition of bacterial communities. In the soil used, relative abundances of the dominant and agriculturally significant bacterial communities, were changed in the presence of silver

nanoparticles. Silver nanoparticles changed the abundance of the three bacterial communities by 26 to 43%. Zinc oxide nanoparticles showed negligible impacts at the genus level. Thus, Ag-NPs may impact bacterial communities in soil, and this in turn may influence processes carried out by soil bacteria. The study evaluated the impacts of AgO and ZnO ENPs on representatives of the three groups of bacteria known to be agriculturally relevant: N₂-fixers, phosphate solubilizers, and biofilm formers. AgO-NPs were bactericidal at relatively lower concentrations (5–25 mg/l), while ZnO-NPs exhibited a bacteriostatic effect and the inhibitory concentrations in some cases were higher than 2500 mg/l. Continuous monitoring of microbial growth in the presence of sub-lethal concentrations of the ENPs enabled observation of finer changes in growth response. A few isolates showed a very long lag with decreased growth which may occur in soil. In addition, soil bacterial community composition showed a pronounced change in the presence of Ag-NPs. It may seem premature to correlate these changes in growth patterns and community composition to agricultural productivity, but it is a distinct possibility.

Keywords: *Ag nanoparticles; bacterial community composition; next generation sequencing; soil PGP bacteria; ZnO nanoparticles*

Biography:



Currently, Prof. Dr. Hosam Bayoumi Hamuda is working at Óbuda University, Faculty of Light Industry and Environmental Engineering, Institute of Environmental Engineering and Natural Sciences (Budapest, Hungary). He was Senior Researcher and Deputy Director of Research Group for Environmental Microbiology of Hungarian Academy of Sciences (Gödöllő University of Agricultural Sciences, Faculty of Agricultural Sciences, Szent István University (Budapest). Briefly, He received the degrees of B.Sc. (Chemistry and Botany), M.Sc. (Biological Sciences), University Doctor (Agricultural Sciences-Soil Microbiology) and C.Sc. in Biological Sciences from Garyounis University, Benghazi, Libya, Gödöllő. University of Agricultural Sciences and Hungarian Academy of Sciences, Budapest, Hungary, respectively. Also, he received the PhD in Biological Sciences, Doctor Habilitation Degree in Environmental Sciences as well as the Professor degree from Szent István University (Gödöllő, Hungary). Also, University Doctor Degree in Natural Sciences from Eötvös Loránd University (Budapest). Prof. Hamuda was awarded many times from different organisations, e.g., the Society of Hungarian Microbiologists (MMT), the Hungarian Professors Council, etc. and he is a member of many Hungarian and International Organisations. Prof. Hamuda was the general secretary and now is the president of International Council of Environmental Engineering Education (ICEEE) originated since 2010 (Budapest, Hungary) and Member of the International Society of Development and Sustainability (Japan), Society of MMT, Soil Science and Agrochemistry Committee of the Agricultural Sciences Department of IV of the Hungarian Academy of Sciences (Budapest) and Association of Hungarian Medical Societies (MOTESZ) and others. He was the director of MSc program titled: Microbial Science and Biotechnology (Szent István University, Gödöllő, Hungary) from 2000 to 2008 and Director of PhD Program titled: Agricultural-, Environmental Microbiology and Soil Biotechnology until from 2007 to 2015 and now a member of the Environmental Sciences Doctor's School at Szent István University and Doctoral School on Materials Sciences and Technologies at Óbuda University. Prof. Dr. Bayoumi Hamuda is acting as editorial member, reviewer of many international journals, and he organize many international conferences and symposiums. He delivered more than 120 plenary and keynote lectures in international events and a member of scientific committee of more than 100 conferences. He is the editor and chair of more than 20 Proceedings Books of International Symposium and Conferences.

Research Interest: Prof. Dr. Bayoumi Hamuda is an Environmental Microbiologist and Soil Biotechnologist dealing with waste and wastewater management. Rhizosphere index, soil microbial biomass and enzymatic activities. Soil Biotechnology, soil health and soil biodiversity. Soil Biosecurity, biocontrol and biofertilizers. microbial inoculants. Colonization of Plant Growth-Promoting Rhizomicrobiomes (PGPR). PGPR microbial inoculants in rhizosphere. Nitrification inhibitors and

crop quality. Monitoring of soil organic matter. Econanotoxicology. Roles of engineered metal oxide nanoparticles in soil. Public health and health care. Bioengineering and Environmental Health. Probiotics, antibiotics, xenobiotics, and human gut microbiotas. Impacts of xenobiotics: pesticides and other pollutants on soil bioactivities. Climatic changes and global security.



VIII. International Symposium-2024

HEAVY METAL LOADS IN THE SLURRY AREA OF THE PAKS NUCLEAR POWER PLANT

**Ágnes BÁLINT¹, Dávid CZEKMEISTER², Xuechu WANG², Csaba
MÉSZÁROS²**

¹*Obuda University, Budapest, Hungary,*

²*Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary*

*E-mail: balint.agnes@uni-obuda.hu; czekmeisterd@gmail.com; victorwxch@gmail.com;
Meszáros.Csaba@uni-mate.hu*

Many people are concerned about the safety of nuclear power plants and whether they do not pollute the soil, water, and air, and whether nuclear waste is safely stored and disposed of. The Paks Nuclear Power Plant Ltd. has been working for several years on the delimitation of heavy metal contamination in the groundwater of its confined area and the identification of possible sources. The most important goal of their operations is the safe generation of electricity in an environmentally sound manner and at competitive prices. To achieve their vision, they are continuously improving their environmental protection activities, in addition to complying with environmental regulations and rules. In this study, we compared our results on heavy metal pollution with several years of data from the Nuclear Power Plant. We attempted to estimate the potential pollution leakage from the Power Plant. Samples were taken at three locations (groundwater monitoring wells, Danube River basin sondes, and Danube sludge) and the concentrations of 6 heavy metals (lead, cadmium, zinc, copper, manganese, iron) were measured. The samples were digested with a Milestone 1200 mega microwave digester in preparation for the measurement. The heavy metal concentrations of the samples were determined by atomic absorption spectroscopy using an ATI UNICAM 939 AAS. Statistical evaluation of the results was performed by one-factor analysis of variance using SPSS 14.0 for the Windows software package. The results and their evaluation are as follows:

For zinc, all the wells in the area reach the contamination limit of 0.2 mg/dm³ as set out in the Joint Regulation 6/2009 (IV. 14.) KvVM-EüM-FVM. It is also noted that the water samples from the northern Danube basin wells contain less zinc than the southern Danube water samples. This can be compared to the zinc concentrations measured in sediments. Manganese is also found throughout the area, but no limit value is set in Regulation 6/2009. The concentration present is probably background. Manganese was detected in lower concentrations in sediment samples from the southern area than in the northern area. All the wells analysed had copper concentrations above the limit value of 0.2 mg/dm³ set by Regulation 6/2009, except for Z01. Copper concentrations above the limit value were measured in the Danube basin wells, but no copper was detected in the sediments. For iron, as for manganese, there is no limit value in Regulation 6/2009. It is found in groundwater monitoring wells at low concentrations dissolved in groundwater but at very high concentrations in sediment samples. The sediment

samples were also subjected to ICP analysis because high concentrations of heavy metals were found in them during atomic absorption studies. The samples contained cobalt, bismuth, beryllium, zinc, aluminium, iron and manganese. In addition, cadmium, lead, nickel, barium, chromium, copper and silver were not present in detectable concentrations.

Joint Decree 6/2009 on cobalt in geological media sets a maximum contamination limit for cobalt of 30 mg/kg dry matter and 100 mg/kg action contamination limit for cobalt, which both samples exceeded by a large margin. As the concentrations in the northern and southern samples were almost identical, contamination from the nuclear power plant can be excluded. The Dunaújváros ironworks is likely the source of the pollution. Further investigations are needed to find out the cause of the high pollution (due to the low number of sediment samples). The samples also contain high concentrations of bismuth, beryllium, manganese, aluminum, and iron. For these substances, no limit values are set in Regulation 6/2009. The presence of bismuth can also be assumed to be due to the activities of the Dunaújváros ironworks. Statistical analysis shows no significant difference between the northern and southern samples, except for manganese. The concentration of manganese is lower in the southern sample, i.e. the sample taken from under the power plant. The concentrations measured by the ICP confirm the results measured by the AAS instrument. As the chemical pool has been a problem several times over the years, we have proposed to upgrade its casing and further research to investigate the cause of the high zinc concentrations found in wells Z01, and Z02. We also proposed to remediate this.

Keywords: Atomic absorption spectrometry (AAS), Heavy metals, inductively coupled plasma atomic emission spectrometry (ICP AES), Nuclear power plant

Biography:



Dr. Ágnes Dr. Habil. Mészáros-Bálint (Ágnes Bálint is the author's name); Education: MSc, Chemistry, and Physics; BSc, Software Information Technologist, Eötvös University, Budapest, Hungary, PhD; habilitation from Szent István University, Gödöllő, Hungary. She is an Associate Professor at Óbuda University, Rejtő Sándor Faculty of Light Industry and Environmental Engineering. Specialty: 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 fertiliser, and Experimental and theoretical modelling of transport processes.



VIII. International Symposium-2024

ARTIFICIAL INTELLIGENCE REVOLUTION IN EDUCATION AND WAY FORWARD ARTIFICIAL INTELLIGENCE REVOLUTION IN EDUCATION AND WAY FORWARD

Ijaz Ahmad TATLAH¹, Durr-e-SHAHWAR²

¹University of Education, Lahore, Pakistan; ²Lahore University of Management
Sciences, Lahore, Pakistan

E-mail: tatlah@ue.edu.pk; durresehvaar@gmail.com

Educational institutions bear a significant responsibility in preparing students for success in today's ever-changing business environment. It is crucial for these establishments to continually adjust to shifting trends, ensuring that their educational offerings remain pertinent and adaptable. Through this approach, they equip graduates with the necessary knowledge and skills to excel. By prioritizing hands-on learning and embracing emerging technologies, educational institutions contribute significantly to shaping the future of business. Moreover, by encouraging diverse perspectives and interdisciplinary approaches, they facilitate a deeper comprehension of the modern business landscape.

The rapid evolution of artificial intelligence (AI) has fundamentally transformed the business realm, necessitating adaptations in educational practices. This article explores the pivotal role of AI in shaping the future of business education, examining its implications for curricular development and teaching methodologies. Furthermore, it delves into the potential challenges hindering the integration of AI into education and proposes strategies to address these obstacles.

Keywords: AI, Education, Offerings, Business education

Biography:



Associate Professor, University of Education, Department of Educational Leadership and Policy Studies (ELPS), **Director**, Office of the Alumni Relations (OAR), **HEC Approved Supervisor** **Lifetime Member (ISDS)** **International Society for Development and Sustainability Japan** **HEC Project Reviewer (NRPU)** **Founder Director**, 'Students Counseling Center' **Former Controller of Examinations** **Chief Evaluator**, Third Party Evaluation Validation for Educational Voucher Schemes **Elementary Public Schools Punjab, Pakistan**
Trainings / Workshops/ Seminars Conducted or Served as Resource Person (100+)

Chaired sessions (25)
Reviewer of Journals (45)
International Research Supervision (5)
Publications (116), **International conferences** (27), **Key-note Speaker** (50+)
Citations (991), *h-Index* (15), *i10-index* (23)
Doctoral Studies Supervised (10), MS (110)
www.ue.edu.pk
<https://www.linkedin.com/in/dr-ijaz-tatlah-bb48921a/>
<https://www.researchgate.net/profile/Ijaz-Tatlah-3>
<https://orcid.org/my-orcid?orcid=0000-0002-4631-1280>
director.ar@ue.edu.pk, tatlah@ue.edu.pk, dritatlah@gmail.com, ijaz@tatlah.pk
Office: Room.No.104, Division of Education, College Road Township Lahore.
Office Ph:042-99262211, Cell: 92-333-4319981,



VIII. International Symposium-2024

MITIGATION OF THE ENVIRONMENTAL EFFECTS OF FATTENING CATTLE BY USING BENTONITE CLAY MINERAL AS A FEED SUPPLEMENT

Sándor KUKOVICS¹, Zoltán NAÁR², Attila SZAKÁCS³, Ferenc KUKOVICS¹

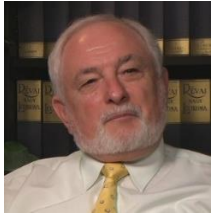
¹Hungarian Sheep and Goat Dairying Public Utility Association Érd, Hungary;

²University of Tokaj, Sárospatak, Hungary; ³Angus Ltd, Adony, Hungary.

Although the reducing of the environmental impact of cattle keeping is the goal of many research programs, a significant obstacle to the spread of new solutions in practice is their cost and time, so in the current economic environment, a significant breakthrough can be expected from these opportunities in the longer term. A feeding trial was set up at the site of Angus Ltd., involving 31 heads of yearling bulls with an average body weight of 285 kg. The beef calves were divided into three groups. Group 1 received 150 g/day/head bentonite, a low-cost clay mineral together with mixed feed and corn silage. Group 2 received 3,000 g/group/week of bentonite once a week, sprinkled on the fresh litter; while Group 3 was the control, which did not receive bentonite. During the 109 days of the experiment, individual weight measurements were taken a total of 8 times. The feed consumed (mixed feed, corn silage, fresh litter straw) and the excrement falling on the litter were sampled four times and analyzed for dry matter, mycotoxin, and ammonia content, as well as a microbiological test to assess the effect of consumed bentonite on a wide scale. The IBM SPSS Statistics 22.0 program was used to process the obtained data. Significant differences in the daily weight gain values were found between the groups at the $P > 5.0\%$ level. The average daily weight gain of group 1 was 1,688 g, while this value reached 1,438 g in group 2 and 1,490 g for group 3. It was established that the feed utilization of group 1 was 11.8% better than the data of the control group. In the laboratory tests, a significant reduction of ammonia content of the faecal sludge was detected: it was 11.74%, lower in the bentonite-fed animals than in the animals of the other two groups. The supplementary feeding of bentonite increased the number of Clostridium bacteria - with negative impacts on animals - excreting intestinal muds. The environmental impact of keeping fattening cattle can therefore be significantly reduced by using a low-cost clay mineral available from domestic sources as a feed supplement by increasing the efficiency of feed utilization and reducing the ammonia content of faecal sludge. AXIS Bentonit Ltd provided the necessary amount of bentonite and financed the costs of the tests.

Keywords: bentonite, cattle feed amendment, reduction of ammonia emission

Biography:



Prof. Dr. Sándor Kukovics spent 40 years in Research Institute for Animal Breeding and Nutrition (Herceghalom, Hungary) being responsible for small ruminants department, edited 40 books, published more than 1,500 articles, having licences for 4 products. He gave courses in various universities in Hungary over the decades. Since 1996 he has been serving as president of Hungarian Sheep and Goat Dairying Public Utility Association and as executive manager of Sheep and Goat Products' Board since 2010.

Between 2015 and 2019 he served as vice president of EU COPA-COGECA Working Party on Sheep and Goats. He has been serving as Member of Board of Directors within International Goat Association since 2016.



VIII. International Symposium-2024

ORGANIC SOIL AND FARMING: AS CLIMATE WARMING ADAPTATION AND MITIGATION STRATEGIES

Hosam E.A.F. BAYOUMI HAMUDA

*Obuda University, Rejto Sandor Faculty of Light Industry and Environmental Engineering,
Institute of Environmental Engineering and Natural Sciences, Budapest, Hungary.*

E-mail: Bayoumi.hosam@uni-obuda.hu, Mobil: +36303900813

Orcid: <http://orcid.org/0000-0001-7358-4260>

Adaptation strategies are essential to enhance soil resilience and maintain productivity under the climate change conditions while the mitigation strategies are helpful to reduce the greenhouse gas concentration in atmosphere. Climate change is a serious problem that have a significant impact on soil ecosystems and natural resources. Soil ecosystem plays a vital role in supporting agriculture, biodiversity, and overall ecosystem functioning. The effects of climate change on soil properties are multifaceted. According to the European Soil Strategy 2050, in relation to climate change, these two main types of soils play an important role: Organic and Mineral soils. Organic amendment is among the global strategies for mitigating the rapidly changing climate resulting from anthropogenic activities, such as increasing inorganic fertilizer applications in agricultural ecosystems. Globally, soil organic matters are estimated to store carbon (C), of global soil C stocks, although estimates vary widely Soil constitutes the largest store of terrestrial C. When managed using Sustainable Soil Management techniques, soil can play an important role in climate change adaptation and mitigation and could enhances the provision of ecosystem services by storing C in the form of C sequestration and decreasing greenhouse gas emissions in the atmosphere. Furthermore, promising Sustainable Land Management (SLM) options are available to improve productivity and contribute to reducing greenhouse gas emissions and increasing carbon sequestration. The identification of potential areas for successful implementation and scaling-out of SLM, supported by proper policies and financial mechanisms, is needed to foster wider uptake and adoption of Sustainable Land Management. It found that soil is managed poorly or cultivated through unsustainable agricultural practices, soil carbon can be released into the atmosphere in the form of carbon dioxide (CO₂), which can contribute to climate change. Secondly, s organic carbon loss occurs when organic carbon stored in the soil is converted into CO₂ or methane (CH₄), both of which are greenhouse gases that are subsequently lost from the soil, or through physical loss of carbon by erosion. Voluntary Guidelines for Sustainable Soil Management have been developed to support climate change adaptation and mitigation in agriculture through Finally, degraded soils are being restored to return to providing of ecosystem services including climate change adaptation, mitigation, and food production. The maintenance and increase of soil organic matter. Proper selection of SLM options for specific conditions provide an opportunity to enhance adaptation and mitigation of climate change and the establishment of a resilient agro-ecosystems. Innovative technologies derived from applied research, combined with appropriate

policies and strategies, are necessary for both adaptation to and the mitigation of climate change.

Keywords: *climatic warming, adaptation and mitigation strategies, soil carbon, organic soil and farming*

Biography:



Currently, Prof. Dr. Hosam Bayoumi Hamuda is working at Óbuda University, Faculty of Light Industry and Environmental Engineering, Institute of Environmental Engineering and Natural Sciences (Budapest, Hungary). He was Senior Researcher and Deputy Director of Research Group for Environmental Microbiology of Hungarian Academy of Sciences (Gödöllő University of Agricultural Sciences, Faculty of Agricultural Sciences, Szent István University (Budapest). Briefly, He received the degrees of B.Sc. (Chemistry and Botany), M.Sc. (Biological Sciences), University Doctor (Agricultural Sciences-Soil Microbiology) and C.Sc. in Biological Sciences from Garyounis University, Benghazi, Libya, Gödöllő. University of Agricultural Sciences and Hungarian Academy of Sciences, Budapest, Hungary, respectively. Also, he received the PhD in Biological Sciences, Doctor Habilitation Degree in Environmental Sciences as well as the Professor degree from Szent István University (Gödöllő, Hungary). Also, University Doctor Degree in Natural Sciences from Eötvös Loránd University (Budapest). Prof. Hamuda was awarded many times from different organisations, e.g., the Society of Hungarian Microbiologists (MMT), the Hungarian Professors Council, etc. and he is a member of many Hungarian and International Organisations. Prof. Hamuda was the general secretary and now is the president of International Council of Environmental Engineering Education (ICEEE) originated since 2010 (Budapest, Hungary) and Member of the International Society of Development and Sustainability (Japan), Society of MMT, Soil Science and Agrochemistry Committee of the Agricultural Sciences Department of IV of the Hungarian Academy of Sciences (Budapest) and Association of Hungarian Medical Societies (MOTESZ) and others. He was the director of MSc program titled: Microbial Science and Biotechnology (Szent István University, Gödöllő, Hungary) from 2000 to 2008 and Director of PhD Program titled: Agricultural-, Environmental Microbiology and Soil Biotechnology until from 2007 to 2015 and now a member of the Environmental Sciences Doctor's School at Szent István University and Doctoral School on Materials Sciences and Technologies at Óbuda University. Prof. Dr. Bayoumi Hamuda is acting as editorial member, reviewer of many international journals, and he organize many international conferences and symposiums. He delivered more than 120 plenary and keynote lectures in international events and a member of scientific committee of more than 100 conferences. He is the editor and chair of more than 20 Proceedings Books of International Symposium and Conferences.

Research Interest: Prof. Dr. Bayoumi Hamuda is an Environmental Microbiologist and Soil Biotechnologist dealing with waste and wastewater management. Rhizosphere index, soil microbial biomass and enzymatic activities. Soil Biotechnology, soil health and soil biodiversity. Soil Biosecurity, biocontrol and biofertilizers. microbial inoculants. Colonization of Plant Growth-Promoting Rhizomicrobiomes (PGPR). PGPR microbial inoculants in rhizosphere. Nitrification inhibitors and crop quality. Monitoring of soil organic matter. Econanotoxicology. Roles of engineered metal oxide nanoparticles in soil. Public health and health care. Bioengineering and Environmental Health. Probiotics, antibiotics, xenobiotics, and human gut microbiotas. Impacts of xenobiotics: pesticides and other pollutants on soil bioactivities. Climatic changes and global security.



Session of Invited Speakers



VIII. International Symposium-2024

SECURING THE BIOSPHERE FOR FUTURE GENERATIONS USING ARTIFICIAL INTELLIGENCE

Neha Singh RAGHUVANSHI*, Arpita JOHARI, Mudit SAXENA

ABES Engineering College, Ghaziabad, Uttar Pradesh, India.

E-mail: nehasr.raghuvanshi@gmail.com 9911407605

In the endeavour to protect the biosphere for future generations, leveraging the potential of artificial intelligence (AI) emerges as a ground-breaking approach. AI technologies offer unprecedented abilities to monitor, assess, and address environmental challenges that endanger ecosystems globally. Through sophisticated algorithms and data-driven insights, AI facilitates comprehensive environmental surveillance, monitoring shifts in biodiversity, identifying pollution levels, and recognizing critical threats like deforestation and the impacts of climate change. Additionally, AI-driven conservation strategies prioritize regions of significant ecological importance, optimize efforts for habitat restoration, and combat illegal wildlife activities using real-time data analysis and predictive modelling. Precision agriculture, climate modelling, and disaster response also benefit from AI's predictive capabilities, promoting sustainable practices and resilience to environmental hazards. Embracing AI advances sustainable development increases public awareness and enables stakeholders to collaborate effectively in safeguarding the biosphere. By harnessing AI's innovation and collective action, humanity can fulfil its duty to preserve and safeguard the planet, ensuring a resilient and sustainable future for generations to come. Concise and factual. It should state briefly the purpose of the research, the principal results and major conclusions.

Keywords: *AI, conservation, sustainable future, generations, research*

Biography



Dr. Neha Singh Raghuvanshi is an Indian academician and a chemist with a decade of academic experience and considerable years in research. Currently, she is engaged as Assistant Professor in ABES Engineering College, Ghaziabad. She is an alumni of University of Lucknow and Amity University. She has also worked in CSIR- Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP)- Lucknow. She has obtained her doctorate in Organo-sulfur drugs, and her research interest also lies in lignocellulosic biomass chemistry and catalysis. Her profile includes research publications and patents. She teaches Chemistry to budding engineers and this book is an attempt to connect chemistry with engineering domain and simplifying chemistry for future engineers.



VIII. International Symposium-2024

SUSTAINABLE FASHION -THE ONLY REMEDY FOR FAST FASHION

Rashmi RATHORE

India. dmtheimagedoctor@gmail.com. +91-9555250502

Fashion is one of the world's most important industries, driving a significant part of the global economy. Also, it is the most resource intensive. Fast fashion has allowed all segments of society, irrespective of class, income, or background to engage in the hedonistic and psychogenic pleasures of fashion. Fashion should be affordable to the individual, but more so to the environment. Fashion brands, big and small, have made ambitious, public commitments to creating more sustainable apparel by 2030. But keeping pace with their decarbonization commitments has been a challenge across the industry. Sustainable fashion refers to a clothing supply chain that is ecologically and socially responsible. It aims to reorient the industry and consumers away from the fast fashion model and toward sustainable practices in sourcing, production, distribution, marketing, and consumption. Sustainability as a fashion statement represents a contemporary approach to clothing that combines ethical values with style. Sustainable fashion offers a multitude of benefits, both globally and personally. Considering the number of factors involved, there are still too few brands out there currently tackling all these complex issues, and even those that will admit that there's always room for improvement. This means simply shopping for items labelled "sustainable" is not enough; we need to completely rethink our purchasing habits and the way we consume clothes. Consumers have the power to change the trajectory of fast fashion. Creating awareness about the impact of fast fashion on environment is the beginning. Practicing sustainable choices is the key. Fashion and styling need not be compromised if correct choices are made. Image management teaches how to dress attractively in a very affordable manner. Let's create a chic world with the help of image management and heal the environment from the super contagious fast fashion pandemic.

Keywords: *Fast fashion. Sustainable fashion. Affordable fashion. Creating awareness. Image management*

Biography



Dr Rashmi Rathore is healing, empowering and transforming lives by bringing health, image management and soft skills training together with her brand "The Image Doctor". She is a practicing medical. She has been an Associate professor with B.H. Medical College. She is also an Internationally certified Image consultant and Soft Skills trainer. She is a Train the Trainer certified consultant. After winning multiple beauty pageants at national level, she is practicing as a Pageant coach too. She is the joint secretary to the NGO, Society for Rural Improvement and has worked with multiple national level NGOs. She is an active member of German New Medicine, Vigyan

Bharti India and Army wives' welfare association. Being married to an army officer, she has been travelling far and wide across the nation and has stayed in 14 States & 6 union territories. She draws her experience by working with multiple organisations and cultures globally.



VIII. International Symposium-2024

ENERGY UTILISATION OF MSW LANDFILL HILLS SITES OF HUNGARY

**Emőke IMRE^{1,2}, László TÓTH², Péter FELKER¹, Ákos NEMCSICS^{2,5},
Antal ÜRMÖS^{2,5}, Tamás WEIDINGER⁶, Martin MAYER³, Tibor
PÁLINKÁS¹, Gábor MILE⁴, Lily TANUI⁷, Ulsbold AYURZANA⁷, Delphin
KABEY², Habaguhirwa VEDASTE¹, Ágnes BÁLINT^{2,8}, Ervin RÁCZ^{2,5},
Zoltán KAPROS¹⁰**

¹*Bánki Donát Faculty, Óbuda University, Budapest, Hungary.*

²*Hydro-Bio-Mechanical Systems Research Center, Óbuda University;* ³*Department of Energy Engineering, Faculty of Mechanical Engineering, Budapest University of Technology and Economics, Hungary.*

⁴*FKF Zrt., Budapest, Hungary.*

⁵*Kandó Kálmán Faculty, Óbuda University, Budapest, Hungary.*

⁶*Faculty of Social Sciences, Eötvös Loránd University, Budapest, Hungary.*

⁷*Doctoral School of Applied Informatics and Applied Mathematics, Óbuda University, Budapest, Hungary.*

⁸*Rejtő Sándor Faculty, Óbuda University, Budapest, Hungary.*

⁹*Faculty of Engineering and Information Technology, University of Pécs, Hungary.*

¹⁰*Ministry of Construction and Transport, Hungary.*

Electric island networks based on renewable energy sources include - in almost all cases an electric generator unit based on fossil fuel (diesel engine) and an energy storage. The more diverse the energy source of renewables (e.g. hydroelectric power plant + photo-electric cells + wind power plant), the lower the performance of the mentioned auxiliary units can be. Where this is possible, it is always advisable to consider landfill gas as a source to produce electricity. In the last few decades, about fifty modern municipal landfill sites have been established in Hungary. The previous part of the research showed that considering the 5, 10 or 15 km vicinity of these municipal landfills, the 24%, 44% and 60% of the total population are found here within the 16%, 37% and 53% of the villages and cities, so a large, decentralized energy system consisting of energy hills could be made by using all landfills. This paper contains the first results of the wind velocity and solar radiation measurements, as a student research, which may serve as a basis of the design of the energy hills. It is found that the geometry of the hill may ensure excellent seashore wind condition, the solar radiation has a more uniform time distribution and excellent cooling condition due to the uniform, surface wind below the solar panels.

Keywords: MSW landfill hill, wind velocity, solar radiation

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 and DEM, in situ -situ testing (e.g. CPT dissipation tests, evaluation methods and software preparation), laboratory experiments. ISSMGE TC102, TC106 and TC201 member, Cost representative of Hungary.



Oral Technical Sessions



Session (A): Healthcare: Risk & Management



VIII. International Symposium-2024

HEPATIC EFFECTS OF GRAPHENE OXIDE (GO): A MACROSCOPIC AND HISTO-BIOCHEMICAL ANALYSIS

Asmaa RHAZOUANI^{1,2,3}, Halima GAMRANI³, Lhoucine GEBRATI⁴, Faissal AZIZ^{1,2}

¹Laboratory of Water, Biodiversity & Climate Change, Cadi Ayyad University, Marrakech, Morocco.

²National Centre for Studies and Research on Water and Energy, Cadi Ayyad University, Marrakech, Morocco.

³Laboratory of Clinical, Experimental and Environmental Neurosciences, Cadi Ayyad University, Marrakech, Morocco.

⁴Laboratory of Materials, Processes, Environment and Quality, Cadi Ayyad University, Safi, Morocco.

Corresponding authors: f.aziz@uca.ma / faissalaziz@gmail.com

Graphene oxide (GO) is a nanometric material derived from graphene, an atomically pure carbon structure. Although graphene oxide is widely used in various biomedical applications due to its unique properties, its safety remains a significant concern. To assess its effects on the liver, we administered GO at doses of 2 mg kg⁻¹ and 5 mg kg⁻¹ intraperitoneally over a period of 46 days to male Swiss strain mice. After the exposure period, macroscopic observation of the organs revealed significant alterations in the structure and appearance of the livers of GO-treated mice compared with the control group. These alterations were clearly dose-dependent, highlighting the sensitivity of the liver to GO exposure levels. In addition, biochemical analyses revealed marked changes in liver enzyme activity. We observed increased activity of catalase, an enzyme involved in peroxide degradation, as well as increased levels of malondialdehyde (MDA), a product of lipid peroxidation, indicating oxidative stress in the liver. Histological results corroborated these observations, showing dose-dependent inflammation and tissue damage in the livers of mice exposed to GO.

Keywords: Graphene oxide, toxicity, liver, macroscopic observation, biochemical analyses, oxidative stress.

Biography



As a 5th year PhD student at Cadi Ayyad University, I'm focusing on studying graphene oxide toxicity in biological systems. My research has already led to the publication of two scientific papers. I have actively participated in several national and international conferences during this research period. These events have been invaluable opportunities for intellectual exchange, sharing ideas and establishing contacts with my peers while keeping me abreast of the latest advances in the field



VIII. International Symposium-2024

REVIEW ON EPIDEMIOLOGICAL INTERFACE OF FOOT AND MOUTH DISEASES BETWEEN WILD ANIMALS, DOMESTIC ANIMALS AND HUMAN

Henok ABEBE¹, Henok MULATU^{2*}, Samuel KELEMEWORK³

Hirna Regional Veterinary Laboratory, Oromiya Regional State, Hirna, Ethiopia

²Habro District Livestock and Fisheries Development Office, Gelemso, Ethiopia

³Guba Koricha District Livestock and Fisheries Development Office, Komona, Ethiopia

Corresponding author: Henok Mulatu: Email: henokmulatu5@gmail.com

Orcid: <http://orcid.org/0000-0001-7358-4260>

Diseases transmission at wild-domestic interfaces is an important epidemiological issue on most continents. Humans live increasingly in the proximity of natural areas, leading to increased interactions between people, their livestock and wildlife. Wildlife is a maintenance host for several significant livestock diseases. The raised strategy for cattle herders at the wildlife/livestock interface might be to decrease the likelihood of livestock depredation by avoiding the use of protected areas when the constraints in communal lands are adequate. Interspecific pathogen transmission may occur in complex socio-ecological systems at wild-domestic interfaces that have so far been seldom studied. The potential spill over of foot and mouth disease (FMD) virus at the wildlife-livestock interface and interventions to control disease transmission at the wildlife-livestock interface is the present-day challenging due to different reasons. The risk of pathogen spill over between sympatric host populations is restricted to limited areas at specific seasons and predators could mitigate interspecific disease transmission. There is also limited studies considering humans, livestock and wildlife concurrently. This review outlines epidemiological interfaces for the spread of Foot-and-Mouth Disease.

Keywords: *Foot-and-Mouth Disease, Epidemiology, livestock-Wildlife-Human Coexistence, interspecific contacts*



VIII. International Symposium-2024

ANALYSIS OF THE MANAGEMENT SYSTEM ACCIDENT RISKS

Kenza IRINISLIMANE

*Mechanical Engineering Department, M'Hamed Bougara University, Boumerdes,
Algeria.*

k.irinislmane@univ-boumerdes.dz, 06.99.95.80.82

In an unstable economic environment, the organization is daily faced with a multitude of risks of very different importance and nature. These risks can disrupt the achievement of these objectives. The question of controlling accident risks is a problem today. This the latter is taken into consideration by the majority of company management or organization. Now, we need to know how these departments react to these risks. To cope, companies are asking for an instrument allowing the daily management of risk within all companies regardless of its sector of activity, its size, this instrument is risk management. Risk management is a management method that allows the company to know its risks and measure their importance and it aims to control all of these risks. To do this, it uses a set of methods and tools to identify, analyze and address risks, with the aim of providing reasonable assurance that the objectives will be achieved. objectives of the organization. It thus involves all members of the organization at all times. levels of the hierarchy.

Keywords: *Environment, management, Risk, organization*



VIII. International Symposium-2024

THREATS TO WILDLIFE

Rahat SIRAJ

Hazara University sub-Campus Battagram, Battagram, Pakistan

Email: rahatsiraj57@gmail.com

Purpose of research

Scientific studies allow us to understand the factors responsible for species declines and to develop appropriate solutions

The Principal Results

- I. Habitat destruction leading to climate change offsets the balance of species keeping up with the extinction threshold leading to a higher likelihood of extinction.
- II. . Human activities, such as destroying native habitats and fragmenting them into smaller areas, have led to the destruction of global nitrogen, carbon, and water cycles, as well as climate change.

Conclusion

Wildlife conservation aims to maintain this interconnected ecosystem between different species.

Keywords: *A world without wildlife is a world without beauty*



VIII. International Symposium-2024

ISOLATION OF PATHOGENIC BACTERIA FROM DISEASED HETEROPNEUSTES FOSSILIS

Rahul KUMAR

*Chaudhary Charan Singh Haryana Agricultural University, College of Agriculture,
Bawal-123501, Rewari, Haryana, INDIA*

Diseases affect the overall productivity of the aquatic ecosystem that directly affects the aquatic food and health management practices. The general public refrains from eating sick and dead animals as food because there is a general possibility that they may become ill due to contaminated aquatic food. People generally avoid skin ulcers on fish as food. Some fish diseases may contain toxins that can affect humans. Therefore, diseases must be controlled to provide healthy food. Bacterial diseases are the most common diseases in fish and are often internal but can also be external. The causative bacteria are generally saprophytic and become pathogenic in fishes with poor nutritional diet, physiological imbalance and non-optimal water. A survey of fish farms focusing on the culturing of *Heteropneustes fossilis* in Haryana was conducted from March 2021 to August 2021, with monthly intervals. The aim was to monitor health management practices. Across six districts of Haryana, various farmers employed distinct management strategies to mitigate diseases in *H. fossilis*. Water quality parameters were consistently recorded during this survey to assess any correlation with *H. fossilis* diseases. Our observations indicated that inadequate water quality significantly contributes to diseases in *H. fossilis*. Diseased fish were dissected in the department of Zoology and molecular identification was done for isolated pathogenic bacteria. Fish again challenged with isolated pathogenic bacteria to confirm the diseased in fish.

Keywords: *bacteria, health management, water quality parameters*



VIII. International Symposium-2024

AMELIORATIVE EFFECT OF ONONIS NATRIX AGAINST CHRONIC LEAD POISONING IN MICE: BIOCHEMICAL AND HISTOLOGICAL STUDY

Asmaa HAJ-KHLIFA, Faissal AZIZ, Maroua Ait TASTIFT, Souad SELLAMI, Hanane RAIS, Miloud HAMMOUD, Naima FDIL, Najib KISSANI, Halima GAMRANI, Moulay Mustapha BOUYATAS

Cadi Ayyad University, Faculty of sciences Semlalia, Marrakech, Morocco

Lead (Pb) is one of the most common heavy metals with toxicological effects on many tissues in humans as well as animals. To counteract the toxic effects of this metal, the administration of synthetic or natural antioxidants is thus required. The aim of this study was to examine the beneficial effect of the aqueous extract of Ononis natrix (AEON) against lead acetate-induced damage from a biochemical and histological point of view. Forty-eight male mice were divided into four equal groups: Ctr (control); Pb (lead acetate 1 g/l); Pb + On 100 mg/kg (lead acetate 1 g/l + AEON 100 mg/kg); Pb + On 500 mg/kg (lead acetate 1 g/l + AEON 500 mg/kg). AEON was administered orally from day 21 after the start of lead exposure up to the end of the experiment. The results revealed that lead induced increased serum levels of liver markers (AST, ALT, and bilirubin), as well as kidney markers (urea and creatinine). At the same time, levels of thiobarbituric acid reactive substances (TBARS) and glutathione peroxidase (GPx) increased significantly. Moreover, Pb caused structural changes in the liver and kidneys of Pb-exposed mice. However, AEON administration significantly improved all lead-induced liver and kidney dysfunctions. Our results suggest that AEON could be a source of molecules with therapeutic potential against liver, and kidney abnormalities caused by lead exposure.

keywords: *ononis natrix, chronic lead poisoning, mice, biochemical and histological study*



Session (B): Soil Biology & Agricultural and Food Security, Ecosystems & Landscape Conservation



VIII. International Symposium-2024

ECOSYSTEMS & LANDSCAPE CONSERVATION

Iram MAJEED

*The Government Sadiq College Women University, Bahawalpur, Pakistan,
E-mail: irammajeed234@gmail.com, Phone number: +923106771369*

This topic explores the vital role of ecosystems and the importance of landscape conservation in protecting our planet's biodiversity and ensuring a sustainable future. Ecosystems are complex systems where living organisms interact with their physical environment. They provide us with clean air and water, regulate climate, and offer a vast array of resources. Landscape conservation takes a holistic approach to protecting natural areas, focusing on entire landscapes and the ecological processes that occur within them. It offers a multitude of benefits, including protecting biodiversity, maintaining healthy ecosystems, and supporting human well-being. However, landscape conservation faces challenges like habitat loss, climate change, invasive species, and pollution. The presentation explores various approaches to address these challenges, including establishing protected areas, creating habitat corridors, promoting sustainable land management, and fostering community engagement. Looking towards the future, collaboration is key. By working together, governments, scientists, NGOs, and local communities can leverage technological advancements and raise public awareness to ensure a future where healthy ecosystems and a sustainable planet thrive.

Keywords: *Ecosystems, Landscape Conservation, Biodiversity, Sustainability, Habitat Preservation, Climate Resilience*

Biography



I am a Graduate in botany with a strong interest in leveraging technology for environmental conservation. My background lies in studying, Plant ecology, Plant physiology, Biodiversity and conservation, and Plant science and Bioinformatics. I am passionate about exploring the potential of Artificial Intelligence in this field. I believe AI can be a powerful tool for monitoring endangered species populations or optimizing habitat restoration efforts.



VIII. International Symposium-2024

EVALUATION OF STORED CARBON IN URBAN TREES OF KOLKATA CITY USING EMERGING TECHNOLOGIES

Sana AHMED¹, Sufia ZAMAN¹, Abhijit MITRA²

¹*Department of Oceanography, Techno India University, West Bengal, Salt Lake, Sector V, Kolkata, India.*

²*Department of Marine Science, University of Calcutta, Kolkata, India.*

E-mail: sanahmed85@gmail.com, E-mail: abhijit_mitra@gmail.com

E-mail: zamansufia123@gmail.com

Dr. Sana Ahmed: + 91 7044925859, Dr. Sufia Zaman: +91 6291373582

Dr. Abhijit Mitra: + 91 8584929005/ 9831269550

The present study highlights a comprehensive evaluation of the stored carbon in urban trees across four sites within the megacity of Kolkata city. These sites are Shyambazar (Stn.1), Garia (Stn.2), Manicktala (Stn.3), and Moulali (Stn.4), utilizing emerging technological approaches. Conducted in December 2023, the assessment employed ground zero to quantify carbon storage, highlighting the critical role urban forestry plays in mitigating urban carbon footprints. The ground zero data obtained from these four sites were used to evaluate stored carbon based on computer language. The results reveal significant spatial variations in carbon storage capabilities across the sites. The stored carbon varied as per the order given Garia (Stn.2) > Shyambazar (Stn.1) > Manicktala (Stn.3) > Moulali (Stn.4). These findings underscore the importance of strategic urban planning and tree management in enhancing carbon sequestration in metropolitan areas. The study advocates for tailored conservation strategies that consider the specific vegetative profiles and urban infrastructure of each site. Furthermore, it emphasizes the need for ongoing monitoring and integration of emerging technologies to better understand and optimize the ecological services provided by urban trees.

Keywords: Kolkata city (India), Urban trees, Stored carbon, Spatial variations

Biography



Dr. Sana Ahmed (M.Sc., Ph.D.).

Address (Official): Department of Oceanography Techno India University, Salt Lake, Kolkata 700 091, West Bengal (India).

Address (Residential): 8, Gora Chand Road Beniapukur Police Station Kolkata 700014, West Bengal, (India).

Date of Birth: 24th of November 1986. **Telephone No.** +91 7044925859 (WhatsApp)/(Mobile)

E-mail: sanahmed85@gmail.com.

Citizenship: Indian.

Present position: Assistant Professor, at Department of Oceanography, Techno India University, West Bengal, Salt Lake City, Sector V, Kolkata 700 091 (INDIA).

Briefly in ResearchGate (Research Interest):

<https://www.researchgate.net/profile/Sana-Ahmed-49>. At a glance in

LinkedIn: <https://www.linkedin.com/in/dr-sana-ahmed-62613819/> **Paper Published-20**



VIII. International Symposium-2024

NAVIGATING THE LEGAL LABYRINTH: BALANCING TOURISM, ENVIRONMENTAL HEALTH, AND BIOSECURITY

Lateefat Adeola BELLO

*Ahmadu Bello University, Zaria, Kaduna State, Nigeria.
attorney4rea@yahoo.com, +234-8031530751*

The burgeoning tourism industry presents a dual dilemma for nations, offering economic prosperity and cultural exchange alongside potential environmental harm and biosecurity risks. This study examines the intricate legal framework at the intersection of tourism, environmental health, and biosecurity. Balancing these often-conflicting objectives is the central challenge. Unchecked tourism can deplete natural resources, harm ecosystems, and disrupt habitats, while stringent environmental regulations might impede economic growth. Additionally, biosecurity concerns arise due to the possibility of invasive species and disease transmission through mass travel. The paper explores existing legal mechanisms governing these realms, including international agreements like the Convention on Biological Diversity and national environmental laws. It also analyses biosecurity protocols established by organizations such as the World Health Organization and the International Civil Aviation Organization to curb disease spread. Emphasizing a holistic approach, the abstract underscores the need to integrate environmental sustainability into tourism development strategies. It advocates for legal frameworks supporting responsible tourism practices, such as eco-tourism initiatives and waste management regulations, alongside robust biosecurity measures like disease surveillance and traveller screening. By fostering legal synergy between tourism, environmental health, and biosecurity, nations can harness tourism's economic benefits while safeguarding ecological integrity and public health. These abstract paves way for further exploration of legal systems conducive to achieving this delicate equilibrium.

Keywords: *Tourism, Biodiversity, Legal Framework, Environment, Ecosystem, Agreements, Law*

Biography



I'm a senior Lecturer, at the Department of Commercial Law Ahmadu Bello University Zaria, with a special focus on Tourism and Hospitality Law, Medical Law and Environmental law, I have presented at quite many conferences and written journals in tourism and climate change amongst others. Before this I also lectured biochemistry for about 18 years and was a company secretary and legal adviser for a bank for 10 years I'm a Female happily married with three grown-up children. I love collaborative and interdisciplinary research and look forward to more such opportunities in the future



VIII. International Symposium-2024

LANDSCAPE SCALE STUDY OF HYDROMORPHOLOGICAL CHANGES OF BÜKKÖS STREAM (SZENTENDRE) AND THEIR EFFECTS ON NATUTAL STATE

Igor DUKAY

*Hungarian University of Agriculture and Life Sciences, Institute for Wildlife
Management and Nature Conservation, Hungary.
dukayigor@gmail.com, +36702350254*

Hydromorfological characteristics of waterbodies has remarkable effects on natural state of wetlands, therefore protection and rehabilitation of them, protection and repair of their role in the green and blue infrastructure network has also hydromorphological aspects. My study area is the Bükkös stream which flows into the Danube at Szentendre (Hungary). As a first step I collected and compared the available hydromorphological and natural data of the stream, then I reconstructed the natural and after intervention state of the streambed and the valley, based on topographical and archive military maps, orthophotos, satellite pictures and local historical documents.

I created an image of the current natural state based on field studies, documents, habitat maps. During examination I could see that stream was affected by huge antropogenic effects (flood protection interventions, deforestation). The largest riverbed regulations happened in the 20th century, when the streambed was straightened and deepened, and its lowest sections received concret protection.

The maintenance works are still affecting the riverbed and its wildlife. Despite all these effects, the woody vegetation was able to regenerate along the stream, and the fishfauna of the Bükkös has an outstanding nature conservation value. In both cases significant factors are that the stream has huge bed length drop, it carries lot of sediments, it has ecological connection with the Danube, furthermore, after riverbed regulations the attitude of the society was changed, the importance and financial sources of maintenance are reduced.

Keywords: *hydromorphology, habitat regeneration, protected fish species, Bükkös stream, Szentendre, Hungary*

Biography



Igor Dukay (born 15 September 1973) biology and geography teacher, nature conservation engineer. He has been working as independent nature conservation expert and environmental protection specialist since 2001. He worked also in the state, municipal and civil sphere. He is second year PhD Student. Study area is rehabilitation of wetland, primarily streams and associated habitats. He edited e.g. one-one methodological handbook of field study of streams and sources and a Hungarian standard for rehabilitation and managing of ecological restored streams.



VIII. International Symposium-2024

BIOBASED HYDROGELS AS A RESILIENT SOLUTION FOR WATER-EFFICIENT AGRICULTURE

Achraf BERRADI^{1,2}, Ahlam LAFDALI^{1,2,3}, Laila MANDI^{1,2}, Faissal AZIZ^{1,2}, Naaila OUAZZANI^{1,2}, Abdelhaq EL ARRAM^{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 Innovative Materials, Energy and Sustainable Development (IMED-Lab), Faculty of Science and Technology, Cadi Ayyad University, Marrakech, Morocco.*

Corresponding author: Prof. AZIZ Faissal, Faculty of Sciences Semlalia of Marrakech, Cadi Ayyad University, Morocco. f.aziz@uca.ma / faissalaziz@gmail.com

The burgeoning agricultural sector, driven by global demands, faces a pressing challenge in sustainable water usage, particularly in arid regions. Water scarcity contributes to soil degradation, desertification, and salinization, exacerbating the need for innovative irrigation solutions. This study addresses these concerns by focusing on developing environmentally friendly hydrogels based on polysaccharides. Our approach involves bio-sourced hydrogels based on natural polymers, which exhibit non-toxicity, cost-effectiveness, biocompatibility, and biodegradability, alongside exceptional water retention and absorption capacities without dissolution. Beyond their application in sustainable irrigation, these hydrogels offer potential in wastewater treatment through adsorption processes and as nutrient reservoirs for slow-release fertilizer systems.

We employed Nuclear Magnetic Resonance (NMR) and Fourier Transform Infrared Spectroscopy (FTIR) to validate our findings for material characterization, confirming successful synthesis. Subsequent investigations into morphological, thermal, and mechanical properties, as well as swelling behaviors, further support the potential utility of these hydrogels in enhancing soil water availability, productivity, and crop growth while minimizing water wastage. As a noteworthy result, our study achieved a maximum swelling capacity exceeding 800 g/g for the carboxymethyl cellulose-based hydrogel, underscoring its efficacy in water absorption.

Keywords: Agriculture; Water; Polysaccharide; Hydrogel; Biobased

Acknowledgments: This research was supported by the Morocco-Tunisian Bilateral Scientific Cooperation Project “2XPS” (20/PRD-MT-06) and the CICLICA-PRIMA program project (Project ID 1727).

Biography



Achraf BERRADI has registered in PhD in 2021 at the age of 26 years at Faculty of Sciences Semlalia, Cady Ayyad University Marrakech, Morocco. The theme of his work is bio sourced hydrogels in agricultural uses. Currently he is in internship in the National Centre of Study and Research on Water and Energy.



VIII. International Symposium-2024

HIP IMPLANT OPTIMIZATION USING LATTICE STRUCTURES

Rashwan ALKENTAR, Tamás MANKOVITS

*University of Debrecen, Faculty of Engineering, Debrecen, Hungary.
rashwan.alkentar@eng.unideb.hu, +36305579620*

Due to the continuous increment in the total hip arthroplasties over the past few years, and for the purpose of reducing the number of revision surgeries, the optimization of hip implants has become a real necessity in the biomedical industry. The research aims at optimizing the hip implant design by manipulating the porosity of the hip implant while trying to keep the strength at the required levels. Young's modulus of the implant is reduced to a level that matches the hosting bone in the human body, which reduces the risk of the stress shielding phenomenon. Compression tests and Finite Element analysis will be conducted on three types of latticed implants with matching porosity to figure out which kind of lattice structure is most suitable to biomedical use. Titanium alloy Ti6Al4V grade 23 will be used as the main material for the hip implants 3D printing process. The three implants will be 3D printed using EOS M 290 3D printing machine. Ansys software will be used to perform the finite element analysis to validate the results.

Keywords: *Hip implant, ANSYS, Finite element analysis, Lattice structures*



VIII. International Symposium-2024

EXAMINING SOIL CHARACTERISTICS USING SATELLITE-BASED IMAGING TECHNIQUES

Karim ENNOURI¹, Monia ENNOURI², Mohamed Ali TRIKI²

¹Digital Research Center of Sfax, Sfax, Tunisia.

²Olive tree institute, Sfax, Tunisia.

Soil is an essential, limited resource that requires the use of new knowledge and advanced technology to balance environmental protection with the need for food and biomass production. Understanding the properties and potential of soil is crucial for sustainable agriculture, as without this knowledge, scientific farming becomes difficult. Remote sensing, which involves analyzing data from devices located far from their target, relies on platforms, sensors, and data to gather valuable insights. By using satellite imagery and advanced techniques, researchers can accurately assess soil properties such as texture, moisture content, and nutrient availability without direct contact. This method improves the precision of soil assessment and helps inform better agricultural practices and land management decisions.

Keywords: *Remote sensing, agriculture, satellite, sensor*



VIII. International Symposium-2024

UTILIZATION OF THE POULTRY INDUSTRY BY-PRODUCTS PAW WASTE FOR THE PRODUCTION OF AN ALTERNATE MATERIAL OF EXOTIC LIKE LEATHER: WASTE TO THE HEALTH

Zerihun TESHOME¹, Tamrat TESFAYE^{1,2}, Tsion BELAY¹

¹*Leather Processing and Products Research and Innovation Centre, Ethiopian Institute of Textile and Fashion Technology, Bahir Dar, Ethiopia;*

²*Biorefinery Research Centre, Ethiopian Institute of Textile and Fashion Technology, Bahir Dar, Ethiopia.*

zerihunteshome2006@gmail.com, phone: +251929271356

Chicken paw skin was available in enormous quantities, which would be considered waste in the Ethiopian poultry industry. Due to a lack of awareness and technology in Ethiopia, chicken paw skin was neither consumed as food by people nor converted into leather and leather products by tanneries. This study aimed to investigate the possibility of poultry waste beneficiation by characterizing poultry wastes and converting them into valuable leather products through different chemical treatments and eco-friendly tanning methods without using polluted sodium sulfide by use natural ice to remove scale. Additionally during this study, organoleptic properties such as tensile strength, tear strength, visual assessment, and water absorption properties of leather and leather products were made from poultry paw wastes analyzed This study obtained that leather produced from poultry paw wastes has a unique grain structure, good strength, and an attractive look, and also shows good physical properties, with tensile strength, elongation, and tear strength of 244.6N, 29%, and 28.6N, respectively, finally this study concludes that's leather produced form poetry paws paw wastes mainly used for leisure small and medium leather products which seems like rare exotic animals like crocodile, snake and alligator which have demanded on leather markets. This study also indicates the potential of the potential of poultry paw skins use as a raw material for highly fashionable leather, which is used for medium-sized leather products with low manufacturing costs, and the feasibility of using poultry paw waste for leather and leather products production.

Keywords: *Poultry wastes; exotic leather; Unique grain structure; Chicken leather; Tanning*



Mr. Zerihun Teshome Kebede has been a senior researcher and lecturer at Bahir Dar University, EiTEX, since 2017. He is also serving as a Leather Technology Learning Research and Innovation Team Coordinator at EiTEX from September 2018 until June 2022. He holds his BSc degree in Leather Engineering from Bahir Dar University in 2017, his MSc degree in Leather Product Design and Engineering from Bahir Dar University in 2019, and his higher diploma programme (HDP) in 2021 from Bahir Dar University. He served as Leather Engineering Programme Head at Bahir Dar University, EiTEX, from the June 2022 update. He has mentored a total of 40

undergraduate students in data collection and analysis for their BSc thesis and guided the students in the preparation and presentation of research findings since 2017. He has more than 11 published articles in internationally reputable journals.



Dr Tamrat Tesfaye (Professor), Scientific Director (Vice President) of Ethiopian Institute of Textile and Fashion Technology of [Bahir Dar University](#) studied at [University of KwaZulu-Natal \(UKZN\)](#) and obtained PhD in Chemical Engineering in 2018. A highly accomplished higher education executive with substantial management experience, he is a pre-eminent scientist in the field of Chemical Engineering and specifically in Biopolymers and Biomaterials. He has successfully graduated over 30 Masters & 15 PhDs students. Dr Tesfaye has published in excess of 100 peer-reviewed papers and has presented in excess of 50 papers at conferences. He serves as Editor-in-Chief of Ethiopian Journal of Textile & Apparel and Ethiopian Electronic Journal of Innovation and Technology Foresight. He is a recipient of various national & international awards & a member of various industry & academic bodies, amongst others the [Ethiopian Academy of Sciences](#) & [Ethiopian Journal's Editors forum](#).



Mr.s Tsion Belay, Researcher and Lectuere at EiTEX, Bahir Dar University, from 2019. She holds his BSc degree in Garment Engineering from Bahir Dar University in 2019, his MSc degree in Fashion Technology from Bahir Dar University in 2023, and his higher diploma programme (HDP) in 2022 from Bahir Dar University. He has 2 published articles in internationally reputable journals.



VIII. International Symposium-2024

SEDIMENT ANALYSIS OF MIOCENE DEPOSITS IN THE RED BAY FORMATION, FLORIDA: INSIGHTS INTO NEARSHORE MARINE FACIES AND LITHOLOGICAL DISCREPANCIES

Belkasim KHAMEISS

Kansas Geological Survey, 1930 Constant Ave., Lawrence, USA

belkasimkahemsis@outlook.com

In a groundbreaking study, three kilograms of sediments sourced from the extinct Red Bay Formation in Florida have undergone meticulous examination. The chosen analytical approach holds significance as the geological outcrop responsible for these samples no longer exists. The scrutinized sediments reveal an abundance of marine invertebrate deposits, showcasing a diverse array of gastropods and bivalves. This research marks a significant milestone by presenting the inaugural comprehensive documentation of foraminifera populations within this geological section, a facet previously overlooked by scientific inquiry. The identified bivalve species, including *Astarte distans*, *Chesapecten covepointensis*, *Crassostrea* sp., *Glyptoactis nodifera*, *Isognomon* sp., *Lirphora latilirata*, and *Pycnodonte* sp., alongside gastropod species such as *Ecphora meganae*, *Turritella tampae*, and *Leptomaria* sp., contribute to the richness of the findings. The age of the sediment bed, inferred from the documented fauna, places it in the middle Late Miocene, suggesting a prevalence of shallow marine environments during that period. These findings substantiate the hypothesis that the sediments attributed to the Red Bay Formation likely originated from nearshore marine settings. However, challenges persist in definitively assigning these sediments to the Red Bay Formation, given the shared lithological similarities with adjacent geological units. This study opens avenues for further exploration and underscores the complexity of geological attribution in paleontological research.

Keywords: *Red Bay Formation, Miocene deposits, bivalve species, gastropod species.*

Biography

Belkasim Khameiss,

Post Doc Reseracher

Kansas Geological Survey.1930 Constant Ave. Lawrence, KS 66047, USA



VIII. International Symposium-2024

AGROECOLOGICAL ASSESSMENT OF HERBICIDE APPLICATION FOR MONOCULTURE MAIZE

Olena DEMYANYUK, Dmitry SHATSMAN, Oleksander POLTAVA

Institute of Agroecology and Environmental Management of NAAS, Kyiv, Ukraine
demolena@ukr.net, +38-067-680-12-43

An agroecological assessment of the impact of soil and crop herbicides on continuous maize cultivation on typical chernozem soil was conducted. The application of herbicides for three consecutive years under continuous maize cultivation led to a reduction in the total amount of microorganisms in the soil by 10.9% to 38.3% and their total biomass content by 8.3% to 58.6% compared to the fallow period. Moreover, a redistribution of microorganisms from major ecotrophic groups occurred in the microbial community structure of typical chernozem: the number of nitrogen-fixing microorganisms decreased by 2.0 to 3.5 times, while the population of bacteria utilizing nitrogen mineral compounds increased by 8.0% to 31.8%, pedotrophs by 4.3% to 15.5%, oligotrophs by 7.4% to 25.5%, and micromycetes by 7.3% to 54.2%. Such redistribution of major ecotrophic groups led to the activation of organic matter decomposition processes in the soil, evidenced by an increase in the mineralization-immobilization coefficient (K_{m-I}) by 2 to 2.4 times and the pedotrophy coefficient (K_{ped}) by 1.6 to 2.1 times. It was found that the use of chemical preparations had no significant effect on soil CO₂ emissions, with differences compared to the control ranging from 2% to 16%. However, compared to natural maize cultivation ecosystems with the application of chemical plant protection agents, this process was activated by 1.3 to 1.5 times, which is negative in terms of greenhouse gas emissions and organic carbon loss from the soil. Additionally, a decrease in humus content by 0.2%, readily hydrolyzable nitrogen by 2.9% to 18.6%, mobile phosphorus compounds by 2% to 8.1%, and potassium by 10.2% to 19.5% was observed in the soil compared to the initial levels. Calculations confirmed a negative nitrogen balance of up to -176.1 kg/ha/year and P₂O₅ balance of up to -50.3 kg/ha/year.

Keywords: agroecological assessment maize, monoculture, herbicides, soil microbiota

Biography



Mrs. Olena Demyanyuk, has the degree of Doctor of Agriculture (2017), Professor of Ecology (2019). Research areas: ecological safety of agricultural production; the quality and safety of agricultural products; food security in the context of climate changes; soil microbiology and in biological diagnostic of soil of the different agroecosystems. She is working with microbiological monitoring in different types of ecosystems. She is author of over 250 scientific publications. Participant and co-organizer of numerous International Congresses and conferences.



VIII. International Symposium-2024

CO-COMPOSTING OF SHRIMP SHELL WASTE AND OLIVE LEAVES: PHYSICO-CHEMICAL AND AGRONOMIC QUALITY ASSESSMENT

Hayet HFAIEDH, Emna BOUAZIZI, Yaakoub GHARBI, Mohamed Ali TRIKI

Laboratory of Olive Genetic Resources: characterization, valorization and phytosanitary protection, Olive Tree Institute, Tunisia.

hayethfaiedh05@gmail.com

Background and aim: To decrease the environmental harm produced by the fishing industry around the port of Sfax, an investigation of the co-composting of shrimp shell waste, olive leaves from tree pruning process and poultry manure, was performed at Olive Tree Institute.

Methods: During the composting process, the organic matter biodegradation and compost quality were monitored using physico-chemical (temperature, pH, conductivity, and C/N) and biological parameters. Furthermore, the phytotoxicity of compost extract and its antifungal activity were tested.

Results: The process lasted three months to achieve maturity. The results showed a rapid temperature increase during the first two days and a relatively short compost maturity phase. Organic matter content was reduced by 36% and C/N ratio shifted from 32 to 20 during the process. The physicochemical characterization of compost shows a final pH value of 7.43 and a relatively high electrical conductivity of 5 mS cm⁻¹. The contents of dry matter, organic and mineral are respectively values 44.94%, 24.1% and 20.84%. The agronomic evaluation demonstrated a good nitrogen (1.05%) and phosphorus (4.62%) contents. Antifungal trials were performed using the diffusion method on several pathogenic fungi, with compost extract and the leachate. When filtered, the compost extract is very effective by totally inhibiting the mycelial growth of *Colletotrichum gloeosporioides*, *Fusarium solani*, *Fusarium oxysporum* and *Verticillium dahliae*. By contrast, the sterilization of the extract by autoclaving reduces its antifungal efficacy. For the leachate, greater inhibition of mycelial growth was recorded with that collected during the first month of composting. Similarly, filtration was more effective than autoclaving to conserve the antifungal features of the compost. The phytotoxicity tests indicated a germination index exceeding 80% for tomato, cucumber and radish. The composts were harmless and did not have any phytotoxic effect. **Conclusion:** the results obtained highlighted the interesting potential of compost derived from shrimp shell waste in the protection of olive crops against various fungal pathogens.

Keywords: *Compost extract; shrimp shell waste; antifungal activity; phytotoxicity; C/N*

Biography



My name is Hayet Hfaiedh. I'm a student in the first year of doctoral studies in Biological Sciences at the Olive Genetic Resource Laboratory, focusing on characterization, valorization and phytosanitary protection at the Olive Tree Institute of Sfax (Tunisia)



VIII. International Symposium-2024

ROLE OF MARINE ALGAE IN PLANT GROWTH AND PROTECTION FOR SUSTAINABLE AGRICULTURE

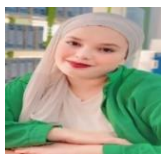
**Eetizez KAROUI, Karim ENNOURI, Mohammed Ali TRIKI, Monia
ENNOURI**

*Olive Tree Institute, Sfax, Tunisia.
eetizazk@gmail.com, +216 44 596 953*

Climate change, population growth and the overuse of chemical pesticides and fertilizers are placing unsustainable pressure on existing agricultural and food production techniques. Finding strategies that reduce the adverse impacts in agriculture industry is crucial to support sustainable food production systems and preserve the health of the environment for future generations. Algae whether macro (seaweed like *Ascophyllum nodosum*, *Sargassum vulgare*, *Gracilaria gracilis*, *Padina gymnospora*) or micro (unicellular like *Chlorella* spp, *Spirulina*) provide a variety of biological solutions for sustainable agriculture. There are a few ways in which algae can contribute to sustainable and ecologically sound agriculture. Algae are used as biological fertilizers rich in nutriment (nitrogen and phosphorous, potassium) that can enhance soil fertility and promote plant growth. Algae-based soil conditioners increase the availability of nutrients, water retention, and soil structure. They also promote and stimulate soil microbial life and the absorption of nutrients by roots. In the same vein, they contain many compounds that act as antioxidants, polysaccharides, phytohormones, vitamins and provide an effective shield against abiotic stresses in plants. Certain algae can function as biocontrol agents against plant diseases by producing chemicals with antibacterial and antifungal activities. Algal extracts may increase plant defenses against illness and inhibit the propagation of diseases, which reduces the need for chemical pesticides.

Keywords: *Agriculture, Algae, Fertilizer, Stimulation, Antibacterial and Antifungal activity*

Biography



Student in the first year of doctoral studies in Biological Sciences at the Olive Genetic Resources Laboratory, focusing on characterization, valorization, and phytosanitary protection at the Olive Tree Institute of Sfax (Tunisia).



VIII. International Symposium-2024

ELECTRO-BLOW SPUN HYBRID NANOFIBERS: A NEW PERSPECTIVE IN ACTIVE PACKAGING MATERIALS

Ghizlane AKHOUY^{1,2}, Lhoucine GEBRATI¹, Yasin AKGÜL³, Mehmet Durmus CALISIR⁴, Manal ZEFZOUFI², Salima ATLAS⁵, Majdouline BELAQZIZ^{2,6}, Faissal AZIZ^{2,6}

¹*Laboratory of Materials, Processes, Environment and Quality, Cadi Ayyad University Safi, Morocco.*

²*National Center for Research and Studies on Water and Energy, Cadi Ayyad University, Marrakech, Morocco.*

³*Karabuk University Iron and Steel Institute, KARABÜK, Turkey.*

⁴*Istanbul Technical University, Istanbul, Turkey.*

⁵*Polydisciplinary Faculty, Sultan Moulay Slimane University, Beni-Mellal, Morocco.*

⁶*Laboratory of Water, Biodiversity, and Climate Change, Faculty of Sciences Semlalia, Cadi Ayyad University, Marrakech, Morocco.*

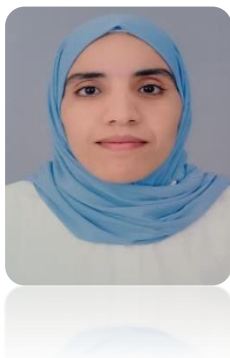
Integrating biodegradable polymers into nanofibers for active food packaging is a promising environmentally friendly solution. These polymers, derived from renewable materials, degrade naturally over time, reducing their environmental impact. Incorporating them into nanofiber structures improves the strength and flexibility of the finished packaging material. The high surface area of nanofibers also allows for the incorporation of active agents, such as antimicrobials, which improves the packaging's functionality. This eco-friendly packaging extends the shelf life of food products while reducing plastic pollution, which aligns with the global trend toward sustainable food packaging practices. Gelatin/Chitosan/polyamide 6 hybrid nanofiber was developed using the electro-blow spinning technique, which combines the advantages of solution blow spinning and electrospinning. In this technology, the electric field helps to stretch the solution uniformly, resulting in higher-quality fibers. Incorporating *Cedrus atlantica* (CAEO) essential oil improves the nanofiber's antimicrobial activity, making it suitable for food packaging applications. In addition, the hybrid nanofibers' morphological properties, thermal behavior, FTIR analysis, contact angle, air permeability, and mechanical properties were investigated. This research yielded promising results for the production of hybrid nanofibers. These nanofibers have good thermal properties and a thin morphology, with an average diameter of approximately 410 nm. Notably, the contact angle measurements showed values exceeding 90°, indicating hydrophobic characteristics, a valuable attribute for food packaging applications. The research evaluated the antioxidant capabilities of the nanofiber mats using DPPH and ABTS methods. Results indicate that the antioxidant activity of the G-Cs-PA6-CAEO5 nanofiber mat improved with increasing CAEO concentration. These findings suggest that the developed nanofiber mat has the

potential to serve as a versatile active packaging solution for preserving and monitoring the freshness of fruits.

Keywords: *electro-blow spinning, food packaging, hybrid, nanofibers.*

Acknowledgments: The authors thank the "BioNanoPack" project, financed by the National Center for Scientific and Technical Research (CNRST) and Türkiye Bilimsel ve Teknolojik Araştırma Kurumu (T ÜBITAK), on behalf of the Moroccan-Turkish Bilateral Cooperation.

Biography



As a PhD candidate at Cadi Ayyad University, my research focuses on developing and applying biodegradable active food packaging materials. This interdisciplinary field intersects food science, materials engineering, and environmental sustainability, addressing the pressing need for innovative solutions to enhance food preservation while minimizing environmental impact. Practical experiences, including an internship at the Iron and Steel Institute, Karabuk University, Turkey, have enriched my academic journey. Furthermore, my scholarly journey has been punctuated by active participation in numerous national and international conferences. These platforms have served as crucibles for intellectual exchange, enabling me to share insights, network with peers, and stay abreast of the latest developments in the field.



VIII. International Symposium-2024

THE EMISSION OF NITRIC OXIDE AND CARBON DIOXIDE FROM CULTIVATED SOIL

Abdousalam AHMED ALGAIDI¹, Hosam E.A.F. BAYOUMI HAMODA², Ibrahim ISSA³, Yosof SALEH HAMID⁴

¹Department of Microbiology, Faculty of Science, Sabha University, Sabha, Libya
algaidiaa@yahoo.com, 00218914387367

²Óbuda University, Rejto Sandor Faculty of Light industry and Environmental Engineering, Institute of Environmental Engineering and Natural Sciences, Budapest, Hungary bayoumi.hosam@uni-obuda.hu, 0036303900813

³Department of Soil Science, Faculty of Agriculture, Sirte University, Sirte Libya; ⁴Department of Soil Science, Faculty of Agriculture, Tripoli University, Tripoli, Libya, Jandoba2002@yahoo.com 00218914366903

A microcosm experiment was carried out using slightly arable soil samples with a low humus content to identify NO and CO₂ emissions under the stressors of varying concentrations of two heavy metals, lead, and cadmium, in the cultivated soil. At a temperature of 15°C the experiment was conducted in glass vessels using homogenized soil samples. Four subsamples were prepared with maize plant residue, KNO₃, or both. Pb (CH₃COO)₂·3H₂O and CdCl₂ concentrations were added to soil samples, contaminating them with 2.5H₂O at 6, 12, and 24 mg Cd kg⁻¹ soil. CO₂ concentrations were found using a Thermal Conductivity Detector and Electron Capture Detector. Gas content was analysed daily, and one-point linear calibration and an external standard were used for the measurements. It has been demonstrated that carbon dioxide concentrations fluctuate more with time than nitrogen oxide concentrations. Gas emissions were inhibited by heavy metals, and soil microcosms revealed that lead (Pb) inhibits NO emission more than (Cd). A greater accumulation of NO and CO₂ was seen when comparing the outcomes of the microcosm assessment with the production of NO and CO₂ resulting from inorganic N fertilizers applied at similar doses in the field and greenhouse experiment. Based on this study, the concentration of NO and CO₂ in gas samples significantly depends on the proportion of nitrogen and carbon in the soil. The mini-experiment method that was conducted is appropriate for achieving the stated objective of this paper.

Keywords: NO and CO₂ emission; cultivated soil; heavy metal; temperature; microcosm experiment



VIII. International Symposium-2024

TAXONOMIC STUDY OF SPIDER (ARACHNIDA: ARANEAE) FAUNA IN DISTRICT BATTAGRAM KP, PAKISTAN

**Izhar ULLAH, Shabir AHMAD, Sardar Azhar MAHMOOD, Said Nawaz
KHAN, Asifa KHAN, Mohammad YOUSAF**

Department of Zoology, Hazara University Mansehra, Pakistan

The current study investigated spiders (Arachnida: Araneae) Fauna in the Battagram District from March to November of 2022. All around up to 900 spider specimens were collected by using a variety of methods, such as the use of bark pitfall traps, ground pitfall traps, cryptic searching, aerial hand collection, ground hand collection, vegetation beating, and white beating sheets from 31 locations throughout the research area, and then were kept in 70% ethanol, and were then classified into 15 families, 41 genera, and 53 species using taxonomic keys of (Tikader, 1987;) and online keys on <http://araneae.nmbc.ch/>; Ali, 2017. The families that have been confirmed are Agelenidae, Araneidae, Corinnidae, Gnaphosidae, Idiopidae, Lycosidae, Pisauridae, Salticidae, Sparassidae, Palpimanidae, Pholcidae, Tetragnathidae, Theridiidae, Thomisidae, Oxyopidae. From the research area, all species have been discovered for the first time; however, *Aculepeira carbonaria*, *Agelena orientalis*, *Allagelena gracilens*, *Araniella inconspicua*, *Agalenatea redii*, *Araniella proxima*, *Araneus angulatus*, *Araniella opisthographa*, *Bassaniodes bufo*, *Cambalida flavipes*, *Drassyllus lutetianus*, , *Gnaphosa leporina*, *Histoipona torpida*, *Heriaeus simoni*, *Langona aperta*, *Palpimanus gibbulus*, *Parasyrisca schenkeli*, *Pardosa bifasciata*, *Pisaura mirabilis*, *Tegenaria lapicidinarum*, *Tegenaria silvestris*, *Thyene calebi*, *Xysticus bifasciatus* and *Xysticus ferrugineus*, for the first time from Pakistan. The Araneidae family was the most prevalent family with 13 species classified under 9 genera; the least number of species reported belonged to the Palpimanidae, Pisauridae, and Theridiidae families. Further investigation into the spider fauna of Battagram could potentially commence from the current study.

Keywords: *Arachnida, Araneae, Taxonomy, Fauna, Spider, Battagram.*



VIII. International Symposium-2024

PEDOLOGICAL BACKGROUND FOR EARTHWORM RESEARCH IN THE GÖDÖLLŐ HILLSIDE

Zita ZSEMBERY¹, Dorottya PUJSZ²

¹*Herman Otto Institute, Budapest, Hungary. zita.zsebery@gmail.com*

²*Hungarian University of Agriculture and Life Sciences, Institute for Wildlife
Management and Nature Conservation, Gödöllő, Hungary.
[pujsh.dorottya.timea@gmail.com](mailto:pujsz.dorottya.timea@gmail.com)*

Earthworms are considered ecosystem engineers because they produce macropores, enrich soils with nutrients, and help soil structure formation, etc. thus affecting soil properties tremendously. Earthworms play an important role in soil formation processes and provide many ecosystem services. The research aims to provide background information for earthworm research in the Gödöllő Hillside. We hypothesize that steep slopes affect earthworm abundance due to the loss of soil and nutrients at the upper third of the slopes and accumulation at the bottom of the slopes. Furthermore, soil moisture is expected to be higher at the bottom than at the top of the slopes. This means more possibilities for plant growth and thus organic plant materials that provide more food and better habitats for earthworms. Soil properties were measured by a Near Infrared Device. Most of the measured properties did not prove our hypothesis. The phosphorous and soil moisture content is higher at the bottom of the slope but other properties are higher at the top. The next step is to examine the number of earthworms and the diversity of the earthworm species to find out if there are any differences due to the slope sections.

Keywords: invertebrates, protected natural area, soil properties,



VIII. International Symposium-2024

EXPLORING THE PHENOLIC COMPOSITION AND SENSORY CHARACTERISTICS OF OLIVE OILS FROM MINOR CULTIVARS IN TUNISIA

Amal OMRI¹, Sofiane ABDELHAMID¹, Mohamed AYADI¹, Cinzia BENINCASA²

¹*Olive Tree Institute, Rue de l'Aéroport, Sfax, Tunisia.*

²*CREA Research Centre for Olive, Fruit and Citrus Crops - via Li Rocchi, Rende CS, Italy.*

Extra virgin olive oil (EVOO) stands as a fundamental element of the Mediterranean diet, for its numerous health benefits. Tunisia, as the second-largest producer of olive oil after the European Community, boasts a diverse varietal heritage with an extensive array of cultivars, numbering up to 200. This study aims to highlight the value of six minor cultivars within this diverse landscape which are Adheffou, Boudaoud, Chemlali chouamekh, Fougi Gtar, Rkhami and Zarrazi Gtar. Evaluating the quality of olive oil derived from these cultivars entails a dual approach, focusing on phenolic composition as physicochemical parameter, and organoleptic characteristics defined through sensory analysis by expert panel. By emphasizing these lesser-known cultivars, the research aims to shed light on their potential contributions to the olive oil industry and the culinary landscape. Understanding the phenolic composition of these oils provides insights into their antioxidant properties and potential health benefits, contributing to the ongoing discourse surrounding the health-promoting attributes of EVOO. Ultimately, by valorizing these minor cultivars and comprehensively assessing their quality attributes, this study contributes to the preservation and promotion of Tunisia's diverse olive cultivation heritage.

Keywords: *Extra virgin olive oil, phenolic compounds, sensory analysis, olive quality*

Biography



Amal OMRI, she is Dr. Eng. in agronomic sciences and environment, graduated from Higher Institute of Agronomy of Chott Mariem, University of Sousse, Tunisia.

Expert on olive oil tasting.

Postdoctoral researcher at the National Engineering School of Sfax and the Olive Institute, Tunisia, as part of the project "Smart Irrigation Management: A Case Study of Olive Trees."



VIII. International Symposium-2024

AN INNOVATIVE APPROACH OF BIOREMEDIATION IN ENZYMATIC DEGRADATION OF XENOBIOTICS

Hosam E.A.F. BAYOUMI HAMUDA

*Obuda University, Rejto Sandor Faculty of Light Industry and Environmental Engineering, Institute of Environmental Engineering and Natural Sciences, Budapest, Hungary. Bayoumi.hosam@uni-obuda.hu, +36303900813
ORCID ID: <https://orcid.org/0000-0001-7556-3447>*

A fundamental challenge for the protection of agricultural productivity and trade in many countries is to confirm the absence of exotic pests and pathogens in arriving or departing cargo consignments. The volume and movement of agricultural goods is increasing rapidly but, although biosecurity regulations require inspections, costs and practicalities limit the extent of sampling and testing. Some organic pollutants enter the agricultural sector as crop protectant from microorganisms and other pests. Xenobiotics are organic compounds of synthetic origin, usually used for domestic, agricultural, and industrial purposes; in the environment, they are present in micropollutant concentrations and high concentrations. Xenobiotics can be categorized according to different criteria, including their nature, uses, physical state, and pathophysiological effects. Globally, environmental pollution due to applications of pesticides and complex mixture of xenobiotic pollutants has become a serious problem. Apart from these compounds are mostly carcinogenic posing health hazards, which persist over a long period of time and are understood to be the alien for biosphere, which do not easily degrade in the environment. Biodegradation/biotransformation is one of the cost-effective method that helps to remove these pollutants from the environment by microorganisms. Microbial metabolic pathways have been found in diversity of microbes that are responsible for the transformation of xenobiotics. Biotransformation of xenobiotics in the natural environment has been studied to understand the microbial ecology, physiology, and evolution for their potential in bioremediation. Prolonged exposure to even low concentrations may have toxic, mutagenic, or teratogenic effects. Wastewater treatment plants that are ineffective at minimizing the release of xenobiotic pollutants are one of the main sources of xenobiotics in the environment. To minimize the negative impacts, various laws and regulations have been adopted in the EU and across the globe, with an emphasis on xenobiotics removal from the environment, in a way that is economically, environmentally, and socially acceptable, and will not result in their accumulation, or creation of compounds that are more harmful. Particular attention should be devoted to the class of xenobiotics and the enzymes such as cytochrome P450, dehydrogenase, laccase, hydrolase, protease, lipase, etc. capable of converting these pollutants into innocuous products. This study attempts to deliver knowledge on the role of various enzymes in the biodegradation of some xenobiotic pollutants. For rapid detection of biodegrading, cultural

media were used to detect the influences of some pesticides on the growth of different soil useful microbiomes. Finally, the results indicated that Some species of *Pseudomonas*, *Bacillus* and *Trichoderma* can transform the applied xenobiotics enzymatically to useful energetic compounds used by the tested microorganisms for their growth and development. Further investigations are needed to detect the processes of biogradation.

Keywords: biodegradation; environmental pollution; microbial enzymes; xenobiotic pollutants

Biography



to

Currently, Prof. Dr. Hosam Bayoumi Hamuda is working at Óbuda University, Faculty of Light Industry and Environmental Engineering, Institute of Environmental Engineering and Natural Sciences (Budapest, Hungary). He was Senior Researcher and Deputy Director of Research Group for Environmental Microbiology of Hungarian Academy of Sciences (Gödöllő University of Agricultural Sciences, Faculty of Agricultural Sciences, Szent István University (Budapest). Briefly, He received the degrees of B.Sc. (Chemistry and Botany), M.Sc. (Biological Sciences), University Doctor (Agricultural Sciences-Soil Microbiology) and C.Sc. in Biological Sciences from Garyounis University, Benghazi, Libya, Gödöllő. University of Agricultural Sciences and Hungarian Academy of Sciences, Budapest, Hungary, respectively. Also, he received the PhD in Biological Sciences, Doctor Habilitation Degree in Environmental Sciences as well as the Professor degree from Szent István University (Gödöllő, Hungary). Also, University Doctor Degree in Natural Sciences from Eötvös Loránd University (Budapest). Prof. Hamuda was awarded many times from different organisations, e.g., the Society of Hungarian Microbiologists (MMT), the Hungarian Professors Council, etc. and he is a member of many Hungarian and International Organisations. Prof. Hamuda was the general secretary and now is the president of International Council of Environmental Engineering Education (ICEEE) originated since 2010 (Budapest, Hungary) and Member of the International Society of Development and Sustainability (Japan), Society of MMT, Soil Science and Agrochemistry Committee of the Agricultural Sciences Department of IV of the Hungarian Academy of Sciences (Budapest) and Association of Hungarian Medical Societies (MOTESZ) and others. He was the director of MSc program titled: Microbial Science and Biotechnology (Szent István University, Gödöllő, Hungary) from 2000 to 2008 and Director of PhD Program titled: Agricultural-, Environmental Microbiology and Soil Biotechnology until from 2007 to 2015 and now a member of the Environmental Sciences Doctor's School at Szent István University and Doctoral School on Materials Sciences and Technologies at Óbuda University. Prof. Dr. Bayoumi Hamuda is acting as editorial member, reviewer of many international journals, and he organize many international conferences and symposiums. He delivered more than 100 plenary and keynote lectures in international events and a member of scientific committee of more than 100 conferences. He is the editor in chair of more than 15 Proceedings Books of International Conferences.

Research Interest: Prof. Dr. Hosam Bayoumi Hamuda is an Environmental Microbiologist and Soil Biotechnologist dealing with: Waste and wastewater management. Rhizosphere index, soil microbial biomass and enzymatic activities. Soil Biotechnology, soil health and soil biodiversity. Soil security, biocontrol and biofertilizers. microbial inoculants. Colonization of Plant Growth-Promoting Rhizomicrobiota (PGPR). PGPR microbial inoculants in rhizosphere. Nitrification inhibitors and crop quality. Monitoring of soil organic matter. Econanotoxicology. Roles of engineered metal oxide nanoparticles in soi. Public health and health care. Bioengineering and Environmental Health. Probiotics, antibiotics, xenobiotics, and human gut microbiomes. Impacts of xenobiotics: pesticides and other pollutants on soil biological activities. Climatic changes and global security.



VIII. International Symposium-2024

COMPARING SOIL PROPERTIES OF NATURAL AND ARABLE AREAS COMPARING SOIL PROPERTIES OF NATURAL AND ARABLE AREAS

Zita ZSEMBERY

Herman Otto Institute, Budapest, Hungary. eryl@gmail.com

Arable farming starts with deforestation or tillage of grasslands. Soil properties suffer tremendous changes in these cases. Since soil is the major natural resource of food production and many ecosystem services, evaluation of its change is crucial for the survival of humans. The purpose of the research is to provide some insight into the changes through the comparison of soil properties of some arable fields and nearby semi-natural areas. Soil properties were measured by a Near Infrared Device. The results prove that some soil properties, e.g. soil organic matter, N- and P-content, pH, etc. can be significantly different between the two examined land use types. Based on the evaluation, we can conclude that besides significant differences there are also similarities, so the hypothesis regarding the changes does not occur to all the soil properties necessarily. The search for finding the reasons behind the causal linkage is exciting.

Keywords: *intensive agriculture, nature conservation, soil change, soil quality, natural areas*



VIII. International Symposium-2024

EFFECT MORINGA OLEIFERA LEAVES ON AEROMONAS HYDROPHILA INFECTED COMMON CARP

REETU¹, Rahul KUMAR²

*¹Department of Zoology, College of Basic Sciences & Humanities, Chaudhary Charan Singh
Haryana Agricultural University, Hisar, Haryana, India;*

*²Zoology, Chaudhary Charan Singh Haryana Agricultural University, College of
Agriculture, Bawal, Rewari, Haryana, India.
rdmsczoochau07@gmail.com*

Fish diseases are a big concern, and in this bacterial disease cause high economic losses to farmers. The gram-negative bacterium *Aeromonas hydrophila* causes infections in fish that have a high fatality rate and present with systemic symptoms, ulcers, fin rot, and hemorrhages. Nonetheless, employing several medicinal herbs might help treat their ailment. Historically, antibacterial illnesses in humans and other animals have been treated with medicinal plants. *Moringa oleifera* leaves are one of them; their possible effects on a variety of creatures, including fish, have been researched. The iron, flavonoids, polyphenols, and vitamins like B12 are found in *Moringa* leaves, helping to reduce the infection caused by *A. hydrophila* by altering the hematological parameters. Common carp with *A. hydrophila* infections were seen to recover in experiments. It was concluded that *M. oleifera* have antibacterial to cure the infection in Common carp.

Keywords: *antibacterial, medicinal, hemorrhages, hematological parameters*



VIII. International Symposium-2024

DETERMINATION OF THE VOLATILE PROFILE OF SIX ENDEMIC PLANTS FROM THE BISKRA REGION (ALGERIA)

Malika BARKAT, Nassim ZOUAOU

*Department of Biotechnology, INATAA, UFMCI, Constantine, Algeria.
barkat.malika@umc.edu.dz, +213664983306*

Currently, there is a growing interest in the secondary metabolites present in plants as tools to enhance the sensory attributes of certain food products. Indeed, these attributes are often linked to volatile organic compounds (VOCs). These compounds are relatively simple and low molecular weight. At high vapor pressure, they occur in relatively high concentration in the gas phase. The most appropriate and advantageous technique is therefore HS-SPME (HeadSpace-Solid Phase MicroExtraction) coupled with GC-MS (Gas Chromatography-Mass Spectrometry). In this context, the volatile profile of six endemic plants from the Biskra region (*T. algeriensis* L., *A. campestris* L., *J. phoenicea* L., *T. polium* L., *A. herba-alba* Asso, and *R. officinalis* L.) was analysed. The HS-SPME analysis method coupled with GC-MS used is equipped with a carboxen/polydimethylsiloxane (CAB/PDMS, 75 μ m) fiber. After extraction (30 min), the needle of the manual HS-SPME holder was directly injected into the GC-MS. Desorption of the volatile compounds was performed in splitless mode. Identification of VOCs was carried out using the SHIMADZU GC17A/GC MS – QP 5050 system. The column used is a capillary type of HP-INNOWAX (60 m $\times$ 0.25 mm $\times$ 0.25 μ m) traversed by a helium flow set at a linear velocity of 0.9 ml/min. Spectra were recorded in the *m/z* range from 33 to 350 in scan mode. VOCs were identified by comparing their mass spectra with data from the integrated WILEY 7 and NIST 08 libraries. A total of 91 VOCs were identified, with 50 for *J. phoenicea*, 42 for *T. polium*, 41 for *A. herba-alba*, 39 for *T. algeriensis*, 37 for *A. campestris*, and 35 for *R. officinalis*. Sesquiterpenes and monoterpenes are among the most dominant volatile organic compounds in *A. campestris*, *R. officinalis*, *J. phoenicea*, and *T. algeriensis*. *T. polium* was found to be rich in sesquiterpenes and monoterpene ketones. *A. herba-alba* was found to be rich in monoterpene ketones. However, some VOCs are revealed in low quantities in certain species or virtually absent in others.

Keywords: *volatile organic compounds, HS-SPME, GC-MS, endemic plants*

Biography



Malika Barkat is a teacher-researcher at the Institute of Nutrition, Food, and Agri-Food Technologies at Constantine1, Frères Mentouri University in Algeria. She is an author and co-author of several articles and has supervised numerous doctoral, master's, and bachelor's theses in food science. Currently, she serves as the head of the biotechnology department.



Session (C):
Air, Water & Sediments Pollution and
Waste Management



VIII. International Symposium-2024

ANALYSIS ON LOW TEMPERATURE SYNTHESIS OF NANO ALPHA ALUMINA POWDER WITH TWO-STEP HYDROLYSIS

Rahele Khosravi NESIANI¹, Meysam NASERI²

¹*Sahand University of Technology, Tabriz, Iran. r.khosravi66esf@gmail.com,
<https://orcid.org/0000-0001-7481-2974>*

²*Amirkabir University of Technology, Tehran, Iran. Meysam.naseri94@gmail.com,
<https://orcid.org/0000-0002-1005-1886>*

Motivation/Background: Aluminium oxide (or Aluminium(III) oxide) is a chemical compound of aluminium and oxygen with the chemical formula Al_2O_3 . It is the most commonly occurring of several aluminium oxides and specifically identified as aluminium oxide. It is commonly called alumina and may also be called aloxide, aloxite, or alundum in various forms and applications. It occurs naturally in its crystalline polymorphic phase α - Al_2O_3 as the mineral corundum, varieties of which form the precious gemstones ruby and sapphire. Al_2O_3 is significant in its use to produce aluminium metal, as an abrasive owing to its hardness, and as a refractory material owing to its high melting point. Corundum is the most common naturally occurring crystalline form of aluminium oxide. Rubies and sapphires are gem-quality forms of corundum, which owe their characteristic colours to trace impurities. Rubies are given their characteristic deep red colour and their laser qualities by traces of chromium. Sapphires come in different colours given by various other impurities, such as iron and titanium. An extremely rare δ form occurs as the mineral deltalumite. **Method** The ultral fine alpha-alumina powder has been successfully synthesized via two-step hydrolysis of aluminum isopropoxide. Glucose and polyvinyl pyrrolidone were used as surfactants during the appropriate processing step. The alpha-alumina powder was used as seed particles. Several synthesis parameters, such as the amount of seeds, surfactants, and calcination temperature, were studied by X-ray diffraction (XRD), Fourier transform infrared spectra (FTIR), Thermogravimetry-differential scanning calorimetry (TG-DSC), scanning electron microscopy (SEM) and transmission electron microscopy (TEM). **Results:** The experimental results showed that glucose greatly lower the phase transformation temperature of alpha-alumina by impelling the gamma-alumina transformed to alpha-alumina directly, and the seed could improve the phase transformation rate of alpha-alumina, the polyvinylpyrrolidone influence preventing excessive grain growth and agglomeration of alpha-alumina powder. Comparatively well dispersed alpha-alumina powder with particle size less than 50 nm can be synthesized through this method after calcinations at 1000 °C for 2 h.

Keywords: Oxide, Chemical synthesis, Phase transitions, X-ray diffraction, Nanostructures.



VIII. International Symposium-2024

DRIVING CIRCULAR ECONOMY THROUGH WASTE VALORIZATION: A CASE STUDY OF TEXTILE (BIO)DYES

Filipa Duque FONSECA^{1,2,3,4}, M. Nazaré Coelho PINHEIRO^{1,2,3,4}

¹*Polytechnic Institute of Coimbra (IPC), Coimbra Institute of Engineering (ISEC),
Department of Chemical and Biological Engineering, Coimbra, Portugal.*

²*CEFT - Transport Phenomena Research Center, Faculty of Engineering (FEUP),
University of Porto, Porto, Portugal.*

³*SISus - Laboratory of Sustainable Industrial Systems, Instituto Superior de Engenharia de
Coimbra, Coimbra, Portugal.*

⁴*CERNAS - Research Centre for Natural Resources, Environment and Society, Escola
Superior Agrária de Coimbra, Coimbra, Portugal.*

ffonseca@isec.pt ; mnazare@isec.pt

The environmental impact of the textile industry stems from the excessive use of water and chemicals, especially in dyeing, leading to pollution, deforestation and climate change. Waste valorization is a key driver in the transition to a circular economy, where materials previously considered waste are transformed into valuable resources. Embracing this sustainable option for agricultural or industrial by-products/wastes is crucial for fostering responsible industrial practices. Onion peel is a rich source of bioactive compounds, emerging as a promising source of natural dyes and is presented as a case study of waste valorization with the extraction of natural pigments to be used as (bio)colorants in textiles. The extraction of pigments from red onion (*Allium cepa* L.) was carried out by solid-liquid extraction using boiling water, under stirring for 5 minutes. The solution obtained, after being filtered and centrifuged, was used to dye three different fabrics (organic cotton, cationized cotton, and wool). The textile samples were immersed in the extract at 50°C with agitation for 100 minutes. After dyeing, various tests were conducted to assess color fastness of the dyed textile samples (cold and hot water washing and exposure to natural light) preceding the evaluation of color in the textile samples. The dyed textile samples showed a uniform and noticeable brown/beige coloration, with the color being more pronounced in the cationized cotton textile sample, indicating that this textile substrate fixes the dye better. A mordant (carbonyldiimidazole, CDI) was used to increase the affinity between the dye and the textile fiber, thus promoting its fixation. The results obtained with this mordant revealed a better color fastness, mainly in terms of light fastness. These preliminary results indicate that onion peel waste as source of bio(dyes) for the textile industry is a promising sustainable process that deserves in-depth study.

Keywords: *biodyes; circular economy; onion peel waste; waste valorization*

Biography



M. Nazaré Coelho Pinheiro, Coordinator Professor at ISEC/IPC, holds a graduation and a PhD in Chemical Engineering from FEUP. Has participated as researcher in several projects. She is author of several articles in international scientific journals and congresses. Her research interests include the transport phenomena and the development of waste recovery processes.



Filipa Duque Fonseca holds a BSc in Biological Engineering and a MSc in Chemical and Biological Engineering from ISEC/IPC. She is currently an invited assistant at ISEC/IPC and a PhD student in Chemical and Biological Engineering at FEUP. Her research interests include sustainable technologies for textile biocolouring.



VIII. International Symposium-2024

A RELATION BETWEEN EXTREME DAILY PRECIPITATION AND EXTREME SHORT-TERM PRECIPITATION

**Y.L. ROMERO¹, J. BESSEMBINDER, N.C. VAN DE GIESEN, F.H.M.
VAN DE VEN**

Beuningen, The Netherlands. p.bronkhorst8@upcmail.nl. +310648114433

The Royal Netherlands Meteorological Institute (KNMI) published the KNMI'06 Climate Scenarios in 2006. These scenarios give the possible state of the climate in The Netherlands for the next century. Projections of changes in precipitation were made for a time scale of one day. The urban drainage sector is, however, more interested in projections on shorter time scales. Specifically, time scales of one 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. Because of this analysis, one can determine a numeric factor to translate daily projections into shorter time scale projections. Eventually, this 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 has a MSc from Water Management at Delft University of Technology, The Netherlands. She is published in Climatic Change which has had numerous worldwide citations. Ms. Romero has worked as a software consultant, AutoCad drafter, advisor at diverse engineering firms and as a wastewater policy worker. She has reviewed papers for diverse journals including Theoretical and Applied Climatology. She currently attends online conferences and won the award for best young researcher at the 12th ICEEE conference. Ms. Romero resides with her husband in The Netherlands.



VIII. International Symposium-2024

TAXONOMIC OBSERVATIONS AND ENVIRONMENTAL SIGNIFICANCE OF RECENT FORAMINIFERA FROM ANTHONY'S BAY, ROATAN, NORTHEAST HONDURAS

Belkasim KHAMEISS¹, Makenna HARRIS²

¹*Kansas Geological Survey. 1930 Constant Ave. Lawrence, USA.*

²*Ritchie Hall | Earth, Energy & Environment Center, Lawrence, USA*
belkasimkahemsis@outlook.com

This research focuses on the taxonomic classification and environmental implications of recent benthic foraminifera along the coast of Anthony's Bay, Roatan, Northeast Honduras. Five sediment samples were collected from the beach at a depth of less than 1 meter. Each sample, weighing 300 grams, underwent standard processing methods to isolate foraminifera. From these samples, eleven benthic foraminifera species were identified, including *Archaias angulatus*, *Cibicidoides crebbisi*, *Lenticulina formosa*, *Peneroplis pertusus*, *Peneroplis planatus*, *Procerolagena gracilis*, *Pyrgo lucernula*, *Siphonaperta irregularis*, *Spiroloculina tenuiseptata*, *Technitella legumen*, and *Textularia agglutinans*. Additionally, one planktonic foraminifera species, *Orbulina universa*, was recorded. The most abundant species observed were *Peneroplis pertusus* and *Peneroplis planatus*. Across all five samples, a significant presence of coral fragments was noted alongside the benthic foraminifera community. Furthermore, the molluscan composition primarily comprised gastropods, with notable occurrences of bryozoans and echinoderms. The elevated abundance of coral fragments in these samples underscores a substantial ecological concern, indicating potential adverse impacts stemming from both human activities and climate change.

Keywords: climate change, Anthony's Bay, Roatan, Recent Foraminifera

Biography

*Belkasim Khameiss,
Post Doc Reseracher
Kansas Geological Survey. 1930 Constant Ave. Lawrence, KS 66047,
USA*



VIII. International Symposium-2024

BIOREMEDIATION OF WASTEWATER AND VALORIZATION OF MICROALGAE: A SUSTAINABLE SOLUTION FOR ENVIRONMENTAL AND ECONOMIC CHALLENGES

**Imane EL-BAGGAR¹, Mohammed ALAOUI MHAMDI¹, Jamila
BAHHOU¹, Salma LATIQUE^{1,2}**

¹*Laboratory of Biotechnology, Conservation and Valorization of Natural Resources, Faculty
of Sciences Dhar El Mahraz, Sidi Mohamed Ben Abdellah University, Fez, Morocco.*

²*Biomedical and Translational Research Laboratory, Faculty of Medicine, Pharmacy and
Dentistry of Fez, Sidi Mohamed Ben Abdellah University, Morocco.*

E-mail: salma.latique@uit.ac.ma

Global energy demand and environmental degradation are critical issues facing humanity, with conventional energy depletion, global warming, and water contamination being the major challenges. The reliance on fossil fuels and the high consumption of clean water, coupled with the discharge of nutrients, heavy metals, and chemicals, have led to the eutrophication and pollution of water resources worldwide.

This abstract proposes a sustainable solution that combines bioremediation of wastewater and valorization of microalgae to address these challenges. Bioremediation technologies, such as anaerobic and aerobic fermentation, activated sludge, composting, phytoremediation, and phycoremediation, utilize bacteria, microbes, plants, and algae to treat wastes and pollutants. Microalgae have emerged as a promising alternative for wastewater treatment due to their photosynthetic capabilities, high growth rates, high photosynthetic efficiency, and adaptability to different environmental conditions. They can remove organic pollutants, heavy metals, and pathogens from wastewater, while producing valuable biomasses and biomolecules, such as carotenoids, lipids, polysaccharides, proteins, amino acids, and carbohydrates. These biomolecules have various applications in food, medical supplements, cosmetics, bioenergy, and other industries, making microalgae a valuable resource for the circular economy. By integrating bioremediation and valorization of microalgae, we can address the environmental and economic challenges and promote a sustainable future for all.

Keywords: *Bioremediation technologies, environmental challenges, circular economy, microalgae*

Biography



I'm passionate about the life sciences, with expertise in biotechnology, ecology and the valorization of phytoresources. My academic career was marked by a bachelor's degree in physical sciences at Lycée Al Massira in 2018, followed by a fundamental bachelor's degree in life sciences with an option in microbial biotechnologies at the Dhar El Mehraz Faculty of Sciences in Fez, completed in 2021. I then went on to obtain a master's degree in biotechnology, ecology and phytoresource development at the same institution from 2021 to 2023. During this period, I also had the opportunity to do an internship in a research laboratory where I worked on the identification, isolation, and biochemical composition of microalgae. My passionate interest is particularly focused on microalgae biotechnology, with an emphasis on the field of phycoremediation. I am determined to explore the innovative solutions that microalgae offer to solve contemporary environmental challenges, particularly in the field of depollution and restoration of aquatic ecosystems.



VIII. International Symposium-2024

HYDROGEOCHEMICAL STUDY OF THE GROUNDWATER IN THE COASTAL AREA, NORTHEASTERN OF BENGHAZI CITY, NE LIBYA

Osama A. EL FALLAH¹, Ahmed ABUHARARA²

¹Department of Earth Sciences, Faculty of Science, Benghazi University, Benghazi, Libya;

²Department of Geology, Faculty of Science, Omar Al-Mukhtar University, Al Byada, Libya.

E-mail: osama.elfallah@uob.edu.ly

Libya is located in a semi-arid region of North Africa, faces a significant scarcity of water sources, both surface and groundwater, particularly in the northern part of the country. To confront this shortage of water sources and to preserve the environment as well as to achieve water security in Libya, surface and groundwater resources must be assessed, protected, and kept unpolluted. This study provides valuable insights into the hydrochemistry, water quality, and potential applications of groundwater resources in the coastal area northeastern of Benghazi, Libya. To understand the origin, type, and characteristics of the groundwater, as well as the relationships between different chemical variables, hydrogeochemical analyses and diagrams were employed for Six groundwater samples from the study area (S1, S2, S3, S4, S5, and S6). Additionally, Phreeqc software was utilized to determine the saturation index of the groundwater with minerals of the aquifer's rocks, the saturation index shows over saturation with respect to carbonate minerals and slightly saturated with respect to the evaporate minerals. However, the groundwater is salty, holding high concentrations of the total dissolved solids (TDS), and is dominated by Sodium and Chloride in the western part of the study area, while holding moderately concentrations of (TDS) and dominated by Bicarbonates and Chloride in the eastern part of the study area due to a response to rock weathering, water-rock interaction and seawater intrusion as they are the most natural processes that controlling chemistry and quality of the groundwater.

Keywords: Groundwater, Water Quality, Saturation Index, Hydrochemistry, Water Type, Irrigation.

Biography



Osama A. El Fallah, (Born in Benghazi-1972), Libyan nationality. I have completed M.Sc. Degree in Hydrogeology and Water Management, at Faculty of Agricultural and Environmental Sciences, Szent István University in Gödöllő Hungary, 2007. My first employment was as Mud-logger geologist in Jowfe Oil Technology Company, now I'm a staff member at earth science department, Benghazi University, Libya. My field of interest in Hydrogeology and Water Quality, I have published some papers in the field of Hydrogeology and earth science as joint papers with other colleagues. Currently, I have enrolled as PhD candidate at Department of Geology, Cairo University.



VIII. International Symposium-2024

UTILIZING AGRICULTURAL WASTE FOR EFFICIENT REMOVAL OF ORGANIC MICRO-POLLUTANTS FROM WATER AND WASTEWATER

Osamah J. AL-SAREJI^{1,2,3}, Mónika MEICZINGER¹, Ruqayah Ali GRMASHA^{2,4}, Viola SOMOGYI¹

¹*Sustainability Solutions Research Lab, Faculty of Engineering, University of Pannonia, Veszprém, Hungary.*

²*Environmental Research and Studies Center, University of Babylon, Babylon, Iraq;*

³*Research Centre of Engineering Sciences, Department of Materials Sciences and Engineering, University of Pannonia, Veszprém, Hungary.*

⁴*Research Group of Limnology, Center for Natural Science, Faculty of Engineering, University of Pannonia, Veszprém, Hungary.*

Corresponding author: osamah.al-sareji@unswalumni.com

The extensive development of technology and the rise of industrialization over the last several decades have both contributed to the emergence of water pollution as a serious environmental hazard. The removal of environmental toxins could be accomplished via the use of adsorption. Using agricultural waste as a by-product waste could be an effective method for removing toxic pollutants from aqueous matrices (water and wastewater). A comprehensive physical and chemical analysis performed on the chemically modified activated carbon that was derived from agricultural waste. Different techniques such as Fourier-transform infrared spectroscopy (FTIR), scanning electron microscopy-electron diffraction (SEM-EDX), and determination of point of zero charge (pH_{pzc}), Boehm titration, Brunauer-Emmett-Teller surface area analysis (SBET), and proximate and ultimate analysis were investigated. A range of pollutant concentrations, pH, temperature, and activated carbon dosage were tested to determine the parameters that enable the most effective removal of pollutants. In addition to that, isotherms, kinetics, and thermodynamics were also investigated. The performance of activated carbon derived from agricultural waste in constantly eliminating pollutants from water and wastewater medium was also be evaluated over several cycles.

Keywords: *Adsorption, removal, process improvement.*

Biography



Osamah is working on removing emerging pollutants. He is widely recognized at the University of Babylon and University of Pannonia for his excellent research in this area. He has published over 35 scholarly works. Currently, he is affiliated with the University of Pannoina, where he pursues his Environmental Engineering fieldwork. The topics of research include:

- Agro-industrial Waste*
- Removal of emerging pollutants*
- Adsorption and - Water and wastewater*



VIII. International Symposium-2024

DETAILED ANALYSIS AND UNDERSTANDING OF CARBON/IRON COMPOSITE MICROFIBER CATALYSTS DERIVED FROM BLOOD HEMOGLOBIN PROTEIN FOR LITHIUM-OXYGEN BATTERIES

Rahele Khosravi NESIANI¹, Meysam NASERI²

¹Sahand University of Technology, Tabriz, Iran.

r.khosravi66esf@gmail.com , <https://orcid.org/0000-0001-7481-2974>

²Amirkabir University of Technology, Tehran, Iran.

Meysam.naseri94@gmail.com , <https://orcid.org/0000-0002-1005-1886>

Motivation/Background: Hemoglobin is the protein that makes blood red. It is composed of four protein chains, two alpha chains and two beta chains, each with a ring-like heme group containing an iron atom. Oxygen binds reversibly to these iron atoms and is transported through blood. The lithium–air battery (Li–air) is a metal–air electrochemical cell or battery chemistry that uses oxidation of lithium at the anode and reduction of oxygen at the cathode to induce a current flow. Pairing lithium and ambient oxygen can theoretically lead to electrochemical cells with the highest possible specific energy. Indeed, the theoretical specific energy of a non-aqueous Li–air battery, in the charged state with Li₂O₂ product and excluding the oxygen mass, is ~40.1 MJ/kg = 11.14 kWh/kg of lithium. This is comparable to the theoretical specific energy of gasoline, ~46.8 MJ/kg. In practice, Li–air batteries with a specific energy of ~6.12 MJ/kg = 1.7 kWh/kg of lithium at the cell level have been demonstrated. This is about 5 times greater than that of a commercial lithium-ion battery and is sufficient to run a 2,000 kg electric vehicle for ~500 km (310 miles) on a single charge using 60 kg of lithium (i.e. 20.4 kWh/100 km). However, the practical power and cycle life of Li–air batteries need significant improvements before they can find a market niche. Understanding the catalyzed formation and evolution of lithium-oxide products in Li–O₂ batteries is central to the development of next-generation energy storage technology. Catalytic sites, while effective in lowering reaction barriers, often become deactivated when placed on the surface of an oxygen electrode due to passivation by solid products. Recycling of bio-waste sources for synthesis of functional electrode materials is an eco-friendly and sustainable approach to realize next-generation energy-storage systems. **Method:** In this study, we present a fabrication method of Fe/ C composite microfibers derived from electrospinning of hemoglobin blood protein, and subsequent calcination, and investigate its functionality as an oxygen electrode catalyst for Li–O₂ batteries. We elucidate the thermal decomposition behavior of raw hemoglobin protein and structural evolution after calcination at different temperatures. We successfully fabricated Fe/C composite microfibers with a uniform and flattened shape by electrospinning of a hemoglobin precursor and thermal treatment. **Results:** Finally, we demonstrated that Li–O₂ cells in which the Fe/C composite microfiber catalyst was incorporated in the oxygen electrodes exhibited improved electrochemical performance compared to a pristine reference cell without the catalyst.

Keywords: *Lithium–oxygen batteries, catalytic membrane, product morphology, nanoparticles, oxygen evolving catalyst.*



VIII. International Symposium-2024

INTERNATIONAL COOPERATION IN THE FIELD OF WATER SECURITY: KAZAKHSTAN ON THE WAYS TO STABILITY

Madina IGIBAYEVA

University of Public Service-Ludovika, Budapest, Hungary

Currently, global climate warming leads to an increase in moisture evaporation in river catchments and a decrease in inflow into rivers. There is a decrease in glacial runoff, which provides up to 50% of river runoff during the growing season. It is generally recognized that energy resources such as oil and gas are currently considered a strategic resource. Their possession allows them to exert some influence in the global economy and politics, but for the Central Asian region, water resources and their possession will play a key role soon. This is because energy resources such as oil and gas are exhaustible sources of energy, whereas water resources are renewable resources. The problem is compounded by the fact that Kazakhstan is heavily dependent on cross-border flows, as well as existing internal problems. The country belongs to the number of States that have limited water resources and are experiencing a significant shortage of them, both to meet the needs of economic sectors and to provide drinking water to the population. Most of the territory of Kazakhstan belongs to desert and semi-desert arid regions, where water supply is an extremely acute problem not only for economic activity, but also for consumption by the population. The problem of sustainable water supply in Kazakhstan and its water security is becoming acute because the most significant sources of surface waters are located on the territory of neighboring states. The country's economy requires three times more water per dollar of gross domestic product than Russia or the United States, and six times more than Australia. While maintaining the current situation of water resources use in economic sectors and by the population by 2030, there is a risk of a decrease in the pace of socio-economic development due to water scarcity.

Keywords: *Water security, Kazakhstan, Central Asia, Global warming, Water resources*

Biography



*Active participant and representative of the Republic of Kazakhstan at the Youth Atlantic Treaty Association
Certified OSCE/ODIHR Observer
Member of the Hungarian Association of Military Science
Accredited specialist by the Kazakhstan Green Building Council.
Author of the book "The role of Kazakhstan in the SCO" (Amazon-USA)
1) "The problem of Uighur separatism in the Shanghai Cooperation Organization", National Security Review: Periodical 2023/2, Budapest.*

- 2) *"Comparing the Shanghai Cooperation Organization and the Collective Security Treaty Organization"*, The „Military Science and 21 centuries” journal, 2023, Budapest, Hungary. ISSN: 2498-5228
- 3) *"Riot or regime – change attempt in Kazakhstan: the causes and consequences"* – *The Eurasia Series Regional Integration in Eurasia 2022*, Budapest, Hungary. ISSN: 2786-4081
- 4) *"Economic mobilization measures for the COVID-19 pandemic in the SCO member states"*, *A Hadtudomány és a 21. Század*, 2021, Hungary: Association of Hungarian PHD and DLA Students, Colorcom Media Kft, Budapest, Hungary. ISSN: 2498-5228
- 5) *"Implementing the Belt and Road Initiative in Kazakhstan"*- *A haza szolgálatában: Konferenciakötet 2019 Bp*, Hungary: Association of Hungarian PHD and DLA Students (2020).
- 6) *"The twenty-year-old Shanghai Cooperation Organization. Security, Economic and Cultural Cooperation"*- *A haza szolgálatában Bp*, Hungary: Association of Hungarian PHD and DLA Students (2021). *National Security Journal*, Issue 2021/1, Budapest. ISBN: 978-615-5586-94-1
- 7) *"The Shanghai Cooperation Organization 20th anniversary summit meeting- Challenges and Prospects"*, - *A haza szolgálatában: Konferenciakötet 2021 Bp*, Hungary: Association of Hungarian PHD and DLA Students 2022. 3-4 Budapest, Hungary. ISBN: 978-615-82054-9-8
- 8) *"Extremism in the Central Asian countries and the Shanghai Cooperation Organization"*, *A Hadtudomány és a 21. Sz. 2020 Bp*, Hungary: DOSZ Hadtudományi Osztály. *National Security Journal*, Issue 2020/1, Budapest. ISSN 2498-5228
- 9) *"China and Kazakhstan relationships at Shanghai Cooperation Organization"* – In: *The Fourth Republic scientific – practical conference for young scholars "Young Scientists: Dialogue of the Science and the Education"*. Almati, Алматы, Kazakhstan: Kazakh Abylai Khan University of International Relations and World Languages (2017)
- 10) *"The Government of Kazakhstan & Its migration policy: to deal with the problem"* – *Chinese scientific journal (in Chinese)*, pp. 31-35., 5 p. (2016) Volume 23, Country: China.



VIII. International Symposium-2024

THE IMPACT OF ANTHROPOGENIC ACTIVITY ON WATER QUALITY IN THE SANHADJA WETLAND COMPLEX (NORTHEASTERN ALGERIA)

Sihem HEDJAL¹, Abdelwaheb BENAMARA²

¹Department of Geological Sciences, Frères Mentouri Constantine-I University, Algeria;

²Faculty of Science and Technology, Department of Civil Engineering, Ziane Achour Djelfa University, Algeria.

benamara.abdelwaheb@yahooho.fr

The present study focuses on evaluating the impact of anthropogenic activity on the quality of surface water. It is based on the results of physico-chemical analyses conducted in 2016. The analyses of surface water reveal the predominance of bicarbonate-magnesium and chloride-magnesium facies, as well as naturally high levels of chlorides, bicarbonates, and magnesium. However, these waters exhibit significant concentrations of sulfates, calcium, and sodium, indicative of good water quality. Surface water has been affected by pollution resulting from high concentrations of organic matter, which has altered their quality in terms of phosphates, ammoniums, and nitrites. These waters are classified into three levels of quality (good, fair, and poor). As for nitrates, most surface waters maintained good quality throughout the sampling period.

Keywords: water quality, impact, surface water, nitrates, anthropogenic activity

Biography

DAIFALLAH.T.2017. *Ressources en eau et leurs utilisations dans le bassin versant de l'Oued Kébir Ouest [Nord Est algérien]. These de doctorat en science, Université*

Badji Mokhtar Annaba, Département de Géologie. 170 Pages

HEDJAL. S., ZOUINI. D., BENAMARA. ABD.W., DANDANE. H. 2017.a. *Ressources en eaux et protection des zones humides du complexe de Sanhadja [Nord-est algérien]. International Symposium: Water Resources and Environmental*

Impact Assessment in North Africa March 24- 26, 2017- Gafsa, Tunisia

HEDJAL. S., ZOUINI. D., BENAMARA ABD.W., DANDANE. H. 2018.a.

Evaluation of the organic pollution index in the surface waters of the complex of wetlands of Sanhadja [North-east Algeria]. International Water Forum March 19-21, 2018 Hammamet, Tunisia.

HEDJAL. S., ZOUINI. D., BENAMARA ABD.W., DANDANE. H. 2018.b.

Hydrochemical assessment of water quality for irrigation: A case study of the wetland complex of Sanhadja [North-East of Algeria]. Journal of Water and Land Development. No. 38 p. 43–52. DOI: 10.2478/jwld-2018-0041.



VIII. International Symposium-2024

FACTORS AFFECTING MARKET ORIENTATION OF RICE FARMERS IN EKITI STATE, NIGERIA

**Felicia Itunu WOLE-ALO*, Bosede Olufunmilayo AKINWALERE, Gbolade Evelyn
AGBOMUSERIN, Abosede ADESOLA**

Department of Agricultural Extension and Communication Technology, Federal University of
Technology, Akure, Nigeria

Corresponding Emails: fiwolealo@futa.edu.ng*, evelyngbolade@gmail.com

Rice became a critical component of the Nigerian household diet and on the other side, a major consumer of the country's foreign exchange as the imported rice is preferred to the local rice. We have different types of rice that grow very well in different states in Nigeria and yet, Nigeria government has yet to harness these potentials to boost local rice production despite its nutritious quality, so this study examined the factors affecting market orientation of 110 rice farmers in Ekiti state, Nigeria. A total number of 110 rice farmers was purposively selected for the study using the multi-stage sampling technique. Data were analysed using descriptive statistics such as frequency, percentage, mean statistics etc. Result showed that only 6.3% of the respondents attempted and completed tertiary education. The major factors that affect market orientation were price fixing ($\bar{x}$ = 1.95), financial performance ($\bar{x}$ = 1.94), customer's preferences ($\bar{x}$ = 1.89), distribution channels ($\bar{x}$ = 1.88) and variety selection ($\bar{x}$ = 1.81). It was concluded the market orientation of the farmers is very low and this is due to the low educational level as it takes a certain level of educational exposure and knowledge to make business decisions that would guide an individual in meeting different consumer's needs and demands to help build strong relationship with consumers, ensuring repeat business and market loyalty. Hence, it was recommended that the rice farmers need to be educated on business marketing.

Keywords: *Rice Farmers, Market Orientation, Consumers*



VIII. International Symposium-2024

FACTORS AFFECTING CONSUMERS ATTITUDE TOWARDS LOCAL RICE PRODUCTION AND CONSUMPTION IN OGUN STATE, NIGERIA

Felicia Itunu WOLE-ALO*, Gbolade Evelyn AGBOMUSERIN, Matthew Olalekan IYANDA

Department of Agricultural Extension and Communication Technology, Federal University of Technology, Akure, Nigeria

Corresponding Emails: fiwolealo@futa.edu.ng, evelyngbolade@gmail.com

Rice is a staple food in many parts of the world, including Nigeria. The demand for rice in Nigeria is increasing due to population growth and urbanization but the local rice popularly known as ‘Ofada rice’ is less preferred among consumers for imported rice, so the study identified the factors affecting consumers’ attitude towards local rice production and consumption in Ogun state. A multi-stage random sampling was employed to generate primary data with the aid of well-structured questionnaire and a total of 108 respondents were selected for the study. Data were analysed using descriptive statistics such as frequency, percentage, mean statistics etc.

The major factors influencing the attitudes were low price of local rice ($\bar{x}=3.72$), its rich quality ($\bar{x}=3.70$) and its freshness ($\bar{x}=3.17$). It was also discovered that the respondents have positive perception ($\bar{x}=2.89$) towards local rice because its freshness and nutritious quality. Further results also showed that there is a moderate level of consumption (66.0%) of local rice in the study areas due to its taste compared to the imported rice, suggesting that it is already a staple food in the study area. Issues like stones in local rice ($\bar{x}=3.65$) and negative experience such as lower flavour ($\bar{x}=3.37$) were the major issues that affects the consumption of local rice. In conclusion, it was recommended that quality control mechanisms should be put in place to ensure that local rice meets high standards for texture, taste, and cooking consistency.

Keywords: *Local Rice, Attitudes, Barriers, Perception*



VIII. International Symposium-2024

MUNICIPAL SOLID WASTE MANAGEMENT. ANALYSIS AND COMPARISON OF PRACTICES IN FINLAND AND THE REPUBLIC OF MOLDOVA

Eva Lota CIUGANSCHI

*Tampere University of Applied Sciences, Tampere, Finland.
eva.ciuganschi@gmail.com, +358403635591*

The scope of this research is to present to the public knowledge the types of municipal solid waste (MSW), as well as ways of management of each type. It reflects the analysis of management methods practiced nowadays, such as recycling, composting, landfilling and Waste-to-Energy method. As a study case, a comparative study case is initiated on the present practices of MSW management in Finland and in the Republic of Moldova. The outcome of the comparison reflects the benefits of waste-to-energy incineration plants towards the landfilling which is the main MSW treatment in Moldova. Based on the specific example of Combined Heat and Power (CHP) incineration plant in Lahti, Finland - Kymijärvi II power plant – it is emphasized the importance for Moldova to switch from landfilling to waste-to-energy technology that benefits both the environment and the recovery of energy that can be used by the citizens. Even if the financial and technological investment is overwhelming in the initial stage, it should be still considered for the sake of long-term benefits that landfilling is incapable of offering. The comparative study case proves that starting from the 10% of electricity generation efficiency in an incineration power plant, it can be already noticed that the incineration system produces from up to 6 times more energy than the landfill system. Since the non-recyclable waste is being combusted and taken advantage of, it helps to switch the focus from the utilization of natural resources, and it contributes to building up circularity between waste and production of new energy.

Keywords: *incineration plant, landfill, municipal solid waste treatment*

Biography



Environmental Engineering Bachelor third-year student. Environmental management is the future intelligent business that can satisfy both human financial eager and ecosystem restoration. The environment can be turned into a suitable engine for both prosperous business and nature rehabilitation. I am here to support the new world.



VIII. International Symposium-2024

DELEGATED PUBLIC DRINKING WATER SERVICES IN THE MUNICIPALITY OF DASSA-ZOUME (BENIN)

Leocadie ODOULAMI, Rene AYEMAN ZODEKON

*Laboratoire Pierre PAGNEY, Climat, Eau, Ecosystème et Développement (LACEEDE)
DGAT/FASHS/ Université d'Abomey-Calavi (UAC), Cotonou, République du Bénin
leocadieo@yahoo.com; Tel. +229 95960784/94608270*

The delegation of water services is one of the alternative methods used by the inhabitants of Dassa-Zoumé municipality to access drinkable water supply networks. But this water technic services have in front of some irregularities. This research analyzes the functioning of modes of water services delegation in this commune.

The documentation on the water management services was done in many services and libraries in Benin. Also, 50 delegates (public and private) of the corporation, 50 households from user associations and 10 resource persons were selected in the commune. The data collected were treated with empirical methods.

The results show that 298 and 9 Village Water Supply are delegated to public and private operators of the commune or out. But, concerning the Drilling Pomp with Human Power, it made to private operators through the leasing contract. Those contractors must pay monthly 5,000 F CFA or 7.62 Euros. This activity generates significant profit to the delegate.

The delegation of the water service is confronted with structural problems such as, the lack of intervention of the private sector in the field, the ignorance of the logical framework of intervention of the actors, the vagueness maintained in the granting of the market to the private one which no longer obliges the delegate to properly complete their specifications. A situation which explains the high cost of water to users. This way of managing the water service is an opportunity for its sustainability.

Keywords: *Bénin (West Africa), Dassa-Zoumé commune, water services, drinkable water*

Biography



Mrs. ODOULAMI Léocadie, Doctor of Geography, Full Professor of universities (CAMES). Specialist: Water, Hygiene, sanitation and Helth; Environment management, Teacher-researcher at Departement de Géographie et Aménagement du Territoire (DGAT)/FASHS, Université d'Abomey-Calavi (UAC), Member of Laboratory Pierre PAGNEY, Climat, Eau, Ecosystème et Développement (LACEEDE)



VIII. International Symposium-2024

THE CURRENT STATUS OF POLYCYCLIC AROMATIC HYDROCARBONS (PAHS) POLLUTION IN LAKE BALATON SEDIMENT, HUNGARY

Ruqayah Ali GRMASHA^{1,2,3,4}, Osamah J. AL-SAREJI^{1,2,4}, Mónika MEICZINGER¹, Csilla STENGER-KOVÁCS^{3,5}

¹*Sustainability Solutions Research Lab, Faculty of Engineering, University of Pannonia, Veszprém, Hungary.*

²*Environmental Research and Studies Center, University of Babylon, Babylon, Al-Hillah, Iraq.*

³*University of Pannonia, Faculty of Engineering, Center for Natural Science, Research Group of Limnology, Veszprem, Hungary.*

⁴*The School of Civil and Environmental Engineering graduate, University of New South Wales, Sydney, Kensington, Australia;* ⁵*HUN-REN-PE Limnoecology Research Group Veszprém, Hungary.*

Corresponding: Ruqayah Ali Grmasha, E-mail: ruqayah.grmasha@unswalumi.com

Several locations in the of Lake Balaton were investigated with the purpose of analyzing the temporal and geographical fluctuations of sixteen polycyclic aromatic hydrocarbons (PAHs). According to the findings, the concentrations of PAHs in sediment were found to be very high during the winter months, ranging from 448.35 to 619.77 ng/g dry weight, and low during the summer months, ranging from 257.21 to 465.49 ng/g dry weight. High molecular weight polycyclic aromatic hydrocarbons (HMWPAHs), which had between five and six rings, had a higher concentration than low molecular weight polycyclic aromatic hydrocarbons (LMWPAHs), which had between two and three rings. During each of the four seasons, the total incremental lifetime cancer risk (ILCR) for both cutaneous and ingestion routes was high for both adults and children. The highest records were recorded during the winter season, followed by the spring season, the summer season, and finally the autumn season. More attention needs to be taken in terms of pollution mitigation strategies in Lake Balaton.

Keywords: *Sediment, pollution, Seasonal variation*

Biography



Ruqayah is a researcher in the field of Environmental engineering. Her research focuses on: - Polycyclic aromatic hydrocarbons (PAHs), - Removal of pollutants from water, - Health risk assessment, and- Dust contamination, - Particulate matter (PM)



VIII. International Symposium-2024

WATER INSECURITY IN THE CITY OF MYKOLAIV UNDER WARTIME CONDITIONS

Olena MITRYASOVA, Oleksandra KOVALSKA

Petro Mohyla Black Sea National University, Mykolaiv, Ukraine.

E-mail: alexandraschwarz2313@gmail.com

The impact of armed conflict on water systems is particularly relevant to human security, as it can negatively affect other basic needs, such as clean water, public health and basic hygiene and sanitation. The purpose of the study is to investigate the level of water insecurity in the city of Mykolaiv. Due to the Russian aggression, a water pipeline was damaged on 12 April 2022, supplying water from the Dnipro River in Kherson Oblast to Mykolaiv. The Mykolaiv region has the lowest drinking groundwater reserves (about 98 liters per person per day). Mykolaiv was left without a sustainable centralized water supply system. Over time, it was decided to temporarily connect to the intake of industrial water from the Bug Lyman. The quality of water supplied to Mykolaiv's centralized water supply system exceeds the standards for chlorides, sulphates, suspended solids, hardness, etc. Water supply from the Lyman leads to negative consequences. The high salt content in the water leads to the rapid destruction of the water supply system itself.

To study the level of water insecurity, the method of questioning the city's population was used. The questionnaire was based on the study "The Household Water Insecurity Experiences (HWISE) Scale: comparison scores from 27 sites in 22 countries". The questionnaire included questions aimed at determining the frequency of situations related to water use risk.

To determine the level of water insecurity, the total number of answers "very often", "not often", "occasionally" and "never" were analyzed. The percentage of answers "very often" was 40%, so it can be determined that the level of water insecurity in Mykolaiv is average. To ensure sustainable water supply in the city in the context of armed conflicts and emergencies, there is an urgent need to form a new water service system by increasing the number of decentralized water supply sources and creating a reserve reservoir as a strategic water reserve for the city. There is also an urgent need to educate the population on water conservation measures.

Keywords: *environmental security, water security, water supply, water resources, decentralized water supply system.*

Biography



Oleksandra Kovalska

I am a PhD student of the Ecology Department

Petro Mohyla Black Sea National University, Mykolaiv, Ukraine

ORCID ID: <https://orcid.org/0009-0008-7173-2563>

e-mail: alexandraschwarz2313@gmail.com



VIII. International Symposium-2024

THE STATUS OF THE SURFACE WATERS OF THE BUZKY ESTUARY WITHIN MYKOLAIV CITY: PRE-WAR AND WARTIME PERIODS

Olena MITRYASOVA, Viktor SMYRNOV, Andrii MATS

Petro Mohyla Black Sea National University, Mykolaiv, Ukraine.

E-mail: lesya.solis28@gmail.com, +380952880479

The object of the research is the water problem of the city during military operations and surface waters within the Mykolaiv city, namely the waters of the Buzky Estuary. The object of the research is the water problem of the city during military operations and surface waters within the Mykolaiv city, namely the waters of the Buzky Estuary.

During the studied period, there is a steady trend towards a gradual increase in hardness, dry residue, sulfates, and chlorides in surface waters. The level of pH, BOD₅, dissolved oxygen fluctuates within the normal range with minor deviations. All defined surface water quality classes correspond to the degree of pollution "dirty" or "very dirty" and the state "poor" or "very poor". Water of this quality is not suitable for household use, as it has an active destructive power to damage the water supply system and all the mechanisms and devices that serve it. The issue of complex assessment of the quality of drinking water during martial law remains open. The quality of drinking water distribution points remain outside state control due to the lack of means of operational control, specialists, and a low level of public awareness.

Keywords: *the index of ecological assessment; water quality; surface waters.*

Biography



Olena MITRYASOVA - DSc, Professor of the Ecology Department of the Petro Mohyla Black Sea National University, Mykolaiv, Ukraine. The author about 350 scientific works, including: 19 monographs and chapters of monographs, 15 textbooks on general chemistry, organic chemistry, history of chemistry, chemical ecology, environmental monitoring, water security for students.



Viktor SMYRNOV – PhD, Associate professor of the Ecology Department of Petro Mohyla National University, Ukraine. The author about 100 scientific works on environmental monitoring, water security.



Andrii MATS – PhD student of the Ecology Department of the Petro Mohyla Black Sea National University, Mykolaiv, Ukraine. The author about 10 scientific works on environmental monitoring, water security.



VIII. International Symposium-2024

ROCK PHOSPHATE AMENDMENT AND THE KEY ROLE OF SERRATIA PLYMUTHICA BMA1 STRAIN IN ENHANCING MINERAL NUTRITION AND HEAVY METAL RHIZO-ACCUMULATION IN VICIA FABA L.

**Afef SAI^{1,2}, Sonia BEN YOUNES^{1,3}, Ali ELLAFI^{1,4}, Amel MOULA^{1,2}, Juan
Manuel SÁNCHEZ-YAÑEZ⁵, Mohamed Ali BORGHI²**

¹*Faculty of Sciences of Gafsa, University campus of Ahmed Zarroug, 2112, University of Gafsa, Gafsa, Tunisia.*

²*Laboratory of Biotechnology and Biomonitoring of the Environment and Oasis Ecosystems (LBEOE). Faculty of Sciences of Gafsa, University campus of Ahmed Zarroug, 2112, University of Gafsa, Gafsa, Tunisia.*

³*Unité de Recherches n°17/ES/13, Faculté de Médecine de Tunis, Université de Tunis El Manar, Tunisia.*

⁴*Laboratory of Analysis, treatment and valorisation of environment pollutants and products, Faculty of Pharmacy, Monastir University, Tunisia.*

⁵*Environmental Microbiology Laboratory, Research Institute in Chemistry and Biology Universidad Michoacana de San Nicolás de Hidalgo. Morelia, Michoacán, México.*

Sonia Ben Younes: benyounes_sonia@yahoo.fr or benyounessoniam@gmail.com.

Tel: +216-7621-1024; Fax: +216-7621-1026

Mohamed Ali Borgi: borgima@fsgf.ugaf.tn; Tel +216 98689682 – Fax: +216 76 211024.

Afef sai: afefsai36@gmail.com; Tel: +21693430631

The geochemical characterization was carried out by analysis of the Gafsa phosphate rock (GRP), essential plant minerals and trace heavy metals, a relatively high concentration of heavy metals was detected in the rock. The evaluation of the level of contamination associated with the GRP soil amendment was carried out by calculating environmental contamination factors. The results indicated that the phosphate rock is contaminated with heavy metals in moderate to very strong concentrations. The potential use of the *Serratia plymuthica* BMA1 strain, recognized as a rock phosphate solubilizer, was explored to improve mineral nutrition in *Vicia faba* L., including its participation in the rhizoaccumulation of heavy metals from rock phosphate. Pot experiments revealed that bacterization with *S. plymuthica* BMA1 in *V. faba*, grown in sand fed with phosphate rock as the sole source of phosphorus, increased the potassium concentration by 64% in roots and 40% in shoots: iron 20% in roots and 10% in shoots and manganese 27% in roots and 20% in shoots, compared to *V. faba* not inoculated with *S. plymuthica* BMA1. The total dry biomass of *V. faba* increased by approximately 85%, while accumulation in the roots of high

concentrations of Cd, Cu, Zn and Pb increased by 114%, 30%, 37% and 44%, respectively. However, in shoots they increased by 35%, 10%, 85% and 25%, respectively: cadmium, copper, zinc and lead compared to non-inoculated *V. faba*. The evaluation of heavy metal translocation factor (FT), bioaccumulation factor (BAF) and bioconcentration factor (BCF), with rock phosphate, highlighted the key role of *S. plymuthica* BMA1 in preventing the mobility, of toxic heavy metals to reach the aerial part. These findings underline the potential of *S. plymuthica* to improve mineral nutrition in *V. faba* and the rhizoaccumulation of toxic heavy metals. This research makes this fact evident considering that cultivated plants are closely related to human nutrition.

Keywords: *Serratia plymuthica* BMA1 Phosphate rock pollution

Biography

My name is Afef Sai I am 29 years old I am Tunisian My PhD is about environment, ecology, plant stress responses, phosphate effluents as anthropogenic stressor, biological sciences, and biotechnology I am an enthusiastic, self-motivated, reliable, responsible, and hard-working person. I am a mature team worker and adaptable to all challenging situations. I can work well both in a team environment as well as using own initiative. I can work well under pressure and adhere to strict deadlines.



VIII. International Symposium-2024

COMPARATIVE EVALUATION OF PHENOL REMOVAL BY MICROALGAE FROM VARIED ECOSYSTEMS

Sara ELHAMJI^{1,2}, Maryem MINHAJ^{1,2}, Karim SBIHI^{1,3}, Jihen ELLEUCH⁴, Naaila OUAZZANI^{1,2}, Faissal AZIZ^{1,2}

¹National Centre for Research and Study on Water and Energy (CNEREE), University Cadi Ayyad, Marrakech, Morocco; ²Laboratory of Water, Biodiversity and Climate Changes, Semlalia Faculty of Sciences, B.P.2390, 40000, Marrakech, Morocco;

³Laboratory Analysis, Modelling, Engineering, Natural Substances and Environment, Natural, Substances, Health and Environment Team, Polydisciplinaire Faculty of Taroudant, University Ibn Zohr, Morocco.

⁴Laboratoire de Génie Enzymatique et Microbiologie, Equipe Biotechnologie des Algues, Ecole Nationale d'Ingénieurs de Sfax, Université de Sfax, Sfax, Tunisia.

The distinct qualities of microalgae, especially diatoms, highlight their significant potential as an environmentally friendly method of phenol elimination. The specific goal of this research is to isolate diatoms from harsh habitats and examine how well they're able to eliminate industrial effluence, particularly that derived from the olive oil industry. This work addresses a current issue of incomplete treatment by isolating various diatom strains and assessing their ability to remove phenol, particularly when treating phenolic compound concentrations between 50 and 250 mg/L.

Measurements of chlorophyll fluorescence were used to assess their stress response, and the results showed that different diatom strains reacted differently to phenol concentrations ranging from 50 mg/L to 150 mg/L. Positively, most strains showed significant phenol removal rates that were above 50%. These results highlight the essential part that isolated diatom strains represent as powerful microorganisms in the field of wastewater treatment treatments by effectively removing phenol.

Keywords: microalgae; diatoms; extreme environment; phenol elimination; wastewater treatment.

Acknowledgments: This research was supported by the Morocco-Tunisian bilateral scientific cooperation, project "DEPHI" (ID: 20/PRD-02) and the National Center for Research and Studies on Water and Energy (CNEREE), Cadi Ayyad University, Morocco.

Corresponding author: Prof. AZIZ Faissal, Faculty of Sciences Semlalia of Marrakech, Cadi Ayyad University, Morocco. f.aziz@uca.ma / faissalaziz@gmail.com

Biography



Sara Elhamji is a third-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.



VIII. International Symposium-2024

EVALUATION OF CONTAMINANT LEVELS IN WATER, SEDIMENTS, AND FISH FOR HEALTH RISK ASSESSMENT IN AQUATIC ECOSYSTEMS

Rainiel Brkryan V. DOMASIAN

Laguna State Polytechnic University Los Banos Campus, Philippines

Corresponding author's email address: rvdomasian@lspu.edu.ph

This study seeks to assess heavy metal pollution in the aquatic ecosystems of San Juan River, Calamba City, Philippines. The focus is on determining contaminant levels in water, sediments, and fish to offer a comprehensive understanding of the environmental impact and potential health risks linked to heavy metal exposure. Water samples were systematically collected from various points along the San Juan River, and concentrations of heavy metals were analyzed using handheld X-ray fluorescence. Sediment samples underwent examination to ascertain the extent of metal accumulation in the riverbed. Additionally, fish specimens from different trophic levels were captured and analyzed to assess bioaccumulation patterns and potential transfer of contaminants through consumption. The results indicate that chromium exhibits high concentrations exceeding the threshold level set by the WHO standard. This raises concerns about potential health risks, suggesting that aquatic organisms may not be safe for human consumption. Furthermore, other metals such as Cd, Pb, As, and Ni show a notable presence in the samples, emphasizing the significance of addressing heavy metal pollution in San Juan River for environmental and public health considerations.

Keywords: *Biomonitoring, Water Quality, Sediments, Fish, Heavy Metal, Health Risk*

Biography



Rainiel Bryan V. Domasian is a graduate of Bachelor of Secondary Education Major in Biological Science at LSPU Los Banos. He finished his master's degree in environmental science at the University of the Philippines Los Banos Laguna, Philippines. He is currently a college instructor at the Laguna State Polytechnic University Los Banos. Also, Mr. Domasian is the Unit head for Extension and Training Services and Curriculum Instruction Development. His research interest includes educational management, environmental pollution (heavy metals), and product development.



VIII. International Symposium-2024

SUSTAINABLE NANOPARTICLE SYNTHESIS FOR EFFICIENT PHENOL ELIMINATION IN OLIVE MILL EFFLUENTS

Imane HAYDARI^{1,2}, Jamila SABYH^{1,2}, Jihen ELLEUCH³, Naaila OUAZZANI^{1,2}, Laila MANDI^{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 (CNEREE), Cadi Ayyad University Marrakech, Morocco.*

³*Laboratory of Enzymatic Engineering and Microbiology, National Engineering School of Sfax, University of Sfax, Sfax, Tunisia.*

Olive oil mill wastewater (OMWW) poses a significant environmental challenge due to its high organic content and concentration of phenolic compounds. This study introduces novel nanoparticle synthesis approaches and their environmental remediation applications. *Verbena officinalis* was a green reducing agent that synthesized reduced graphene oxide (RGO). Subsequently, RGO nanoparticles were cross-linked with sodium alginate (SA) to form SA-RGO beads. The characteristics of SA-RGO beads were assessed using scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS), Fourier-transform infrared spectroscopy (FTIR), and X-ray diffractometer (XRD). Batch and fixed-bed column adsorption experiments for phenol were conducted to evaluate the sorption capacity of SA-RGO and CuO-SA beads. The kinetics, isotherm models and adsorption thermodynamics show that the pseudo-second order and Freundlich best present phenol adsorption and the endothermic reaction. Thomas and Yoon-Nelson's models satisfactorily described fixed-bed column adsorption. The results indicated a phenol adsorption capacity of 994 mg g⁻¹ was achieved for an initial phenol concentration of 4000 mg L⁻¹.

Keywords: Adsorption; nanoparticle synthesis; Olive mill wastewater; Phenol

Acknowledgments: This research was supported by the Morocco-Tunisian bilateral scientific cooperation (20/PRD-02) “DEPHI project” and the National Center for Research and Studies on Water and Energy (CNEREE), Cadi Ayyad University, Morocco.

Biography



Imane HAYDARI has registered in PhD in 2021 at the age of 26 years at Faculty of Sciences Semlalia, Cadi Ayyad University Marrakech, Morocco. The theme of her work is industrial wastewater treatment and its recovery. Currently she is in an internship in the National Centre of Study and Research on Water and Energy.



VIII. International Symposium-2024

DIATOM EFFICIENCY IN ORGANIC MICROPOLLUTANTS REMOVAL: AN EVALUATION STUDY

Maryem MINHAIJ^{1,2}, Sara ELHAMJI^{1,2}, Karim SBIHI^{1,3}, Jihen ELLEUCH⁴, Naaila OUAZZANI^{1,2}, Faissal AZIZ^{1,2}

¹*National Centre for Research and Study on Water and Energy (CNEREE), University Cadi Ayyad, Marrakech, Morocco.*

²*Laboratory of Water, Biodiversity and Climate Changes, Semlalia Faculty of Sciences, Marrakech, Morocco.*

³*Laboratory Analysis, Modelling, Engineering, Natural Substances and Environment, Natural, Substances, Health and Environment Team, Polydisciplinaire Faculty of Taroudant, University Ibn Zohr, Morocco.*

⁴*Laboratoire de Génie Enzymatique et Microbiologie, Equipe Biotechnologie des Algues, Ecole Nationale d'Ingénieurs de Sfax, Université de Sfax, Sfax, Tunisia.*

This study investigates the efficacy of using freshwater diatom algae to remove an organic micropollutant from olive mill wastewater, a phenolic compound. The diatom culture was exposed to different phenol concentrations; by subjecting the diatom culture to varying levels of phenol, the study monitored changes in chlorophyll fluorescence as an indicator of stress response. The study notably demonstrated the diatom's exceptional resistance to phenol concentrations as high as 145.9 mg/L. This diatom species' resistance highlights its potential as an effective treatment for phenol removal in challenging industrial wastewater settings, such as those found in olive mills. Utilizing diatoms' significant capacities and ecologically friendly characteristics represents a practical approach to reducing phenol contamination, solving environmental issues, and satisfying regulatory requirements for treating the olive mill wastewater.

Keywords: *Diatom algae, Phenolic compounds, Chlorophyll fluorescence, Stress response, Industrial wastewater, Phenol removal*

Biography



Maryem Minhaj is a master's student specializing in biodiversity, climate change, and sustainable development at the Faculty of Sciences Semlalia, University Caddy Ayyad Marrakech, Morocco. The theme of her work is treatment of industrial effluents using microalgae. Currently, she is doing her final internship at the National Centre of Study and Research on Water and Energy.



VIII. International Symposium-2024

NUMERICAL SIMULATION AND FLOW VISUALIZATION OF BAGHDAD CITY TIGRIS RIVER USING COMSOL MULTIPHYSICS

Mustafa HATHAL, Viola SOMOGYI

Sustainability Solutions Research Laboratory, Faculty of Engineering, University of Pannonia, Veszprém, Hungary.

E-mail: mus.mhathal@phd.mk.uni-pannon.hu, +36704025127

The present research examines the fluid dynamics and thermal properties of the Tigris River in Baghdad, with a specific focus on changes observed in recent decades and their potential impact on water supply and quality. Using historical data, the effects of varying water flow rates in a dry climate were assessed. Methodology employed digital reconstruction techniques as a basis for Computational Fluid Dynamics (CFD) simulations, with the k-epsilon turbulence model effectively representing the dynamics of the river flow. In addition, simulations were conducted to analyse heat transfer and evaluate thermal stratification throughout different seasons. Results uncover notable changes in the river's flow patterns throughout the year. An uptick is apparent in the number of areas with low flow, influenced by environmental factors. The contour analysis offered a comprehensive perspective on flow variations which may be hidden if decision is made only by relying on measurements in a few predefined spots. The study discovered areas with little movement where pollution can build up and analysed changes in temperature, connecting lower flow rates to harm to the environment. It is worth mentioning that there was a noticeable increase in stagnant regions and temperature difference in August 2019. The findings highlight the pressing requirement for implementing sustainable river monitoring strategies to address the negative impacts on the river's ecosystem and the communities residing nearby.

Keywords: *Tigris River; Stagnation Zones; Water Quality; Thermal Analysis; Hydrodynamic Modelling; Computational Fluid Dynamics*

Biography



Mustafa Hathal: *phD student in Chemical Engineering and Material Science Doctoral School/ University of Pannonia, B.sc & M.sc Chemical Engineering/ Al-Nahrain University, Iraq, Senior Engineering in Iraqi Ministry of Industry and Mineral. Published more than 18 articles, participate in more than 25 conferences, Google scholar h index is 6.*



VIII. International Symposium-2024

DEVELOPMENTAL, BEHAVIORAL AND BIOCHEMICAL EFFECTS OF ANTHRACENE AND Pb^{2+} TO ZEBRAFISH EMBRYOS

Abdelfettah GHERIB^{1,2}, Inês DOMINGUES³

¹Laboratory of Environmental Analysis, Biotechnology Research Centre (CRBt), Constantine, Algeria.

²Laboratory of Biology and Environment (LBE), Department of Biology and Plant Ecology, University of Brothers Mentouri Constantine 1, Constantine, Algeria.

³Department of Biology & Centro de Estudos do Ambiente e do Mar (CESAM), University of Aveiro, Campus Universitário de Santiago, Aveiro, Portugal.

This study aims to assess the toxicity of lead Pb^{2+} and anthracene to zebrafish (*Danio rerio*) eleutheroembryos survival, development, behavior and neurotoxicity. Fish embryo toxicity tests were conducted according to the OECD guideline TG 236. The video tracking system Zebrabox® was used to evaluate the effects of these chemicals on 120 hpf larvae behavior. Data showed that both chemicals have a moderate toxic effect on fish embryo survival: Pb^{2+} 96h-LC50 value was 76.51 mg/L. Anthracene 96h-LC50 value was 133.35 mg/L. Regarding behavioral, anthracene decreased total swimming distance (TSD) and total swimming time (TST) at concentrations of 3.2, 6.4, 12.8 and 25.6 mg/L in light and dark periods suggesting hypoactivity. Although less pronounced, Pb^{2+} also affected locomotion by increasing distance travelled in rapid movements after 120 hpf exposure at 0.1, 1 and 10 mg/L suggesting hyperactivity. Besides, AChE was not responsive and sensitive to Pb^{2+} or anthracene after 120 hpf exposure.

Keywords: PAHs, Behavior, FET, Lead, AChE and development.

Biography

Corresponding author: Abdelfettah GHERIB

Address: Centre de Recherche en Biotechnologie Ali Mendjli Nouvelle Ville UV 03 BP E73 Constantine, Algeria.

Phone: +213 (31) 77 50 37/+213 (31) 77 50 39

Fax: +213 (31) 77 50 44

E-mail: a.gherib@crbt.dz / gheribfettah@gmail.com

ORCID ID: <https://orcid.org/0000-0002-7354-8873>



VIII. International Symposium-2024

LEBANESE AGRO INDUSTRIES' KNOWLEDGE IN FOOD LOSS IS AN INITIAL STEP TOWARD THE SUSTAINABLE DEVELOPMENT GOAL 12.3

Nathalie PANO¹, Nada NEHME², Jalal HALWANI^{1,3}, Kostas KARANTININIS⁴, Najah TALEB²

¹*Lebanese University, Doctoral School of Science and Technology, Hadath, Lebanon;*

²*Lebanese University, Faculty of Agricultural Engineering and Veterinary Medicine, Dekwene, Lebanon.*

³*Lebanese University, Water & Environment Science Lab, Tripoli, Lebanon.*

⁴*Swedish University of Agricultural Sciences, Alnarp, Sweden.
Beirut, Lebanon*

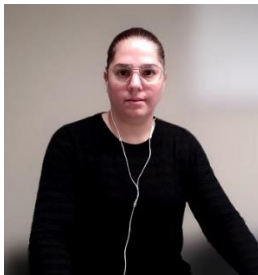
E-mail: nathaliepano@gmail.com, +9613071723

The drive to diminish food waste is embedded within the 2015 Sustainable Development Goals (SDG), particularly under Goal 12, which aims to foster sustainable consumption and production practices. Specifically, SDG 12.3 sets the target of cutting per capita global food waste in half at both the retail and consumer levels, while also curbing food losses across production and supply chains by 2030. Consequently, mitigating food loss and waste (FLW) stands out as a crucial step toward transforming our food systems. The understanding and knowledge of value chain actors regarding this issue is vital for kick-starting initiatives and implementing processes aimed at measuring, preventing, and reducing FLW. What is the level of knowledge of the Lebanese food industries toward FLW?

Based on literature review, a survey was designed to collect the relevant data from various agro-industries in Lebanon. 30 agro industries participated in the 16 questions' survey. The data collected were statistically analyzed. The results show that there is a significant gap in the public awareness and understanding of food waste, which may hinder the efforts to reduce food waste and achieve a sustainable food system. 20.69 % have no knowledge at all, 31.03% misunderstand the issue, 27.59% have partial knowledge and only 20.69% have extensive knowledge. Finally, awareness and knowledge about food waste are essential in addressing this global challenge. With informed individuals and organizations, effective strategies can be implemented to reduce losses along the entire value chain, and work towards sustainable food systems that ensure reaching the SDG 12.3.

Keywords: *Awareness, Food waste and loss, Food-industry, Knowledge, Lebanon, SDG 12*

Biography



Nathalie Pano is an agricultural engineer holding a Master of Science in Project Engineering and Public Policies. Nathalie has more than 13 years of professional experience in managing international development projects in the field of agriculture, food system and circular economy. In addition, she conducted different research projects in related fields such as natural resource management, green consumerism, and food system sustainability. Currently Nathalie is a second year PhD candidate conducting her research on Food system transformation toward a resilient system that can face climate change challenges focusing on food waste at processing and retail levels.



VIII. International Symposium-2024

ECO-FRIENDLY POLYSACCHARIDE-BASED HYDROGELS FOR SUSTAINABLE IRRIGATION

Abdelhaq EL ARRAM¹, Achraf Berradi^{1,2}, Ahlam Lafdali^{1,2,3}, Faissal AZIZ^{1,2}

¹National Center for Research and Studies on Water and Energy (CNREEE), Cadi Ayyad University, Marrakech, Morocco.

²Laboratory of Water, Biodiversity, and Climate Change, Faculty of Sciences Semlalia, Cadi Ayyad University, Marrakech, Morocco.

³Laboratory of Innovative Materials, Energy and Sustainable Development (IMED-Lab), Faculty of Science and Technology, Cadi Ayyad University, Marrakech, Morocco.

Corresponding author: Prof. AZIZ Faissal, f.aziz@uca.ma / faissalaziz@gmail.com

The rapidly expanding agricultural sector, driven by global demands, confronts a critical challenge in sustainable water usage, particularly in arid regions. Water scarcity exacerbates soil degradation, desertification, and salinization, underscoring the urgency for innovative irrigation solutions. This study addresses these concerns by focusing on developing environmentally friendly hydrogels derived from polysaccharides. Our approach involves using bio-sourced hydrogels based on polysaccharides, which possess non-toxicity, cost-effectiveness, biocompatibility, and biodegradability. Additionally, these hydrogels exhibit exceptional water retention and absorption capacities without dissolution. These hydrogels have potential uses in wastewater treatment via adsorption processes and as nutrient reservoirs for slow-release fertilizer systems, in addition to sustainable irrigation. To verify successful synthesis, we used Fourier Transform Infrared Spectroscopy (FTIR) and Nuclear Magnetic Resonance (NMR) to validate our findings for material characterization. Additional research on these hydrogels' morphological, mechanical, thermal, and swelling behaviors lends credence to their potential use in enhancing crop growth, productivity, and soil water availability while reducing water waste.

Keywords: Agriculture; Water; Polysaccharide; Hydrogel; Biobased

Biography



Abdelhaq El Arram, 23 years old, holder of a bachelor's degree in chemistry Organic of the Faculty of Sciences at the Ibn Zohr University of Agadir (Morocco). Currently on a research internship at the National Center for Studies and Research on Water and Energy, part of Cadi Ayyad University in Marrakech, Morocco, developing new biopolymer superabsorbent. Passionate and persevering, my passion for chemistry and science natural is reflected in my particular interest in chemistry organic and laboratory experiments. Always eager to explore new fields, I acquired significant experiences while constantly seeking to expand my knowledge.



VIII. International Symposium-2024

COMPREHENSIVE STUDY ON THE EFFICIENT ELIMINATION OF ALIZARIN RED S DYE IN WATER USING AN ECO-FRIENDLY CLAY-CHITOSAN COMPOSITE: EXPERIMENTAL AND THEORETICAL INVESTIGATION

**Mouhsine BELLAJ¹, Hicham YAZID², Abdelmajid REGTI²,
Mohammadine EL HADDAD², Abdelkrim ABOURRICHE¹, Lhoucine
GEBRATI¹, Faissal AZIZ^{3,4}**

¹Laboratory of Materials, Process, Environment, and Quality, National School of Applied Sciences, Cadi Ayyad University, Safi, Morocco.

²Laboratory of Analytical and Molecular Chemistry, Faculty Poly-disciplinary of Safi, Cadi Ayyad University, Safi, Morocco.

³Laboratory of Water, Biodiversity, and Climate Change, Faculty of Sciences Semlalia, Cadi Ayyad University, Marrakech, Morocco.

⁴National Center for Research and Studies on Water and Energy, Cadi Ayyad University, Marrakech, Morocco.

Alizarin Red S, a commonly used dye in the textile industry, presents a significant environmental challenge when discharged without proper pretreatment. This research conducted a comparative investigation into removing organic compounds from the dye using composite-based clay chitosan as an exceptionally effective adsorbent for the anionic dye. Several characterization techniques, such as FTIR, XRD, and EDX, were utilized to uncover the physical and chemical properties of the prepared material. Key factors like adsorbent dosage, pH, reaction time, and initial concentrations were optimized in a batch system. The findings revealed that the optimal adsorbent dosage was 50 mg, resulting in maximum adsorption at a low pH. Equilibrium adsorption of the dye was achieved in approximately 12 minutes, with an optimal initial concentration of 30 mg/L. Additionally, the study discussed adsorption kinetics, isotherms, and thermodynamic parameters. The pseudo-second-order kinetic model accurately represented the reaction kinetics, while the thermodynamic data indicated an endothermic and spontaneous process ($\Delta H = 27.22$ kJ/mol, $\Delta G < 0$), suggesting favorability with increasing temperature. Furthermore, density functional theory (DFT) calculations were performed to elucidate the adsorption mechanism, highlighting the involvement of benzene rings and oxygen atoms in Alizarin Red S as electron donors and explaining the behavior of chitosan active sites with Alizarin Red S. The synergistic combination of chitosan and clay shows promise in the development of adsorbents that can effectively remove both anionic and cationic dyes from water treatment in future applications.

Keywords: Adsorption, Alizarin Red S, Chitosan-Clay Composite, thermodynamic and kinetic study, DFT.

Biography



As a third-year PhD student at Cadi Ayyad University, I'm focusing on studying micropollutant adsorption using new biomaterials and theoretical chemical studies. I have actively participated in many national and international conferences in parallel with my research. These events have been invaluable opportunities for intellectual exchange, sharing ideas, establishing contacts with my peers, and keeping abreast of the latest advances in the field.



Session (D): Artificial intelligence, Bioinformatics, Circular Economy Strategy



VIII. International Symposium-2024

COMPUTATIONAL ESTIMATION OF THE ECO-TOXICITY RISKS, BIODEGRADABILITY, PERSISTENCE AND BIOACCUMULATION FACTOR OF FOUR BIO-COMPOUNDS

Mohamed Sabri BENSAAD

Department of Biology of Organisms, Faculty of Natural and Life Sciences, University Batna 2, Fesdis, Batna, Algeria.

E-mail: mohamed.bensaad@univ-batna2.dz, +213557932380

The potential of bioinformatics tools in the agri-food and biosciences sectors continues to evolve, creating innovative solutions every day. For example, This new discipline enabled the scientific community to better understand the relative toxicity of certain xenobiotics and their biotransformation processes, considered fundamental criteria during drug formulation processes. In this context, some computational approaches were used in this work to investigate the eco-toxicity profile, possible biodegradation, persistence and bioaccumulation factor of four natural compounds, principally derived from a plant species. Results revealed that the four bio-compounds could be toxic for avian species but concerning aquatic species, it is interesting to underline that the four compounds could be considered non- toxic for *Daphnia magna*, while compound 4 could be the only compound with no harmful effect on Fathead minnow. Compound 1 exhibited the lowest bioaccumulation factor value (0.17). Finally, all tested compounds may possess a non persistent profile, while the UM-BBD based approach indicated that only compound 1 and 4 could possibly be biodegradable with almost the same reliability percentage but with an impact score more pronounced for compound 1 (1.087). However, NITE based approach indicated that only compound 1 could potentially be ready biodegradable. This preliminary work, revealed once again the potential of phyto-compounds and certain fundamental aspects, which could represent an initial step for further investigation.

Keywords: *Biodegradation, Persistence, Phyto-Compounds, Eco-Toxicity Profile.*

Biography



Mohamed Sabri Bensaad graduated with a PhD degree in Biological Sciences from the University Batna 2. He specializes in Animal Physiology and his research focuses on Cell Biology, Physiology, Histology, Traditional medicine and Bioinformatics. He is currently an Assistant Professor at the Department of Biology of Organisms of the University Batna 2.



VIII. International Symposium-2024

GROUP METHOD OF DATA HANDLING-BASED MODELS FOR PREDICTING ARSENIC CONCENTRATION IN SEDIMENTARY PHOSPHATE ROCK

Mohamed DASSAMIOUR¹, Djamel SAMAI², Naima FAGHMOUS³, Rédha BOUSTILA⁴

¹*Department of Geological Sciences, Faculty of Earth Sciences, Geography and Spatial Planning, Constantine 1 - Frères Mentouri University, Constantine, Algeria.*

²*Univ Ouargla, Fac. des nouvelles technologies de l'information et de la communication. Lab. de Génie Électrique, Ouargla, Algeria.*

³*Process Engineering Laboratory for Sustainable Development and Health Products, National Polytechnic School of Constantine, Constantine, Algeria.*

⁴*Département des Sciences de la Terre, Institut d'Architecture et des Sciences de la Terre, Université Ferhat Abbas Sétif 1, Sétif, Algeria.*

E-mail: mohamed.dassamiour@umc.edu.dz, Tel.: +213.666.44.79.17

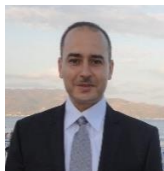
Marine sedimentary phosphate rock is the primary source for manufacturing phosphate fertilizers. It is composed mainly of phosphorus and other elements. Some of these elements, including heavy metals, occur as trace elements. Notably, arsenic, classified as a Group I human carcinogen, is among them. It has significant environmental impacts by contaminating water, soil, and air through certain industrial activities associated with phosphate extraction. The purpose of this study is to develop an explicit equation model to predict the concentration of arsenic in sedimentary phosphates using two-group methods of data handling algorithms: the combinatorial and type neural networks. A database of 277 geochemical data sets was compiled from the literature. The input data for the models are the contents of major oxides (P_2O_5 , CaO , MgO , SiO_2 , Al_2O_3 , Fe_2O_3 , K_2O , and Na_2O) in phosphate samples. Twenty-one models were constructed by combining various parameters, like the transformation function of input data and the neuron activation function. The performance of the proposed models was evaluated using metrics such as mean squared error (MSE), mean absolute error (MAE), and coefficient of determination (R^2).

In addition, sensitivity analysis was performed to inspect the impact of input variables on the model output. The results showed that the combinatorial algorithm provides the best model for predicting arsenic concentration with the highest level of prediction accuracy (MSE = 3.949 ppm, MAE = 5.466 ppm, R^2 = 0.935).

The validation results suggest that the combinatorial algorithm can be considered a promising approach for predicting heavy metal concentrations in sedimentary phosphates with high accuracy.

Keywords: *Heavy metals, Trace elements, Explicit equation, Combinatorial algorithm*

Biography



Mohamed Dassamiour works in the Department of Earth Sciences at the University of Constantine 1 in Algeria. His research focuses on understanding the processes involved in the diagenesis of sedimentary phosphorites using geochemistry and sedimentary techniques. Additionally, he is keenly interested in stochastic modeling and artificial neural networks, specifically exploring their application in the environmental domain. One of his significant endeavors involves utilizing machine learning for predicting pollutants associated with natural resource exploitation.



VIII. International Symposium-2024

CHANNEL SELECTION ENHANCEMENT IN COGNITIVE RADIO NETWORKS BASED ON FUZZY APPROACH

Akeel BDRANY¹, Sattar B. SADKHAN²

¹*Department of field crops, College of Agriculture, University of Diyala, Iraq;* ²*College of Information Technology, University of Babylon, Al-Mustaqbal University, Babylon, Iraq.*
E-mail: akeelbdrany@uodiyala.edu.iq

The great increase in devices (laptops, smartphones, etc.) during the last decade that uses wireless communication as communication technology has increased the need for different spectral frequencies, for their use by these devices, this demand has led to a phenomenon called spectrum scarcity. Statistics issued by the Federal Communications Commission (FCC) have shown inefficiency in allocating fixed spectrum. To solve this problem (spectrum scarcity) the concept of cognitive radio is proposed. One of the promising responses to using the available (unused) spectrum is the so-called cognitive radio (CR), which was developed to enable secondary users (SUs) to exploit the spectrum holes in authorized channels. Secondary users should quickly clear the channel and change to another available channel if access to the primary user is sensed. One of the most important measures of the efficiency of spectrum use by secondary users is the continuous reduction of channel exchange. In this paper, it is proposed to use artificial intelligence algorithms to improve the selection of the best available channels. The metrics to evaluate the artificial intelligence algorithms are channel switching, throughput, and delay time.

The simulations were done using MATLAB Simulator. Neural network algorithms have shown promising results compared to some FIS (TSK, Mamdani). Also, the ANFIS algorithm showed superiority compared to the FIS algorithms in the throughput of data.

Keywords—*Cognitive Radio, Channel Selection, FIS, ANFIS.*



Session (E): Energy Research & Applications



VIII. International Symposium-2024

DESIGN OF NOVEL COAXIAL MAGNETIC FOR HIGH POWER DENSITY APPLICATIONS

Amberbir WONDIMU, Yang CHAOJUN, Guo YAFE, Ebenezer OMARI

School of Mechanical Engineering, Jiangsu University, Zhenjiang, China
<https://orcid.org/0000-0002-5386-0034>, Email: ambirewondimu@gmail.com, Phone: +8618252583623

It is evident that energy is a significant challenge facing the world soon. To address this issue, the world must develop new energy sources or enhance the performance of existing energy generation devices. The design of a new coaxial magnetic gear for high-power density applications offers a promising solution to meet the increasing demand for sustainable energy sources. This research focuses on improving the power density and performance of current coaxial magnetic gear in green energy applications through innovative design elements like a new modulator and outer rotor design. By utilizing theoretical analysis and simulation studies, this research aims to enhance power density by 3% and reduce losses to less than 5%, ultimately boosting energy generation performance. These findings have the potential to transform the field of green energy technology, leading to more sustainable and eco-friendly energy solutions.

Keywords: Coaxial magnetic gear, green energy, power density

Biography



My name is Amberbir Wondimu, I am a PhD Candidate in Mechanical Engineering since 2021 at Jiangsu University, Zhenjiang, China. My research area is Design and Application of Magnetic Gear for Wind Turbine Power Generation.



VIII. International Symposium-2024

STUDY OF POLLUTANT EMISSIONS FORMATION IN A PREMIXED BURNER MODEL: EFFECTS OF EQUIVALENCE RATIO AND GEOMETRY MODIFICATION

Abdelkader HEMAIZIA¹, Dominique THEVENIN²

¹*Faculty of Mechanical engineering and Processes engineering, USTHB, Algeria.*

²*Institute of Fluid Dynamics and Thermodynamics, OVGU, Germany.*

E-mail: thevenin@ovgu.de, +493916758570

The formation of the pollutant emissions in technical combustion systems depends mainly on the dynamic and thermal behaviour of the flames used. One goal of modern combustion chamber development is the reduction of emissions formation while keeping the flame stable during the combustion process. The first aim of this work is to investigate the effect of equivalence ratio (ϕ) and the throat diameter of the convergent-divergent (Dth) nozzle on flame stabilisation and the concentration of the carbon monoxide (CO) and nitrogen oxide (NO_x) emissions using Steady-Reynolds-Averaged –Navier-Stokes approaches implemented in ANSYS-FLUENT software. The combustor operates under atmospheric pressure ($p = 1$ atm), with swirl number $Sn = 1.4$ and fixed mass flow rate $m_{mix} = 0.046$ kg/s. Three different equivalence ratios, $\phi = 0.3, 0.5, 0.8$, and three throat diameters, Dth: 20 mm, 16 mm, and 14 mm, were applied. Turbulence-chemistry interaction is treated using Realizable $k-\epsilon$ turbulence model, and Eddy dissipation concept (EDC) is combined with a 66-step reduced reaction mechanism. The flow behavior is well predicted by Realizable $k-\epsilon$ model, and the swirled premixed flame is well reproduced by EDC. Two dominant strong recirculation zone are detected, inner recirculation zone (IRZ) in the centreline and the outer recirculation zone (ORZ) in the combustor corners. The temperature field indicates that the flame mainly stabilizes in the shear layer located between IRZ and ORZ. It is found that both ϕ and Dth have a strong effect on the flame stabilisation and CO and NO_x concentrations, with CO ranging from 542 ppm to 608 ppm and NO_x from 0.33 ppm to 0.23 ppm, respectively.

Keywords: *Pollutant emissions, Swirl, Propane, NO_x, CO, Premixed flame*

Biography



I am pursuing PhD studies in Numerical combustion.

My area of interest and research is an interdisciplinary study that combines heat transfer, fluid mechanics, mass transfer, chemical reaction, thermofluids, and molecular transport.

I am currently working on a project that has the ambition to study the effect of hot gases on the stabilization of the premixed flame and reduction of pollutant emissions type NO_x.



VIII. International Symposium-2024

ENERGY CRISIS IN SOUTH AFRICA: ASSESSMENT OF THE EFFECTS OF LOAD SHEDDING ON THE LOGISTICS CONTEXT

Mathapelo Kgolomela MOTIMELE

Széchenyi Istvan University, Győr, Hungary
E-mail: kgolo.motimele@gmail.com, +36202935063

This research aims to investigate the energy crisis and its impacts on logistics in South Africa. With its severity having increased since it first began in 2007, the year 2023 has been recorded as being the worst year ever with up to 10 hours of blackouts per day, the logistics operations will inevitably be affected. A study is done over three main key areas that can offer a better understanding of the issue at hand, the history of the energy crisis, the economic impacts of logistics operations in South Africa, and the current load shedding status and its impacts. Through an extensive literature review, an understanding of the above-mentioned topics can be had.

The research employed a mixed-methods approach through the usage of both primary and secondary data. An in-depth literature review from African journals will give insight into the Energy crisis as well as possible alternatives that have been introduced to cater to the energy needs of South Africans. To explore the extent to which the damage has been done a survey is designed and will target drivers from Coca-Cola Beverage South Africa Pretoria (CCBSA) Pretoria, South Africa. The widespread availability of social media will also be taken advantage of by posting the survey on several “truck drivers in South Africa” pages to cover a wide range of participants.

This paper contributes to the ongoing discourse around Load shedding and how it is changing as well as challenging the South African Landscape as we know it.

Keywords: *Energy, Eskom, “Load Shedding”, Logistics, “South Africa”, Traffic*

Biography

Akpeji, K. O., Olasoji, A. O., Gaunt, C., Oyedokun, D. T., Awodele, K. O., & Folly, K. A. (2020). Economic impact of electricity supply. SOUTH AFRICAN INSTITUTE OF ELECTRICAL ENGINEERS.

Ateba, B. B., Prinsloo, J. J., & Gawlik, R. (2019). The significance of electricity supply sustainability to industrial growth in South Africa. Energy Reports, 1324-1338.

Baker, L., Newell, P., & Phillips, J. (2014). The political economy of energy transitions: The case of South Africa. New Political Economy.

ESKOM. (1998). 1998-Annual-Report. Johannesburg: Eskom Corporate Communication.

<https://www.eskom.co.za/heritage/wp-content/uploads/2021/10/1998-Annual-Report.pdf>

- Flash, N. Folly, K. A. (2021). *Local Electricity Markets*. Cape Town: Academic Press.
- Havenga, J. (2010). Logistics costs in South Africa - The case for macroeconomic measurement. *South African Journal of Economics*, 460-476.
- McKune, A. (2016). *The Indirect Impact of Road Freight Transport Case Study: N3 Johannesburg to Durban Road Freight Corridor*. Cape Town: University of Cape Town.
- Merven, B., Hartley, F., & Ahjum, F. (2019). *Road freight and energy in South Africa. South Africa-Towards Inclusive Economic Development*.
- Montsho, M. (2022). *SA experiencing the longest load-shedding streak – here’s what needs to happen*. Gauteng: IOL.
- Ndlovu, V., & Inglesi-Lotz, R. (202). *The causal relationship between energy and economic growth through research and development (R&D): The case of BRICS and lessons for South Africa*. *Energy*, 1.
- Peixoto Neto, A., Galves, M., & Lima Júnior, O. (2008). *Challenges of urban transport problems and city logistics: Sao Paulo city centre case*. *WIT Transactions on The Built Environment*, 133-141.
- Schoeman, T. (2018). *The impact of power outages on small businesses in the City of Johannesburg*. *10th Conference on Education, Business, Humanities and Social Sciences Studies (EBHSSS-18)*, (pp. 329-332). Cape Town.
- Shrouf, F., & Miragliotta, G. (2015). *Energy management based on Internet of Things: practices and framework for adoption in production management*. *Journal of Cleaner Production*, 100, 235-246.
- Sós, E. & Földesi, P. (2023) *Application of the QFD Technique Method in Logistics Strategy*. *Acta Polytechnica Hungarica*. Vol. 20. No. 2, pp. 145–164.
- Sós, E., Horváth A., & Földesi P. (2023) *Effects of Cognitive Biases and Their Fuzzy Measure During Freight Transportation*. *Lecture Notes in Logistics*, pp. 29–43. Doi: 10.1007/978-3-031-28236-2_3/COVER
- Sós, E. & Nagy Z. A. (2020) *Exploring options for reducing CO 2 emission from freight transport*. *Annals of Faculty of Engineering Hunedoara: International Journal of Engineering*, pp. 157–162.
- Western Cape Mobility Department. (2023). *Growing the economy with Freight*. Western Cape Government for You.
- Whitepaper FuE-Themen. (2015). *Plattform Industrie 4.0: Industrie 4.0*.



VIII. International Symposium-2024

THE ANTIFUNGAL ACTIVITY OF TWO-FERMENTED COMPOST TEAS AGAINST FUSARIUM CROWN AND ROOT ROT

Asma BEN AMARA^{1,2,3}, Manel CHEFFI², Monia EL HAJJI³, Emna AMMAR^{1,4}, Mohamed Ali TRIKI²

¹*Laboratory of Environmental Sciences and Sustainable Development, University of Sfax, Preparatory Institute for Engineering Studies of Sfax, Sfax, Tunisia.*

²*Laboratory of Improvement and Protection of Olive Tree Genetic Resources, Olive Tree Institute, University of Sfax, Sfax, Tunisia.*

³*Laboratory of Advanced Research in Industrial and Logistic Engineering, Team OSIL, National High School of Electrical and Mechanical Engineering, University Hassan II, Casablanca, Morocco.*

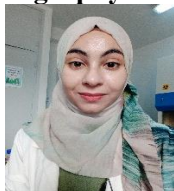
⁴*Laboratory of Environment Sciences and Sustainable Development, University of Sfax, National Engineering School of Sfax, Tunisia.*

E-mail: Benamara.asma2015@gmail.com, cheffimanel@yahoo.fr, m.elhaji@ensem.ac.ma, ammarenis@yahoo.fr, mohamedalitriki2@gmail.com, +21628390227

Fusarium oxysporum f.sp. radicis lycopersici (Forl) is a fungal pathogen responsible for crown root rot and vascular wilt diseases, which severely impact tomato plant development and lead to significant yield losses. To face this phytopathogen, human's resort to the use of chemical fungicides, which are harmful to the human health and the environment. Compost tea (CT) is considered as an eco-friendly bio-fertilizer that may reduce/replace the use of chemical pesticides. The beneficial effect of CT on plant disease is mainly associated with the microbial diversity and the presence of antagonist bacteria. This study aimed to evaluate the capacity of two aerated CTs; M1 and M2, resulting from a compost obtained from a "smart" composting of by-products of the extraction of the oil of effluent and pomace mixed with green waste and poultry droppings, obtained at two different durations of the process, to inhibit the growth of the Forl. To assess the antifungal potential of these CTs both before and after sterilization and filtration, the well-cut diffusion method was used. Subsequently, an extensive collection of bacteria was isolated and subjected to testing in order to assess their capacity to inhibit the growth of the Forl. The results demonstrated that both of the CTs exhibited significant antifungal activity against this pathogen. The primary source of this antifungal activity was attributed to the microbial population present in the CTs rather than their chemical composition. The antagonists exhibited varying levels of inhibition on the Forl mycelia growth, with the highest inhibition rate of 37.18% attributed to M1A5 for M1 and 33.97% attributed to M2A11 for M2. This inhibition results in coiling of mycelium, mycelia vacuolation, and lysis, and loss of cytoplasm compared to normal mycelial growth.

Keywords: *Fusarium oxysporum f.sp. radicis lycopersici*; Antifungal activity; Compost tea; Antagonist; Biopesticide

Biography



My name is Asma Ben Amara. I am a third-year doctoral student in Biological Sciences at the Laboratory of Environmental Sciences and Sustainable Development, in the Preparatory Institute for Engineering Studies of Sfax and at the Laboratory of Improvement and Protection of Olive Tree Genetic Resources at the Olive Tree Institute of Sfax.



VIII. International Symposium-2024

OLIVE POMACE VALORIZATION

Meriem BENAMARA-BELLAGHA, Malika BARKAT¹, Rim Tinhinene MAOUGAL

Biotechnology and food quality laboratory (Bioqual,) INATAA, UPMC1, Constantine, Algeria.

meriem.benamara@umc.edu.dz, barkat.inataa@yahoo.fr, rym.maougal@umc.rdu.dz

To respond to an environmental problem, the recovery of waste from the olive industry seems to be an interesting market. In this context we were interested in the valorization of olive pomace. Several samples were taken from several localities in eastern Algeria and were characterized by their analysis and by the extraction of the pigments found there by immobilizing them in sodium alginate capsules. Obtaining pigments from olive pomace was carried out by the solvent extraction method. This technique made it possible to obtain yields of 18%. The quality of the pomace was measured by the analysis of some physicochemical characteristics. The results indicate a humidity of between 46 and 54% and an ash level of 2 to 4%. Olive marc is an appreciable source of total polyphenols and flavonoids with contents of 140 to 154 mg EAG/g and 6 to 9 mg Q/g respectively and a chlorophyll and carotenoid content of 2.11 to 5.4 mg/kg and 1.6 to 3.6 mg. /kg respectively. The antioxidant power varies between 20 to 23.5%. Regarding encapsulation, the optimal conditions for inclusion of the extracted pigments in a sodium alginate gel were determined.

Keywords: olive pomace, characterization, encapsulation, valorization

Biography



Ms. Benamara-Bellagha is a doctor in the department of food biotechnology, at the Institute of Food Nutrition and Agro-Food Technologies (INATAA). Part of the Bioqual laboratory. Dr Benamara-Bellagha is interested in the valorization of bioresources and waste of plant origin through the extraction of pigments and substances of interest. Several students were supervised in these areas of research as part of obtaining the master's degree in food biotechnology.



Poster Sessions



VIII. International Symposium-2024

GRAPHENE, A GAME-CHANGER IN SCIENCE AND TECHNOLOGY

Asad ULLAH

Khayaban-e-Jinnah Road, Johar Town, Lahore, Pakistan,

*Email: lf20bsch7238@ucp.edu.pk, asadullah7238@gmail.com Telephone #
+923015346873*

Science and technology are about to undergo a revolution thanks to graphene's extraordinary characteristics and adaptability. It leads in many industries thanks to its remarkable strength, high electrical and thermal conductivity, flexibility, and transparency. It has been shown via intensive research that graphene-based materials have great potential for use in energy storage, electronics, biomedical devices, and environmental applications. The results of this study highlight graphene's promise as a revolutionary material that outperforms conventional materials in terms of efficiency and performance. With continuous research and development, graphene is opening the door to ground-breaking ideas, establishing itself as a catalyst for revolutionary change throughout industries, and tackling important global issues.

Moreover, graphene's adaptability goes beyond its physical characteristics because of its atomic structure, which permits nanoscale manipulation and opens up new possibilities for specialized applications. Because of its biocompatibility and impermeability, it has great promise for applications in biomedicine, including drug delivery systems and biosensors. Graphene-based materials promise faster charging times and longer battery life in energy storage applications such as batteries and super capacitors. Moreover, graphene's potential for environmental remediation—such as pollution management and water purification, illustrates its ability to meet urgent sustainability issues. Graphene continues to be a source of innovation, pushing the boundaries of science and technology with never-before-seen impact as research opens up new possibilities.

Keywords: *Graphene, Derivatives of Graphene, Innovative Technology*

Biography



*My name is Asad Ullah, a dedicated researcher exploring the potential of graphene. Pursuing a Bachelor's degree with last year in Chemistry at University of Central Punjab, Lahore, Pakistan, my fascination with the material began during undergraduate studies. Known for my innovative approach and rigorous experimentation. I am making significant contributions to graphene synthesis and applications. With a passion for pushing the boundaries of scientific knowledge, I collaborate across disciplines to unlock graphene's potential in electronics, energy, biomedicine, and environmental sustainability. My commitment to excellence drives me to **shape** a future where graphene revolutionizes technology and address pressing global challenges.*



VIII. International Symposium-2024

ENVIRONMENTALLY SAFE MAGNETIC NANOCATALYST FOR THE PRODUCTION OF BIODIESEL FROM PONGAMIA PINNATA OIL

Hafiza Qurat ul Ain SAMI

Nano and Biomaterials Lab, Department of Chemistry, University of Agriculture, Faisalabad 38040, Pakistan.

quratulainsami.annie@gmail.com, +923023742122

Biodiesel is an alternative fuel in many developing and developed countries worldwide. Biodiesel has significant and numerous economic, environmental, and social benefits. However, the problem with conventional biodiesel production is the high industrial production cost, mainly contributed by the raw materials. Therefore, catalysts and feedstock are essential in increasing total biodiesel production rates and minimizing production costs. Magnetic nano-catalysts play a crucial role in heterogeneous catalysis due to their easy recovery, recyclability, excellent selectivity, and fast reaction rates, owing to their larger surface area. This research activity used heterogeneous magnetic nano-catalysts of ICdO, ISnO, and their modified form, to produce biodiesel. The synthesized nanocatalysts were made through co-precipitation and found quite efficient for transesterifying Pongamia pinnata oil. The effect of various parameters on biodiesel yield in the presence of prepared magnetic nano-catalysts has been studied. In the transesterification supported by ISnO, high yield, i.e., 99%, was achieved after 2 h of reaction time at 60 °C. The nano-catalysts were magnetically recovered and reused 4–5 times without any change in their activity. All the synthesized magnetic nano-catalysts performed SEM analysis. Each fraction of the produced biodiesel was assessed for different quality parameters, and the results were per ASTM standards. The components present in biodiesel produced from Pongamia pinnata oil were determined by GCMS.

Keywords: *magnetic nano-catalysts; heterogenous catalysis; Pongamia pinnata oil; biodiesel*

Biography



My name is Qurat ul Ain Sami. I have done an M.Phil. in chemistry from the University of Agriculture Faisalabad. I also have done B.Ed. from AIU. Currently, I am teaching in a college and have teaching as well as research experience. In my master's studies I have researched the synthesis of nanocatalysts and produced the biodiesel by using these catalysts. I also published a paper with the title "Environmentally Safe Magnetic Nanocatalyst for the Production of Biodiesel from Pongamia pinnata Oil" in Catalysts Journal in 2022.



VIII. International Symposium-2024

THE EFFECT OF WOODY BIOCHAR ON SOIL BULK DENSITY AND PORE SIZE DISTRIBUTION

Evan DAYOUB, Jihad IBRAHIM, Samar HASAN, Ola KAJO

*Tishreen University, Latakia, Syria.
dayoubewan@gmail.com, +963995105176*

A completely randomized field design experiment was conducted in Latakia/in 2022/ to investigate the effect of four biochar rates (0-1-3-6 t ha⁻¹) on loamy soil bulk density and pore size distribution. The results revealed that soil bulk density significantly decreased with increasing biochar doses reaching the lowest value at 6 t ha⁻¹ biochar rate. On the other hand, soil total porosity reached the maximum value of 55.72% at 6 t ha⁻¹ biochar dose in comparison to the control. The same trend was seen for pores containing available water 0.2 -10 µm and pores >10 µm reaching 18.6% and 21.91%, respectively at 6 t ha⁻¹ biochar rate. While pores containing unavailable water <0.2 µm decreased significantly after gradual biochar amendment reaching the highest reduction at 6 t ha⁻¹ of biochar dose.

Keywords: *biochar-bulk density -total porosity-plant available water.*

Biography



A PhD candidate at soil and water science department, Tishreen University, Latakia, Syria. He completed his MSc in 2020 from Tishreen University, Soil and Water Sciences Department. He completed his bachelor of Agricultural engineering in 2015 from Tishreen University, Soil and Water Sciences Department. He is interested in biochar applications and production in addition to its impacts on soil physical and chemical characteristics as well as plant growth and productivity.



VIII. International Symposium-2024

PROMOTING ENVIRONMENTAL HEALTH THROUGH PÁLINKA SPENT WASH COMPOSTING

Lara Rúbia BORGES SILVA, Levente KARDOS

*Institute of Environmental Sciences, Department of Agro-Environmental Studies, Hungarian
University of Agriculture and Life Sciences, Budapest, Hungary.
E-mail: silva.lara.rubia.borges@phd.uni-mate.hu, +36706164888*

The Pálinka distillery industry in Hungary generates a significant amount of organic waste, including a byproduct known as 'spent wash' or 'mash'. Pálinka spent wash (PSW), a residue produced after distilling fermented fruits, poses environmental challenges due to its high organic load, low pH, and diverse compounds, including macro and micronutrients, polyphenols, and recalcitrant substances. Moreover, PSW has elevated copper levels resulting from the corrosion of distillery rectification columns made of copper due to their resistance to the acidic mash environment. Conventional disposal methods, like wastewater treatment or direct soil disposal, result in unpleasant odors and disrupt nutrient cycles, potentially leading to soil and water pollution. Therefore, composting has emerged as a sustainable solution to manage PSW, converting it into stable humic material and neutralizing phytotoxic substances. This study focused on addressing the initial challenges of PSW, including acidic pH, high moisture content, and elevated copper levels, through aerobic composting. Mineral additives such as alginite and andesite, along with organic additives such as garden compost, diatomaceous earth, and wood ash, were utilized to enhance the composting process. Germination tests confirmed the unsuitability of the spent wash for plant growth without composting. Additionally, matured spent wash compost was evaluated for its ability to immobilize heavy metals using lettuce and tomato as test plants irrigated with lead and iron-contaminated water. The study highlighted improvements in mineral levels, stable organic matter, and enzyme activity in PSW compost. The reduction of copper levels was tracked over time, notably reduced in the garden compost treatment. Ongoing research explores new composting methods (e.g. breathable drum composter) and additives (e.g. vinasse, coconut fiber, and calcium sulfate) to optimize the treatment of PSW. This study underscores the urgency to tackle environmental health and safety concerns, emphasizing composting's potential as a soil amendment for enhanced fertility and sustainable agriculture.

Keywords: *Pálinka spent wash, composting, stable organic matter, copper, heavy metals immobilization, soil amendment*



VIII. International Symposium-2024

THE APPLICATION OF HMDS THERMOCHEMOLYSIS FOR THE MOLECULAR CHARACTERIZATION OF AN OMBROTROPHIC PEAT BOG: A PRINCIPAL COMPONENT ANALYSIS APPROACH

Sara MOGHNIE^{1,2}, Jalal HALWANI¹, Khaled YOUNES², Grasset LAURENT³

¹*Water and Environment Sciences Laboratory, Lebanese University, Tripoli, Lebanon.*

²*College of Engineering and Technology, American University of the Middle East, Kuwait.*

³*Université de Poitiers, Institut de Chimie des Milieux et Matériaux de Poitiers IC2MP CNRS UMR 7285, Equipe Eaux, Biomarqueurs, Contaminants Organiques, Milieux, France.*

In this study, a silylating agent, Hexamethyldisilazane (HMDS), was used to analyze natural products resulting from polar molecules, specifically to assess lignin degradation in sediments accurately. The goal was to develop characteristic indicators for the state of lignin degradation based on the relative distribution of lignin phenols, measured chromatography after HMDS thermochemolysis. For that purpose, the singular contribution of the 11 aromatic moieties yielded, along with SGC, and the most lignin degradation proxies, were applied. It has been shown that HMDS thermochemolysis exhibited the capacity to reveal oxidized and degraded lignin fractions, following the increase trend yielded for most moieties and SGC proxy. In addition, C/G and S/G showed their highest input in the upper half of the core. This bias in the ratios could indicate that HMDS thermochemolysis is to be applied for geological samples, where low G-compounds exist. For the sake of validating HMDS thermochemolysis' application, Principal Component Analysis (PCA) was then applied to the molecular fingerprint. Following the higher variance yielded in the case of PCA for ratios (78.75%), indicating the efficiency of these ratios and indexes, in describing the molecular fingerprint of peat depth records. In addition, a higher separation between the contributions of the investigated, along the first two PCs, were noticed. These findings indicate a higher reliance in applying the ratios and proxies of HMDS thermochemolysis.

Keywords: *Peatland, PCA, Lignin, HMDS thermochemolysis, Organic matter*

Biography



I am a PhD candidate of Chemistry in the faculty of science. I obtained my master's degree in Biochemistry from Kuwait University in 2014. I have been working as a Chemistry lab instructor at the American University of the Middle East since 2015. Recently, I'm participating in a study targeting the application of artificial intelligence techniques for the assessment of the efficiency of chemical and thermochemical depolymerization methods for Lignin valorization. This granted me a point of interest for PhD. I currently published 3 papers related to this field.



VIII. International Symposium-2024

A HIERARCHICAL ANALYTICAL PROCESS TO ASSESS THE LONG-TERM BEHAVIOR OF THE WATER SUPPLY SYSTEM – CASE OF KHEMIS MILIANA, AIN DEFLA, ALGERIA

Karima DRICI^{1,2}, Cherifa ABDELBAKI³, Yamina EL MEDDAHI^{1,2}

¹Department of Hydraulics, Faculty of Civil Engineering and Architecture, University of Hassiba Benbouali Chlef, Algeria.

²Vegetal Chemistry -Water-Energy Laboratory, University of Chlef, Algeria.

³EOLE laboratory, Faculty of Technology, University of Tlemcen, Algeria.
cherifa.abdelbaki@univ-tlemcen.dz

Assessing the sustainability of water distribution networks requires various techniques, including developing a multi-criteria decision-support tool based on known operational, physical, hydraulic, and environmental factors. The methodological tool uses the Analytic Hierarchy Process (AHP) to evaluate and prioritize short and long-term planning options by integrating the results of the hydraulic simulation model with the opinions of experts in the hydraulics engineering and management of water supply systems. The evaluation model was applied to a total of 89 individual water pipes. According to the results of the network state, 3.37% of the pipes have good performance, 79.78% have acceptable performance, and 16.85% have poor performance. A long-term performance evaluation was carried out, illustrating the effect of varying the C value in the Hazen-Williams equation on head loss and water pressure due to pipe aging. According to the results, some tubes' performance decreased up to 39.50%, as T07. The AHP model that has been developed has great potential as a valuable tool for assessing the pipes used in water supply services.

Keywords: Analytic Hierarchy Process; Drinking water supply systems; Assess system performance

Biography



- 2013: Secondary education baccalaureate (scientific).
 - 2013 - 2015: 2 years at the science and technology preparatory school (EPST) at Tlemcen, Algeria.
 - 2018: Engineering degree in Hydraulics, from the National Hydraulic School (ENSH). BLIDA, ALGERIA)
 - 2019: master 2 in hydraulics at ENSH,
 - 5 th year PhD student at the University of CHLEF, specializing in urban hydraulics, research topic -Optimization of the operation of a drinking water supply system: cartographic approach.
- Study area Khemis miliana w.AIN DEFLA



VIII. International Symposium-2024

SOIL MICROBIOCENOSIS IN THE CURRENT STATE

Iryna GUMENIUK, Alla LEVISHKO

*Department of Agroecology and Biosafety, Institute of Agroecology and
Environmental Management of NAAS, Kyiv, Ukraine.
gumenyuk.ir@gmail.com*

The study of microbial diversity is important not only for fundamental scientific research, but also for understanding the relationship between the diversity of microorganisms, the structure of their communities, and the functions they perform in the environment. Anthropogenic and technogenic factors negatively affect diversity of ecosystem biocenoses, and microbial diversity. In the context of agricultural land use, soil's important properties are maintaining biological productivity and self-regulation. Thus, the ecological conditions of ecosystems, and accordingly, human health, depend on soil quality. Soil microbiota assessment using molecular genetic methods allows us to overcome the problems of low information content of the taxonomic, functional and spatial structures of microbiocenosis during crop cultivation to create sustainable and highly productive agroecosystems. The current condition of intensification of agricultural production involves the introduction of intensive farming technologies, which involves the large-scale use of pesticides and agrochemicals. In turn, uncontrolled and excessive use of chemicals causes undesirable changes in agroecosystems. Namely, the physical, chemical and biological components of the soil, which in turn affects the structure and functional components of the microbiocenosis. Previous studies have shown that the soil microbial community is a determining factor and a reserve for increasing the productivity of agrophytocenoses. Natural biogeocenoses are characterised by high biodiversity and resistance to environmental factors. The ability to self-regulate and efficiently use energy resources of natural ecosystems was ensured by numerous trophic levels and the high adaptive potential of organisms. The species of organisms living in a natural ecosystem have evolved to such an extent that only in combination do they ensure the integrity and optimal structure of the ecosystem. This creates the conditions for compensatory reactions in case of disruption of certain chains in the system under the influence of negative environmental impacts.

Keywords: *structures of microbiocenosis, agroecosystems, diversity of microorganisms, soil microbiota*

Biography



Iryna Gumeniuk has completed her PhD at the age of 26 years (Institute of Agroecology and Environmental Management of NAAS) in Biological Sciences (Ecology). She is Senior Researcher in Laboratory Microbial Ecology (Department of Agroecology and Biosafety of Institute of Agroecology and Environmental Management of NAAS). Author of 40 scientific works, including 6 publications that are included in SCOPUS or Web of Science databases, co-author of 3 monograph, 3 training manuals, and 2 methodological recommendations. Scientific interests: Ecology of soil microorganisms; Microbiology, agroecology and biosafety; Legume-Rhizobium symbiosis; Developing biological preparations based on agronomically beneficial microorganisms. Member of National Public Organization Vynohrads'kyj Society of Microbiologists of Ukraine (SMU) and FEMS; Member of All-Ukrainian Public Organization "Vavilov Society of Geneticists and Breeders of Ukraine"; Member of the All-Ukrainian Public Organization "Association of Agroecologists of Ukraine"; Head of the microbiological testing group of TL "DAB"; Lecturer of the course of lectures "Environmentally safe agricultural technologies", "Biological safety of agroecosystems", "Ecology of microorganisms".



VIII. International Symposium-2024

THE STATE OF THE SOIL MICROORGANISM COMMUNITY UNDER THE INFLUENCE OF THE ORGANO-MINERAL FERTILISER DIAMOND GROW

Alyona BUNAS, V. DVORETSKYI

Institute of Agroecology and Environmental Management of NAAS, Metrologichna, Kyiv,
Ukraine.

bio-206316@uke.net, +38-0975265043

Any ecosystem is characterised by a complex trophic and spatial organisation, but at the same time it is dynamic, balanced and self-regulating. Soil microbial communities are in close interaction with all components of the ecosystem, and primarily with plants. The structure of microbial populations (spatial, taxonomic, functional) mainly depends on the set of relationships that develop within the community. It is practically proven that most agrochemicals and pesticides are broad-spectrum toxicants. Soil samples were tested in the following ways: control, 1-fold minimum fertiliser rate (1 min*P)-3.85 µg/kg soil; 1-fold maximum (1 max*P)-19.2; 10-fold maximum fertiliser rate (10 max*P)-0.19.

It was found that OMF-DG at the minimum, maximum and 10-fold maximum concentrations promote the growth of the number of microorganisms of the main ecological, trophic and taxonomic groups studied. The percentage of soil clods contaminated with bacteria of the genus *Azotobacter* was 100 %. The number of ammonifiers, bacteria that immobilise mineral forms of nitrogen and oligotrophs increased by 1.2-1.5 times compared to the control and depended on the OMF-DG application rate. The number of micromycetes increased by 1.2-1.5 times compared to the control. The increase in the number of streptomycetes was recorded to 3 times relative to the control sample and fertiliser application rate. The intensity of CO₂ emission under the application of 1 min*P OMF-DG was 156.22 µg CO₂/g soil, which is 8.61 µg CO₂/g soil more than in the control variant (147.6 µg CO₂/g soil). The application of 1 max*P and 10 max*P contributed to an increase in carbon dioxide emissions by 9.4 and 13.2%. Thus, the studies have shown that the use of the organo-mineral fertiliser Diamond Grow does not have a toxic effect on the soil microflora, including agronomically beneficial microorganisms.

Keywords: *ecosystem, microorganisms, soil, fertiliser, pesticides, Azotobacter*

Biography

Alyona Bunas, PhD in Biology, Senior Researcher at the Microbial Ecology Laboratory. Effects of different fertilizer systems and hydrothermal factors on microbial activity in the chernozem in Ukraine doi.org/10.15421/011846; Activity of the microbiocenose of the root zone of corn plants under the action of plant protection agents doi.org/10.31407/ijees13.402; Ecology of the agrosphere: textbook DOI: https://doi.org/10.33730/978-617-7785-30-8.

https://scholar.google.com.ua/citations?user=1QoK9GAAAAAJ&hl=ru



VIII. International Symposium-2024

WHY IS IT IMPORTANT TO MONITOR PESTS AND PATHOGENS OF THE COMMON HOP IN URBAN ECOSYSTEMS?

Anatolii ORLOVSKYI¹, Nazarii SUS², Iryna GUMENIUK³, Viktoriia TSVIHUN⁴

¹*Institute of Horticulture of the National Academy of Agrarian Sciences of Ukraine, Novosilky, Ukraine. mumuk6500@gmail.com*

²*Institute of Agroecology and Environmental Management of the National Academy of Agrarian Sciences of Ukraine, Kyiv, Ukraine. , email@nazariy-sus.com*

³*Institute of Agroecology and Environmental Management of the National Academy of Agrarian Sciences of Ukraine, Kyiv, Ukraine. gumenyuk.ir@gmail.com*

⁴*Institute of Agroecology and Environmental Management of the National Academy of Agrarian Sciences of Ukraine, Kyiv, Ukraine. vika-natceovich@ukr.net*

The common hop (*Humulus lupulus* L.) is represented in the urban ecosystems as a wild, escaped, or ornamental plant (Wittig, 2004; Banaszek et al., 2017; Korpelainen & Pietiläinen, 2021). Given its rare ornamental use, studies on pests and pathogens of hop plants have been conducted in agroecosystems or natural ecosystems, but not in urban ecosystems. Here, we substantiate the need of monitoring *H. lupulus* growing in cities for pests and pathogens. Pests and pathogens are most transmitted through vegetative propagation materials of alien ornamental plants, which are mainly introduced into urban ecosystems. In addition, cities, in particular large ones, serve as transportation hubs, and pests and pathogens are often transported as contaminants of commodities. As a result, urban ecosystems are often the first point of contact with alien pests and pathogens (Dehnen-Schmutz et al., 2007; Hulme, 2009; Paap et al., 2017; Branco et al., 2019; Hammond et al., 2023). Some of them, particularly polyphagous pests, and generalist pathogens, may infest hop plants growing in urban ecosystems. Finally, alien pests and pathogens of urban hop may subsequently spread to hop gardens and harm commercial hop plants. Therefore, for early detection of new pests and pathogens of hop plants and prevention of their spread to commercial hop gardens, ongoing monitoring of urban hop plants should be conducted.

Keywords: pest, disease, monitoring, *Humulus lupulus*, urban ecosystem

Biography



Anatolii Orlovskiy was born in 1991. He is a Candidate of Biological Sciences and researcher at the Institute of Horticulture of the National Academy of Agrarian Sciences of Ukraine, located in Novosilky village (Kyiv Oblast, Ukraine). His research primarily focuses on studying pests and diseases of forest trees and the common hop, plant viruses, and eco-friendly plant protection measures.



VIII. International Symposium-2024

FACTORS EFFECTING HOST PREFERENCES OF METCALFA PRUINOSA (SAY, 1830)

Nazarii SUS¹, Liliya JANSE², Anatolii ORLOVSKYI³, Viktoriia TSVIHUN⁴

¹*Institute of Agroecology and Environmental Management of the National Academy of Agrarian Sciences of Ukraine, Kyiv, Ukraine. email@nazariy-sus.com*

²*National Academy of Agrarian Sciences of Ukraine, Kyiv, Ukraine. liliya.janse@gmail.com*

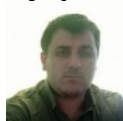
³*Institute of Horticulture of the National Academy of Agrarian Sciences of Ukraine, Novosilky, Ukraine. mumuk6500@gmail.com*

⁴*Institute of Agroecology and Environmental Management of the National Academy of Agrarian Sciences of Ukraine, Kyiv, Ukraine. vika-natcevich@ukr.net*

Metcalfa pruinosa (Say, 1830), the citrus flatid planthopper, is an invasive, highly polyphagous insect that has a wide host range in Europe: over 300 species in 78 families (Bagnoli and Lucchi 2000; Alma et al. 2005). To date it has already colonized 15 European countries and continues to spread in the region (Byeon et al., 2018; Świerczewski et al., 2022). Our previous studies demonstrated that in Kyiv (Ukraine) *M. pruinosa* infests at least 55 plant species belonging to 49 genera, 35 families, and 23 orders (Sus et al., 2023). However, *M. pruinosa* did not show host preference. The infestation symptoms and damage included deformation, wilt and injury of leaves, shoots, and twigs, as well as appearance of considerable amounts of honeydew, later colonized by sooty moulds. The present study was conducted to determine colonization preferences by *M. pruinosa* in relation to host plant habitus. It was shown that simple leaves or leaflets more than 1 cm in both length and width were more attractive for *M. pruinosa* among 50 out of 55 host plants. The hosts where leaf size appeared not important were *Ambrosia artemisiifolia* L., *Asparagus* sp., *Buxus sempervirens* L., *Erigeron canadensis* L., and *Tamarix ramosissima* Ledeb. In addition, *M. pruinosa* preferably infested plants whose leaves were located less than 1.5 m above soil level. The significance of these factors (size of leaves and distance of leaves to soil level) on host plant colonization are currently under investigation, taking all taxonomic plant groups into consideration.

Keywords: *citrus flatid planthopper, Ukraine, Kyiv, leaf size*

Biography



*Nazarii Sus is a researcher and PhD student at the Institute of Agroecology and Environmental Management of the National Academy of Agrarian Sciences of Ukraine, located in Kyiv, Ukraine. His research primarily focuses on studying pests and diseases affecting the common hop (*Humulus lupulus*).*



VIII. International Symposium-2024

ALTERNATIVE CARBON IN AGRICULTURAL PRODUCTION

Yeuheniia TKACH, I. MOVCHAN

Institute of Agroecology and Environmental Management of NAAS, Metrologichna, Kyiv,
Ukraine

bio_eco@ukr.net, +38-0976855516

The effectiveness of the interaction between edaphotope, climate and biotope determine the main indicators of soil fertility and physical and chemical properties. It is microbial communities that evolution has assigned the most important mission-the cycle of substances in the biosphere, decomposition and mineralisation of a huge mass of organic matter, etc. In Ukraine, agriculture annually produces an average of about 50-60 mil. tonnes of grain and approximately the same amount of straw and crop residues. It has been found that more than 20-40% of straw is not used at all. Agricultural producers usually solve the problem of organic material accumulation in agroecosystems in three common ways. The first is burning straw on the field. This is the most irrational and destructive way for all types of biogeocenosis components. The inexpediency of this method lies in the fact that the burning of organic residues pollutes the atmosphere with CO, CO₂, nitrogen oxides, chlorine-containing substances and heavy metals that were directly part of the plant material. The second is the collection and removal of straw from the field with the subsequent use of post-cutting organic materials such as bedding or cattle feed. Carbon is returned to the agroecosystem in the form of humus. The third (biological method) is the decomposition of straw in the field using various biological products. In field studies determine the effectiveness of biological products for the destruction of organic material containing active bacterial strains of the genera *Paenabacillus*, *Azotobacter*, *Enterobacter* and genus *Trichoderma*. It was found that the use of biological products for the treatment of straw and post-harvest residues of winter wheat contributed to a 2-fold increase in the overall biological activity of the soil compared to the control. It was shown that the level of cellulolytic activity increased from 23 to 34 %, and the antifungal activity increased by 2.5-3 times compared to the control. The obtained results of field studies indicate the prospects for agriculture of various forms of ownership.

Keywords: *biological method, ecosystem, microorganisms, soil, fertiliser*



VIII. International Symposium-2024

FREQUENCY OF OCCURRENCE, ABUNDANCE OF ADVENTIVE PLANT SPECIES IN AGROCENOSSES (ON THE EXAMPLE OF ODESA REGION)

Viktoriya STARODUB, Yevheniia TKACH, Andrii KRYZHANIVSKYJ

*Department of Agroecology and Biosafety, Institute of Agroecology and Environmental Management of NAAS, Kyiv, Ukraine.
myrzavica88@ukr.net*

It is known that agrocenoses are contaminated by many segetal weed species, among which a significant proportion are adventitious (invasive) alien species. Having entered a new territory where they have not been found before, these species compete with native species for moisture and light, thereby completely or partially displacing their populations. The result of each route survey is data on the following ecological indicators: species richness, frequency of occurrence and abundance of local populations of all adventive plant species. The concept of "biodiversity" is complex and multifaceted and often uncertain, but it is described by such components as the frequency of occurrence and abundance of species that are common, particularly agrocenoses. The frequency of occurrence and the abundance of a species are not directly related. A species may be rare but occur quite often, or abundant but have a low frequency of occurrence. Therefore, the identification and assessment of species by such indicators is essential for further determining the role and place of the species in the studied cenosis. Thus, in the farm located in Bobryk Pershyi village, Odesa region, 42 species of weeds were identified in winter wheat crops, of which 16 species were classified as class 2, with the highest abundance being the following: *Avena fatua* L, *Grindelia squarrosa* L, *Stellaria media* L., *Sisymbrium officinale* L, *Thlaspi arvense* L *Setaria glauca* L.; 1 species was recorded in class 3 – early spring: *Fallopia convolvulus* L.; up to class 4, seven species of overwintering, with an average abundance over the years of research of 1.13, 1.47 pcs/m² *Tripleurospermum inodorum* L, *Capsella bursa-pastoris* L; up to class 5–6 species, among them were perennial root sprouts *Elytrifia repens* L, annual plants – *Centaurea cyanus* L, *Bromus arvensis* L, *Anagallis arvensis* L.; class 6 occurrence includes 12 species, including annual adventitious species *Ambrosia artemisiifolia* L., *Iva xanthifolia* (Nutt.), perennial – *Xanthium strumarium* L., among the segetal species, overwintering species contaminated the agrocenosis – *Galium aparine* L, root sprouts – *Sonchus arvensis* L, *Convolvulus arvensis* L., annuals – *Amaranthus album* L, *Chenopodium album* L, *Consolida regalis* L, *Papaver rhoeas* L, *Sonchus oleraceus* L, *Lactuca serriola* L.

Keywords: *agrocenoses, segetal weed species, adventive plant species*



VIII. International Symposium-2024

VIRAL AND BACTERIAL DISEASES OF PLANTS IN FOREST ECOSYSTEMS OF UKRAINE

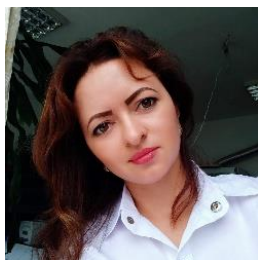
Viktoriya TSVIHUN, Iryna GUMENIUK

*Department of Agroecology and Biosafety, Institute of Agroecology and Environmental Management of NAAS, Kyiv, Ukraine.
vika-natcevich@ukr.net*

Currently, the assessment of the ecological situation of forest biocenoses shows that the impact of biotic and abiotic factors on biodiversity causes significant changes in their structure and functioning. Under such conditions, pathogens of different taxonomic groups become dangerously variable and harmful. As a result of these factors, the plant organism reduces its productivity against the background of significant pathologies. The aim of the study was to test plants of forest ecosystems for damage by bacterial and viral pathogens. Virological, microbiological, immunological and statistical research methods were used in the study. The results of the study show that woody plants in forest biocenoses were often exposed to viruses and bacteria, forming a complex infection that causes significant pathological changes in plants. Among the viruses, tobacco mosaic virus (TMV), carlavirus, irarvirus, and cucumber mosaic virus (CMV) dominated. It is worth noting that carlaviruses often latently infect plants such as wild hops, hazel, and birch. Pathogens of tobacco mosaic virus were found on plants of sharp-leaved maple, sycamore and lodgepole pine. It also infected various plantain species growing along roads. This pathogen has high antigenic activity. CMV was diagnosed with birch plants. It was found that wild pear plants in field protection strips are often infected with the bacterium *Erwinia amylovora*. This type of bacteria on plants often causes the tops of the plant and lateral branches to dry out, and the fruits of the wild pear become smaller and covered with black-brown spots. In addition, our research revealed the pathogen *Pseudomonas quercus*, which causes oak cancer. The disease is manifested by the formation of halo-like growths on the trunks of plants and deformation of the bark. We consider it expedient to use modern technologies for the diagnosis of pathogens of different taxonomic groups to obtain high-quality planting material for forest wood plants.

Keywords: *forest biocenoses, diagnosis of pathogens diagnosis of pathogens, pathological changes in plants*

Biography



PhD in Biological Sciences (Virology). Head of Virology and Biosafety named after A.L. Boyko labor. Scientific fields: Cucumber and tobacco mosaic virus; Prevalence of viral diseases of agricultural plants on the territory of Ukraine.

Agroecology and biosafety. Professional skills: Molecular methods: Isolation of DNA; Polymerase chain reaction (PCR); Enzyme immunoassay (ELISA); Gel electrophoresis; Southern blotting. Author of 57 scientific works, including 3 in publications that are included in the scientometric databases of Scopus or Web of Science, co-author of 5 monographs and 6 methodological recommendations. Member of National Public Organization Vynohrads'kyj Society of Microbiologists of Ukraine (SMU) and FEMS; Member of All-Ukrainian Public Organization "Vavilov Society of Geneticists and Breeders of Ukraine"; Member of the All-Ukrainian Public Organization "Association of Agroecologists of Ukraine"; Head of the physics-chemical testing group of TL "DAB"; Lecturer of the course of lectures "Ecology of the biosphere", "Ecology of viruses", "Ecology of microorganisms", "Biosafety", "Eco-safe agricultural technologies".



VIII. International Symposium-2024

IMPACT OF WASTE MANAGEMENT ON CLIMATE CHANGE ON THE EXAMPLE OF KAZAKHSTAN

Danara SMAIL^{1,2}

¹*Licensed Expert on “green building”, Kazakhstan,*

²*University of Pécs, Hungary*

danarasmail@gmail.com, +7 7012725503

The article “Impact of Waste Management on Climate Change on the Example of Kazakhstan” considers waste management methods applied in Kazakhstan and their impact on climate change. When writing the article, data on the volume and composition of waste in Kazakhstan were collected and analyzed. Based on the data, the country produces about 4 million tons of solid domestic waste annually, of which only 10% is recycled and 90% is disposed of in landfills. The analysis showed that such waste management practices lead to high emissions of methane and other greenhouse gases, which exacerbates the problem of climate change.

The results of the study indicate the need for reforming the waste management system in Kazakhstan, including improving recycling technologies, composting and reducing waste disposal. The article describes proposed measures to introduce efficient waste management technologies, strengthen recycling-related legislation and increase environmental awareness of the population.

Undoubtedly, the adoption and implementation of active measures, including the need to build waste treatment plants in the regions, will reduce greenhouse gas emissions, minimize the environmental impact of waste and contribute to the achievement of sustainable development goals, which is essential to meet the challenges of climate change in Kazakhstan.

Keywords: *Waste management, Climate change, Sustainable development*

Biography



Danara Smail, PhD student in Law at University of Pécs, Hungary, DOSZ Ambassador-24/25, Chairwoman of AlumniHU-KZ, licensed Expert on “green building” (Kazakhstan, 2024) participates in projects aimed at supporting and implementing sustainable development goals in Kazakhstan.



VIII. International Symposium-2024

EFFECT OF DEFICIT IRRIGATION ON BARLEY YIELD AND WATER PRODUCTIVITY THROUGH FIELD EXPERIMENT AND MODELING AT KOGA IRRIGATION SCHEME, AMHARA REGION, ETHIOPIA

Bekalu Melis ALEHEGN¹, Dagnenet Sultan ALEMU²

¹Assosa University, college of Agriculture, Department of Soil Resource and Watershed Management, Ethiopia. [Email.bekalumelis6@gmail.com](mailto:bekalumelis6@gmail.com)

²Bahir Dar university faculty of civil and Water Resource Engineering, Ethiopia

The insufficiency of water is the most severe restraint for the expansion of agriculture in arid and semi-arid areas. An important strategy for increasing water productivity and improving water productivity deficit irrigation at different growth stages is important to advance the yield and Water Productivity of barley in water scarce areas. A field experiment was conducted at the Koga irrigation scheme in Ethiopia to examine barley yield response to different irrigation regimes and validate the aqua crop model. The experimental setup comprised six randomized treatments (T) with three replications for one irrigation season because of financial limitations. The irrigation regimes were selected 100%, 75%, and 50% application level in different growth stages of gross irrigation requirement using try and error in order to selecting the optimal water application level. The treatments were: no stress at all (T1), 25% stressed during all crop stages (T2), 50% stressed at all stages (T3), 50% stressed at development stage (T4), 50% stressed at mid-stage (T5) and 50% stress at initial and late season (T6). The agronomic parameters including canopy cover, biomass, and grain yield were collected to compare the ground-based crop yield and the aqua crop model. The results showed that the initial and late stages and stress 25% through the whole season were the right time for practice deficit irrigation without significant yield reduction. The highest (2.62kg/m³) and the lowest (2.03 kg/m³) water productivity were found under T3 and T4, respectively. The stress of 50% at the mid-growth stage and stress 50% of the full irrigation water requirement at all growth stages significantly ($\alpha=5\%$) affected the canopy expansion, biomass and yield production. The aqua Crop model performed well in simulating the yield of barley for most of the treatments ($R^2 = 0.84$ and $RMSE = 0.7 \text{ t ha}^{-1}$).

Keywords: Aqua Crop, barley, deficit irrigation, irrigation regimes, water productivity,



VIII. International Symposium-2024

EVALUATION OF THE PERFORMANCE AND QUALITY OF VETIVER PLANT UNDER THE INFLUENCE OF SOME ENVIRONMENTAL FACTORS (CASE STUDY: SIDE AREA OF SANGAR DAM RESERVOIR - IRAN)

Sahel HAGHIGHI, Forood SHARIFI

*Soil Conservation and Watershed Management Research Institute, Tehran, Iran,
Sahel.haghighi66@gmail.com*

Following the change of climatic conditions in recent decades and with the intensification of soil erosion and pollution, in many countries of the world, in order to protect the environment and natural resources, planting a large area of Vetiver plant under the title (soil bioengineering) has been considered. In this research, sampling of Vetiver plant roots and soil from the depth of 0-50 cm on the side of the dam wall with different slopes: the first level (30-40 degrees), the second level (40-50 degrees), The third level (60-70 degrees) was done in four repetitions. A total of 12 soil samples (untouched) and 12 soil samples along with Vetiver plant roots were sampled using a steel ring and 12 Vetiver plant samples. Soil characteristics from soil texture by hydrometric method, soil by weight method, acidity by saturated mud method, electrical conductivity by extraction method and soil salinity by EC meter, percentage of organic matter, lime and soil potassium by using film device. Photometers were measured in the laboratory. The results of this research show that the planting of Vetiver plant in the sloping slopes due to its high adaptability in different climates and conditions, the possibility of several meters of root growth, to stabilize the soil and prevent sliding and erosion in the sloping Lands.

Keywords: *Slope, root, weight, resistance, shear stress*

Biography:



Dr. Sahel Haghi completed his high school and pre-university education at the "Talaash" Model State School in Kermanshah Province. In high school, he won first place in the Chemistry Olympiad. SHe received a bachelor's degree in "Range and Watershed Engineering" and a master's degree in "Range Sciences" with honors from Malayer State University. She earned an interdisciplinary doctorate in "Medicinal Plants-Range" from Mazandaran University of Medical Sciences and Mazandaran University of Agricultural Sciences with honors. She is currently studying as a postdoctoral researcher at the Soil Conservation and Watershed Management Research Institute (IRAN-Tehran) to carry out the "Electrophysiology of Water, Soil and Plants" project. SHe is the inventor of "Herbal Medicine for the Treatment of Fungal and Bacterial Infections". She is also the translator of the book "Vetiver" and the author of numerous scientific research and scientific extension books and articles.



MANUSCRIPTS OF ORAL AND POSTER PRESENTATIONS



VIII. International Symposium-2024

SUSTAINABILITY OF FOOD SUPPLY OF MIDDLE-EAST, NORTH-AFRICA AND INDIA BETWEEN 2010-2020

Sándor J. Zsarnóczai*, Hosam E.A.F. Bayoumi Hamuda

Óbuda University, Rejtő Sándor Faculty of Light Industry and Environmental Engineering,
Institute of Environmental Engineering and Natural Science, Doberdó u. 6, H-1034 Budapest,
Hungary, e-mail: zsarnoczaisandorjozsef@gmail.com; bayoumi.hosam@rkk.uni-obuda.hu

Abstract:

The study overviews the possible balanced food demand-supply ratio in the MENA region and India during the researched period of 2010-2020. The sustainability of food supply of selected countries is very sensitivity accompanying with income-able agricultural production based on the advanced innovative technology. The food self-sufficient ratio mostly needs for setting up increasing agricultural production and not food import. To obtain wide-side overview for the food balance of selected countries, the study needs for the working out the SPSS as statistical program for social science system. Very strong correlations were between agriculture; value added in percent of GDP and value of food imports over total merchandise exports in period of 2010-2020. The food import also could increase food self-sufficiency of these selected countries, but this did not decrease their food import dependence coming abroad. For the researched period this MENA region and India have sharply increased their food import dependence. To solve food import issue for decreasing food dependence is to develop the innovation of agricultural and food production mostly in fields of mechanization, irrigation system and chemical materials included in input, as pesticide and fertilizer accompanying with possible less increasing trend of populations of these selected countries.

Keywords: Advanced innovative technology, agricultural gross value-added, agricultural production, import dependence, irrigated agriculture, self-sufficient ratio

INTRODUCTION

Recently, sustainability of food supply became considerable issue for ensuring demands of the populations in Middle East, North Africa (MENA) and India. The study overviews some main elements of the food supply and several economic background of changing food conditions for the period of 2010 and 2020. The economic, social and natural conditions can make serious influences on changes of food conditions in this region of the world economy.

The sustainability of food supply of this region is very sensitivity, because the adequate food supply and positive balance of food supply and food demand can contribute to quite normal balanced social conditions in these selected countries. The satisfactory food supply can ensure more highly level of standard of life. The food supply can be ensured by increasing profitable, income-able agricultural

production based on the advanced innovative technology with highly educated agricultural producers within a successful rural development.

The successful food supply can also be ensured by food import from other different regions of the world economy, for which the MENA region and India can be wide-side continuous fixed markets for longer time. The food self-sufficient ratio (SSR) is based on the domestic food production and food import minus the food export. The Middle East and North Africa and India are closed to the European Union; therefore, these selected countries can be possible important trading and economic partners for the EU and other European countries. Additionally, to these reasons for analysing this region, the crude oil exporting Arab countries and Iran can supply important fossil energy resources for the European countries. The most of crude oil exporting countries of this region are mostly depending on the food import coming from the European Union. From this point of view, common economic interests can ensure more deeply trading partnership between the European Union and selected countries of this study. The study analyses the sustainable food supply of these selected countries, which are as follows: Algeria, Morocco, Tunisia, Libya, Egypt, South Sudan, Sudan, Somalia in North Africa, Lebanon, Syria, Jordan, Iraq, Yemen, Iran, Türkiye in Middle East, and Kuwait, Bahrain, Qatar, UAE (United Arab Emirates), Oman, Saudi Arabia in Gulf region, and also India.

The main economic conditions concerning the sustainable food supply of MENA region and India as objects can be analysed based on main economic variables as economic features of the selected countries, which are as follows: agricultural GVA (gross value-added) produced by irrigated agriculture, total country area cultivated, agriculture, value added in % of GDP, change of GDP per capita, human development index, food availability average protein supply, value of food imports over total merchandise exports, per capita food supply variability, change of irrigated agriculture water use efficiency and finally change of total population.

Aims of the study are to analyse correlations among economic variables as economic features of selected countries of the study. There are some main hypotheses, which are as follows based on the Table-1 and Table-2 (FAO AQUASTAT, Rome, 2023).

The analyse correlations between agricultural GVA produced by irrigated agriculture in 2010 and in 2020 (AGVAi101, AGVAi202).

Analyse correlations of agricultural GVA produced by irrigated agriculture in 2010 and in 2020 (AGVAi101, AGVAi202) with agriculture, value added in % of GDP in 2020 (AVA20GDP6), human development index (HDI8) and change of total population in period of between 2021 and 2020 (TotalPo16).

Analyse correlations between percent of total country area cultivated in 2010 and in 2020 (ToCoAcu103, ToCoAcu204).

Analyse correlations of agriculture, value added in % of GDP in 2010 and in 2020 (AVA10GDP5, AVA20GDP6) with human development index (HDI8), the value of food imports over total merchandise exports (%) (3-year average) in 2009-2011 and in 2019-2021 (FoodIm0911, FoodIm2012), and change of total population in period of between 2021 and 2020 (TotalPo16).

Analyse correlations of food availability average protein supply (g/capita/day) (3-year average) between 2009-2011 (FoodP119) between 2018-2020 (FoodP2010) with value of food imports over total merchandise exports (%) (3-year average) in 2009-2011 (FoodIm0911) and in 2019-2021 (FoodIm2012).

Analyse correlations of food availability average protein supply (g/capita/day) (3-year average) between 2018-2020 (FoodP2010) with value of food imports over total merchandise exports (%) (3-year average) in 2019-2021 (FoodIm2012).

Analyse correlations of per capita food supply variability (kcal/capita/day) in 2020 (FoodPeCa2014) with change of total population in percent in 2020 (2010=100) (TotalPo16).

Analyse somehow increases of food availability average protein supply (g/capita/day) (3-year average) (FoodP119, FoodP2010) and per capita food supply variability (kcal/capita/day) for the period of 2021 and 2020 (FoodPeCa1013, FoodPeCa2014), while in the same time the value of food imports over total merchandise exports (%) (3-year average) (FoodIm0911, FoodIm2012) increased, therefore the food import dependence of the region increased.

The wide-side data base come from the main scientific sources mostly national statistical books of selected countries and then FAO (Food and Agriculture Organization of United Nations) and FAO AQUASTAT, OECD (Organisation for Economic Co-operation and Development) and IFAD (International Fund for Agricultural Development) is an international financial institution and a specialized agency of the United Nations. The IFAD dedicated to eradicating poverty and hunger in rural areas of developing countries (OECD-FAO 2018, FAO 2023).

IFAD stated that the delivery of high-quality and effective country programmes will be IFAD's direct means for achieving its objectives. However, ensuring that IFAD's development impact is bigger, better and smarter will also require state-of-the-art knowledge and evidence, proactive engagement in international policy processes, mobilization of additional resources, diversification of financial products to cater to clients' evolving needs, and an effective and efficient institutional platform (IFAD, 2016, IFAD 2019).

The food value chain accounts for c. 25- 30% of total Green House Gas (GHG) emissions. According to the IPCC (Intergovernmental Panel for Climate Change), observed climate change is already affecting food security through increasing temperatures, changing rain patterns, and a greater frequency of extreme events. Combining supply-side actions such as efficient production, transport, and processing with demand-side interventions such as modification of food choices and reduction of food loss and waste, can reduce Green House Gas emissions and help feed the planet's projected 9 billion population in 2050 (MCO 2024).

The sustainable food supply faced some difficult climate changes even at recent decade (see more in Bucchignani et al 2018). Some authors declared the importance of foreign trade and increasing domestic food production in MENA region in order to meet domestic food demand ([Lofgren - Richards](#), 2003). MENA region has high and growing dependence on international markets for key staple food products, while MENA is one of the most land and water constrained regions of the world, it has the lowest water tariffs in the world, and it heavily subsidises water consumption at about 2% of its GDP. (World Bank, 2018).

While fruits and vegetables both consume less water and provide higher economic returns per drop, about 60% of harvested land remains in water-thirsty cereals, The food security aims to reduce dependence on imports, particularly for cereals. But in some countries, consumption of basic foodstuffs, which in conjunction with rising incomes is contributing to excess consumption of starches and sugars leading to dietary and health concerns such as obesity (FAO 2017a; FAO, 2017b; Ruckstuhl -Ward 2017).

The only 4% of land in the MENA region has soils judged of high or good suitability for rain-fed cereal cultivation and 55% is unsuitable FAO (2018). In addition to the dearth of suitable land for cultivation, soils currently used for farming are severely degraded to the point, where their productivity is estimated to have been reduced by up to 30 to 35% of potential productivity (FAO and ESCWA, 2018).

The region also suffers from severe land constraints. Less than 5% of land is arable in two-thirds of the countries of the region, while many countries (Saudi Arabia, Lebanon, Tunisia, Morocco, Yemen, Mauritania and Syria) have huge desert pastures for livestock grazing. The region is the most water-stressed in the world, and two-thirds of countries continue to use groundwater at rates exceeding renewable internal freshwater resources (World Bank, 2018).

The study overviews the food supply-food demand balance in MENA region and India, which balance is depending on the social economic conditions accompanying with foreign trade and geographic - climate situations. This last one, because the global warming and longer drought period yearly, has become less favourable for the food production and food supply for populations of these selected countries. The following chapters overview statistical method and food balance in these countries emphasizing trend of the increasing food import-dependence.

MATERIALS AND METHODS

To obtain wide-side overview for the food balance of selected countries, the study needs for the working out the SPSS (Statistical Program for Social Science) system. The SPSS system has become more traditional one based on the work of [Mitev - Sajtos](#) (2007), [Horváth - Mitev](#) (2023) and Field (2020).

Additionally, to the data base for sustainability of food supply of MENA region and India some agricultural economic data are needed for understanding the food supply-demand balance, which concern irrigated agriculture, cultivated areas, GDP growth per capita and foreign trade according to the food supply in selected countries of this study.

The economic variables as features of countries used in the research, which are as follows: the agricultural GVA (gross value-added) produced by irrigated agriculture in 2010 (AGVAi101) and in 2020 (AGVAi202), in percent of total country area cultivated in 2010 (ToCoAcu103) and in 2020 (ToCoAcu204), agriculture, value added in % of GDP in 2010 (AVA10GDP5) and in 2020 (AVA20GDP6), change of GDP per capita in percent in 2020 from 2010 (GDPpCap7), human development index (HDI) in 2020 (HDI8), food availability average protein supply (g/capita/day) (3-year average) between 2009-2011 (FoodP119) and between 2018-2020 (FoodP2010), value of food imports over total merchandise exports (%) (3-year average) in 2009-2011 (FoodIm0911) and in 2019-2021 (FoodIm2012), per capita food supply variability (kcal/capita/day) in 2010 (FoodPeCa1013), and in 2020 (FoodPeCa2014), change of irrigated agriculture water use efficiency in 2020 (2010=100) in percent, US\$/m³ (IrAgWatUE15) and finally change of total population in percent in 2020 (2010=100) in 1000 inhabitants (TotalPo16) (Table-1; Table-2; FAO AQUASTAT, Rome, 2023, National statistical books). The above-mentioned data are analysed in correlation system among the economic variables; therefore, these data are averagely calculated within the correlation matrix for whole researching period of 2010-2020 with participating all selected countries in Table-3 (FAO AQUASTAT, Rome, 2023, National statistical books).

The Table-4 shows the KMO and Bartlett's Test, which means that because the KMO measure is 0.593 over level of 0.500 and the Bartlett's Test of Sphericity Approx. Chi-Square is 395.920 higher than 100.000 and the significance is 0.000; the data base is correct and satisfactory for analysing. The Table-5 shows the Total Variance Explained, which means that first five components are totally in values of 84.148 (84,1%), which are more than 60%, as adequate for analysing. The Table-6 shows rotated component matrix including all economic variables selected into five components concerning following Figures 1-4. (FAO AQUASTAT, Rome, 2023, National statistical books). The component-1 (AVA10GDP5, FoodIm0911, AVA20GDP6, FoodIm2012, TotalPo16) is at line horizontal X line of coordinate system in all of four coordinate system of Figures-1-4, while the component-2 (AGVAi101, AGVAi202, FoodPeCa2014) at line vertical Y in the Figure-1; the component-3 (FoodP119, FoodP2010, HDI8, FoodPeCa1013) at line vertical Y in the Figure-2; the component-4 (ToCoAcu204, ToCoAcu103) at line vertical Y in the Figure-3; the component-5 (IrAgWatUE15, GDPpCap7) at line vertical Y in the Figure-4.

The rotated component matrix (Table-6) accompanying with above mentioned Figures-1-4 are needed to analyse differences of selected countries base on their economic features and to demonstrate ordering of countries comparably each-others. Figures-1-4 can show positions of each country in the coordinate system, when either one economic variable increases in the positive session of the coordinate system or the other one decreases in the negative session of this coordinate system.

STATISTICAL ANALYSIS AND GRAPHICAL PRESENTATION

Table 1: Means of economic variables

Economic variables	Means of economic variables	Years	Sources
AGVAi101	% of agricultural GVA produced by irrigated agriculture in 2010	2010	FAO AQUASTAT
AGVAi202	% of agricultural GVA produced by irrigated agriculture in 2020	2020	FAO AQUASTAT
ToCoAcu103	% of total country area cultivated in 2010	2010	FAO AQUASTAT
ToCoAcu204	% of total country area cultivated in 2020	2020	FAO AQUASTAT
AVA10GDP5	Agriculture, value added (in % of GDP) in 2010	2010	FAO AQUASTAT
AVA20GDP6	Agriculture, value added (in % of GDP) in 2020	2020	FAO AQUASTAT

GDPpCap7	Change of GDP per capita in percent in 2020 (2010=100) current US\$/inhab	2010-2020	FAO AQUASTAT
HDI8	Human Development Index (HDI) [highest = 1] in 2020	2020	FAO AQUASTAT
FoodP119	Food availability Average protein supply (g/capita/day) (3-year average)	2009-2011	FAOSTAT
FoodP2010	Food availability Average protein supply (g/capita/day) (3-year average)	2018-2020	FAOSTAT
FoodIm0911	Value of food imports over total merchandise exports (%) (3-year average)	2009-2011	FAOSTAT
FoodIm2012	Value of food imports over total merchandise exports (%) (3-year average)	2019-2021	FAOSTAT
FoodPeCa1013	Per capita food supply variability (kcal/capita/day) in 2010	2010	FAO AQUASTAT
FoodPeCa2014	Per capita food supply variability (kcal/capita/day) in 2020	2020	FAO AQUASTAT
IrAgWatUE15	Change of Irrigated Agriculture Water Use Efficiency in 2020 (2010= 100) in percent, US\$/m ³	2010-2020	FAO AQUASTAT
TotalPo16	Change of Total population in percent in 2020 (2010=100) in 1000 inhabitants	2010-2020	FAO AQUASTAT

Source: FAO AQUASTAT, Rome, 2023, National statistical books

Note: The last one figure or last two figures of the titles belonging to the economic variables are ordering number of the variables in this study. Before these ordering number the years are shortly shown. The titles of the variables generally follow short names of the economic variables.

Table 2: Economic features of food supply in MENA region and India in percent between 2010-2020 in million dollars and average protein supply (9,10) in g/capita/day, and per capita food supply variability in kcal, capita per day (13,14)

	Horizontal line X					Vertical line Y										
	Component-1					Component-2			Component-3				Comp-4		Comp-5	
	5	6	11	12	16	1	2	14	8	9	10	13	3	4	7	15
Egypt	13.3	12	39	45	23	100	100	19	0.7	99	95	45	4	4	38	36
India	17	16	5	6	12	71	72	21	0.6	58	66	43	51	51	36	63
Jordan	3.6	5	33	43	41	54	40	41	0.7	76	64	60	3	3.2	15	16
Lebanon	3.9	4	47	52	38	97	97	47	0.7	78	69	26	23	26	3	-48
Syria	20	21	28	127	-18	41	41	24	0.6	56	76	88	31	31	-70	-45
UAE	0.8	0.8	5	4	16	100	100	35	0.9	83	83	77	1.1	1.3	7	100
Bahrain	0.3	0.3	7	9	37	93	93	62	0.8	31	62	31	6	5.9	-5	20
Iraq	5	3.8	9	15	35	68	60	23	0.7	63	64	25	10	12	-11	19
Kuwait	0.45	0.38	3	8	43	100	100	46	0.8	107	102	67	0.9	0.8	-36	-14
Oman	1.4	2.3	6	9	67	100	100	136	0.8	84	86	36	0.23	0.35	-34	92
Qatar	0.1	0.2	2	4	55	100	100	67	0.8	34	67	34	1.6	2.1	-24	172
Saudi A	2.6	2.2	5	8	27	100	100	40	0.9	87	89	54	1.6	1.7	4	10
Iran	5.7	14	7	13	14	55	49	37	0.8	83	83	39	9.8	10	57	126
Somalia	53	53	94	472	-25	12	12	18	0.4	11	18	11	1.8	1.8	30	0.1
Sudan	20	20	33	55	2	23	23	42	0.5	25	75	18	11	11	74	1
Yemen	10	19	31	259	19	55	55	44	0.4	59	53	18	3	2.8	-30	-38
Algeria	8	14	12	28	22	22	28	42	0.7	87	90	25	3.5	3.6	-25	78
Libya	1.8	4.7	6	16	12	39	39	21	0.7	53	82	8	1.2	1.2	-65	-46
Morocco	13	12	21	18	16	29	29	30	0.7	94	100	23	20	21	7	27
S Sudan	3.5	3.7	9	40	1	2	2	43	0.4	21	43	21	4	4	-5	0.1
Tunisia	6	10	11	14	11	16	17	19	0.7	96	100	41	32	30	-20	78
Türkiye	9	6	6	7	17	31	31	23	0.8	103	111	24	31	30	-20	186
Average	9	10.2	19	57	21	59.5	58.5	40	0.7	67.6	76.3	37	11.4	11.6	-3.4	38

Source: FAO AQUASTAT, Rome, 2023, National statistical books

Note: The structure of the Table-1 is based on the coordinate system in Figures-1-4

Countries of this table are distributed into four sessions of the coordinate system based on the economic variables of componenet-1 and componenet-2. Component-1 at horizontal line X; Components-2-3-4-5 at vertical line Y, Saudi A = Saudi Arabia, S Sudan = South Sudan, UAE = United Arab Emirates

Table 3: Correlation Matrix																	
		AG VAi10 1	AG VAi20 2	To Co Acu 103	To Co Acu 204	AV A10 GD P5	AV A20 GD P6	GD Pp Ca p7	H D I 8	Fo od P1 19	Fo od P2 010	Foo dIm0 911	Foo dIm2 012	Foo dPe Ca1 013	Foo dPe Ca2 014	IrA gW atU E15	To tal Po 16
Co rrel ati on	AG VAi 101	1.0 00	.99 4	-.22 5	-.20 2	-.471	-.526	-.03 1	.6 3 7	.29 6	.20 0	-.27 7	-.34 8	.426	.426	.095	.69 9
	AG VAi 202		1.0 00	-.21 1	-.18 9	-.457	-.512	-.05 6	.6 3 0	.29 5	.22 1	-.28 5	-.34 2	.408	.433	.100	.67 8
	ToC oAc u10 3			1.0 00	.99 8	.181	.127	.05 7	-.0 9 5	.15 0	.20 4	-.06 8	-.14 6	.111	-.377	.117	-.30 6
	ToC oAc u20 4				1.0 00	.175	.118	.06 5	-.0 9 2	.14 6	.18 9	-.05 6	-.15 0	.103	-.371	.096	-.28 8
	AV A10 GD P5					1.00 0	.966	.33 0	-.6 2 0	-.41 5	-.48 5	.81 7	.82 7	-.217	-.378	-.198	-.71 3
	AV A20 GD P6						1.00 0	.30 1	-.6 6 5	-.40 1	-.50 1	.80 1	.86 9	-.249	-.361	-.214	-.72 6
	GD PpC ap7							1.0 00	-.1 3 3	-.14 1	-.17 8	.31 6	.07 5	-.148	-.175	.152	-.17 2
	HDI 8								1 0 0 0	.61 3	.66 9	-.58 5	-.68 0	.435	.247	.481	.59 4
	Foo dP1 19									1.0 00	.84 0	-.34 6	-.46 9	.384	-.021	.265	.36 1
	Foo dP2 010										1.0 00	-.55 7	-.68 1	.303	.009	.360	.30 4
	Foo dIm 091 1											1.0 00	.84 4	-.232	-.251	-.413	-.46 7
	Foo dIm 201 2												1.0 00	-.257	-.202	-.355	-.54 5

	FoodPe Ca1 013												1.00 0	- .006	.031	.06 6
	FoodPe Ca2 014												1.00 0	.192	.68 9	
	IrAg Wat UE1 5														1.00 0	.28 3
	Tota lPo1 6															1.0 00

Source: FAO AQUASTAT, Rome, 2023, National statistical books based on the SPSS owned calculation

Table 4: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.593
Bartlett's Test of Sphericity	Approx. Chi-Square	395.920
	df	120
	Sig.	.000

Source: FAO AQUASTAT, Rome, 2023, National statistical books based on the SPSS owned calculation

Table 5: 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	6.671	41.694	41.694	6.671	41.694	41.694	4.470	27.935	27.935
2	2.854	17.840	59.535	2.854	17.840	59.535	2.930	18.314	46.248
3	1.574	9.836	69.370	1.574	9.836	69.370	2.470	15.436	61.685
4	1.260	7.875	77.245	1.260	7.875	77.245	2.300	14.373	76.057
5	1.104	6.902	84.148	1.104	6.902	84.148	1.295	8.091	84.148

Extraction Method: Principal Component Analysis.

Source: FAO AQUASTAT, Rome, 2023, National statistical books based on the SPSS owned calculation

Table 6: Rotated Component Matrix^a

	Component				
	1	2	3	4	5
AVA10GDP5	.883				
FoodIm0911	.882				
AVA20GDP6	.874				
FoodIm2012	.834				
TotalPo16	-.634				
AGVAi101		.939			

AGVAi202		.928			
FoodPeCa2014		.439			
FoodP119			.845		
FoodP2010			.794		
HDI8			.598		
FoodPeCa1013			.552		
ToCoAcu204				.980	
ToCoAcu103				.976	
IrAgWatUE15					.742
GDPpCap7					.711

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. a. Rotation converged in 7 iterations.

Source: FAO AQUASTAT, Rome, 2023, National statistical books based on the SPSS owned calculation

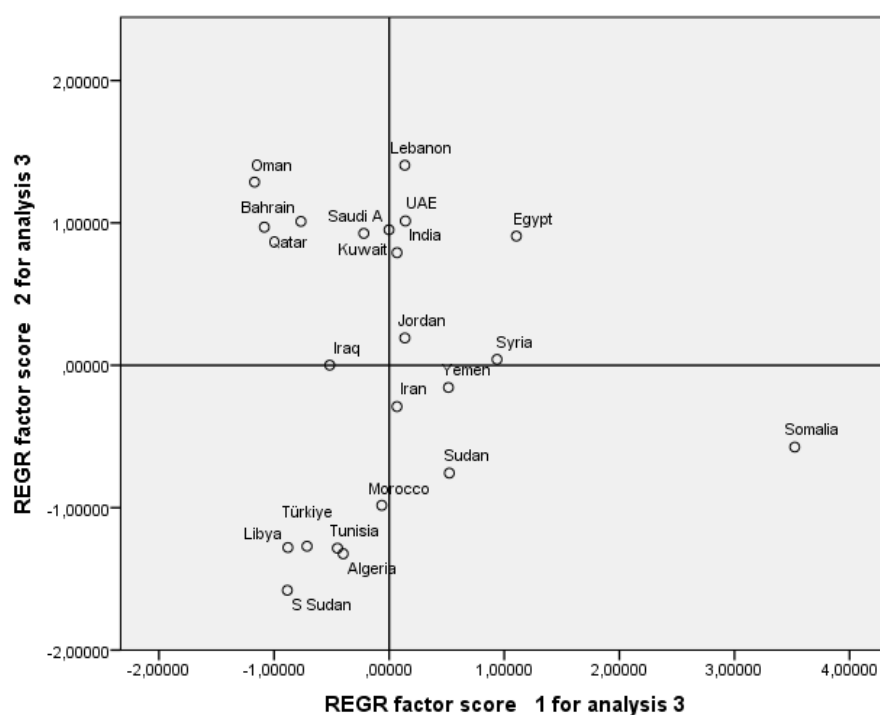


Figure 1: REGR factor score 1 and 2. Correlations among component-1 (AVA10GDP5, FoodIm0911, AVA20GDP6, FoodIm2012, TotalPo16) and component-2 (AGVAi101, AGVAi202, FoodPeCa2014); Source: FAO AQUASTAT, Rome, 2023, National statistical books based on the SPSS owned calculation

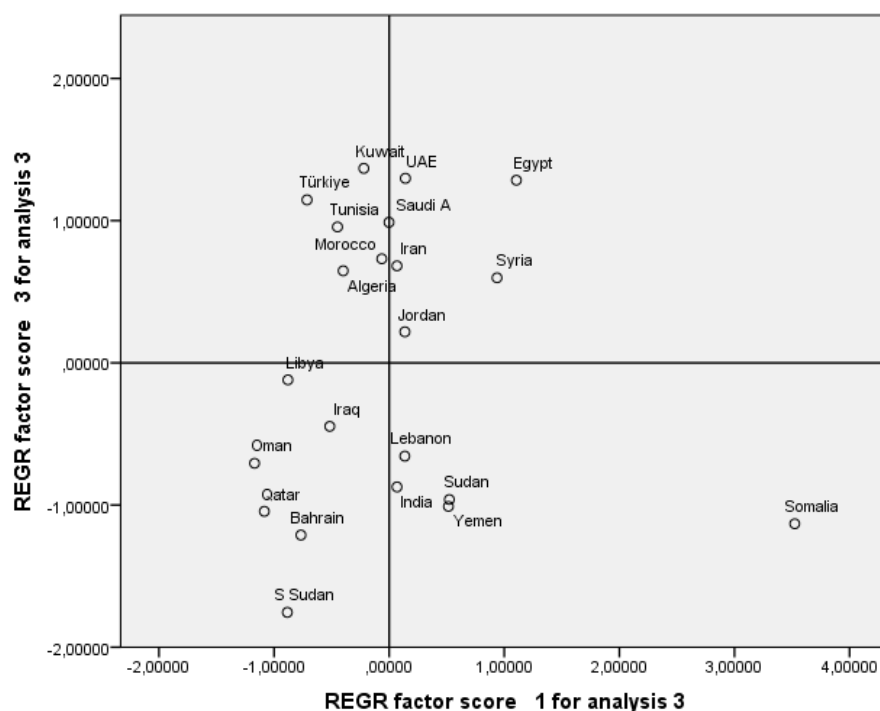


Figure 2: REGR factor score 1 and 3. Correlations among component-1 (AVA10GDP5, FoodIm0911, AVA20GDP6, FoodIm2012, TotalPo16) and component-3 (FoodP119, FoodP2010, HDI8, FoodPeCa1013); Source: FAO AQUASTAT, Rome, 2023, National statistical books based on the SPSS owned calculation

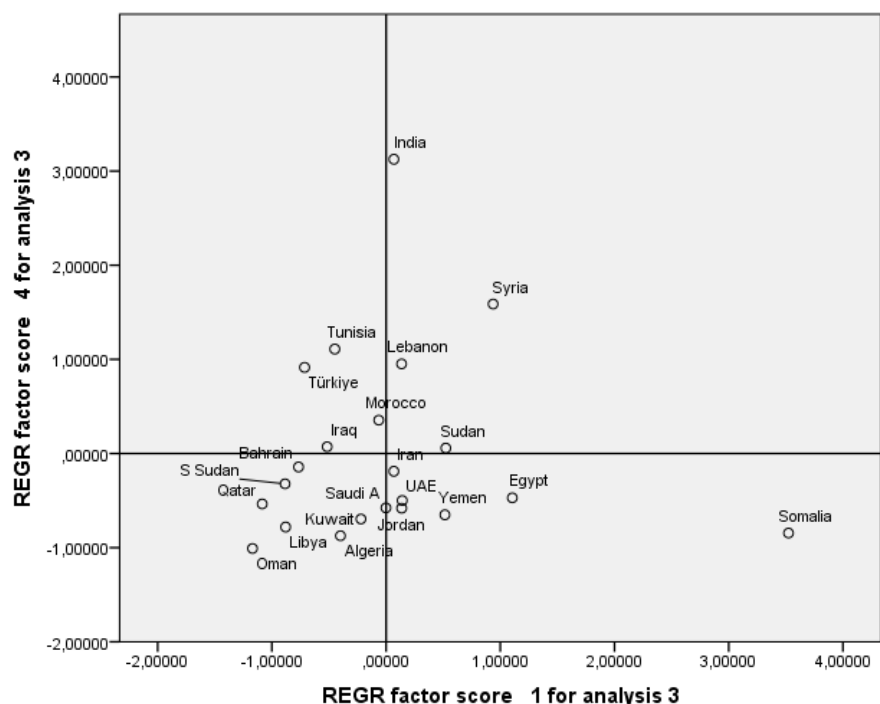


Figure 3: REGR factor score 1 and 4. Correlations among component-1 (AVA10GDP5, FoodIm0911, AVA20GDP6, FoodIm2012, TotalPo16) and component-4 (ToCoAcu204, ToCoAcu103); Source: FAO AQUASTAT, Rome, 2023, National statistical books based on the SPSS owned calculation

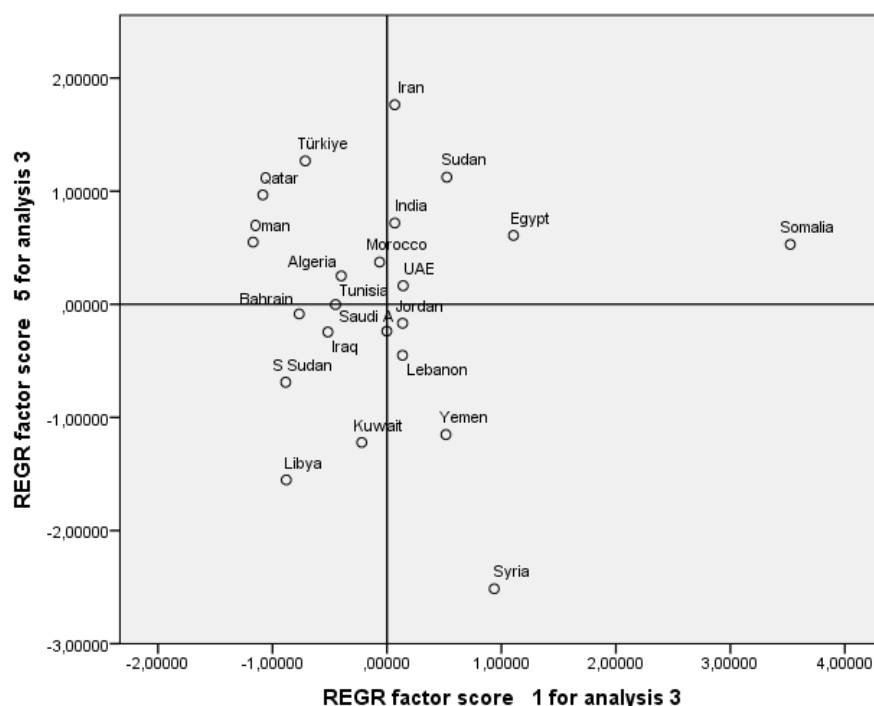


Figure 4: REGR factor score 1 and 5. Correlations among component-1 (AVA10GDP5, FoodIm0911, AVA20GDP6, FoodIm2012, TotalPo16) and componenet-5 (IrAgWatUE15, GDPpCap7);
Source: FAO AQUASTAT, Rome, 2023, National statistical books based on the SPSS owned calculation

RESULTS AND DISCUSSION

The strategic issue in case of food supply in MENA region and India is to increase the food production and domestic food supply to increase food self-sufficiency accompanying with necessary food import based on the balanced market food supply-demand. The moderate increasing level of number of populations also contributes to creating this balanced food market. The human, social and the natural conditions including water supply for possible satisfactory irrigation can lead to more increasing food self-sufficiency at the national level. The Table-1 contents main economic variables to make clearly overview these conditions of the selected countries.

In cases of Bahrain, Qatar, South Sudan (S Sudan) data of per capita food supply variability (kcal/capita/day) in 2010 and 2020 are absent, therefore these data are the same with data of Food availability Average protein supply (g/capita/day) (3-year average) in 2009-2011 and 2018-2020.

In case of Somalia data of Food availability Average protein supply (g/capita/day) (3-year average) in 2009-2011 and 2018-2020 are absent, therefore these data are the same with data of Per capita food supply variability (kcal/capita/day) in 2010 and 2020. No any data can be absent in this table, because the SPSS (special program for social science) needs for all data of these selected countries to analysing. In spite that India is not a country of MENA region, but the economic influence of India is globally important. Human Development Index (HDI) [highest = 1]: The Human Development Index (HDI) is a statistic developed and compiled by the United Nations since 1990 to measure various countries' levels of social and economic development. It is composed of four principal areas of interest: mean years of schooling, expected years of schooling, life expectancy at birth, and gross national income (GNI) per capita. This index is a tool used to follow changes in development levels over time and compare the development levels of different countries (The Investopedia Team, 2023).

Food self-sufficiency ratio (SSR), which means that the food production with food import and minus export, which this last one is the food supply for international markets out of domestic market (production+import-export)

The Table-1 provides means of economic variables belonging to selected countries of this study.

The Table-2 contents economic features of food supply in MENA (Middle East and North Africa) region and India with some additional other economic data in percent calculated between 2010 and 2020 (FAO AQUASTAT, Rome, 2023, National statistical books). Figures, as Figure-1-4 show local positions of selected countries based on economic features of each country in coordinate system following their data changes. The statistical analyse needs for more figures of coordinate system, because one figure cannot show all of changing economic data of countries.

The Table-3 provides correlations among different economics variables, as economic features of this country group for the researched period of 2010-2020. This table shows correlations of economic variables based on the summarised general average of economic features of these countries and not for each country. Therefore, the statistical analyse needs for showing economic data base of each country (Table-1). The Table-3 shows the measure or value of the correlations among economic variables. If the value of correlations among economic variables or features more than 0.800 (80%), this means that the correlations are very strong. But if this value is between 0.500 (50%) and 0.800 (80%), the correlations are only strong. Under level of 0.500 the correlations are not important among variables.

Sometimes the value of correlations is negative, this means the correlations of negative valued variables are inversely proportional to the other positive valued variables. In this case of negative correlation of variables this value decreases, while positive value of variables increases. Naturally the negative valued correlation of variables is direct proportional to other negative valued correlation of variables. Also, the correlation analysing emphasises the different importance of each economic variable for the given selected countries and years of the researched period. Finally, the correlations of the economic variables are calculated based on the average economic features of the selected countries averagely for years of the researched period, while rotated component matrix with figures of REGR factor score analyses economic features of each selected country per each year to measure differences of these countries.

The Table-3 shows that correlations were very strong by 0.994 (99.4%) between agricultural GVA produced by irrigated agriculture in 2010 and this one in 2020 (AGVAi101, AGVAi202). This means that the agricultural GVA produced by irrigated agriculture has not so differently changed in both years. The correlations were very strong by 0.998 between percent of total country area cultivated in 2010 and in 2020 (ToCoAcu103, ToCoAcu204).

The correlations of agriculture, value added in % of GDP in 2010 (AVA10GDP5) were very strong by 0.966 (99.6%) with agriculture, value added in % of GDP in 2020 (AVA20GDP6), by 0.817 with value of food imports over total merchandise exports (%) (3-year average) in 2009-2011 (FoodIm0911) and by 0.827 with value of food imports over total merchandise exports (%) (3-year average) in 2019-2021 (FoodIm2012). The correlations of agriculture, value added in % of GDP in 2020 (AVA20GDP6) were very strong by 0.801 with value of food imports over total merchandise exports (%) (3-year average) in 2009-2011 (FoodIm0911) and by 0.869 with value of food imports over total merchandise exports (%) (3-year average) in 2019-2021 (FoodIm2012).

The correlations of food availability average protein supply (g/capita/day) (3-year average) between 2009-2011 (FoodP119) were very strong by 0.840 with food availability average protein supply (g/capita/day) (3-year average) between 2018-2020 (FoodP2010). The correlations were very strong by 0.844 between value of food imports over total merchandise exports (%) (3-year average) in 2009-2011 (FoodIm0911) and value of food imports over total merchandise exports (%) (3-year average) in 2019-2021 (FoodIm2012). The correlations of agricultural GVA produced by irrigated agriculture in 2010 (AGVAi101) were strong by 0.637 with human development index (HDI8), by 0.699 with change of total population in period of 2010-2020 (TotalPo16) and by -0.526 with agriculture, value added in % of GDP in 2020 (AVA20GDP6). The correlations of agricultural GVA produced by irrigated agriculture in 2020 (AGVAi202) were strong by 0.630 with human development index (HDI8), by 0.678 with change of total population in period of 2010-2020 (TotalPo16) and by -0.512 with agriculture, value added in % of GDP in 2020 (AVA20GDP6).

The correlations of agriculture, value added in % of GDP in 2010 (AVA10GDP5) were strong by -0.620 with human development index (HDI8), by -0.713 with change of total population in period of 2010-2020 (TotalPo16). The correlations of agriculture, value added in % of GDP in 2020 (AVA20GDP6) were strong by -0.665 with human development index (HDI8), by -0.726 with change of total population in period of 2010-2020 (TotalPo16). The correlations of food availability average protein supply

(g/capita/day) (3-year average) between 2018-2020 (FoodP2010) were strong by -0.557 with value of food imports over total merchandise exports (%) (3-year average) in 2009-2011 and (FoodIm0911), and by -0.681 with value of food imports over total merchandise exports (%) (3-year average) in 2019-2021 (FoodIm2012).

The correlations of value of food imports over total merchandise exports (%) (3-year average) in 2019-2021 (FoodIm2012) were strong by -0.545 with change of total population in period of 2010-2020 (TotalPo16). The correlations of per capita food supply variability (kcal/capita/day) in 2020 (FoodPeCa2014) were strong by 0.689 with change of total population in period of 2010-2020 (TotalPo16). The Figures-1-4 show differences of selected countries in fields of their economic features in the researched period of 2010-2020. In Figure-1 the component-1 (AVA10GDP5, FoodIm0911, AVA20GDP6, FoodIm2012, TotalPo16) are lying at horizontal line X, while the component-2 (AGVAi101, AGVAi202, FoodPeCa2014) are lying at vertical line Y.

In Figure-1 in the first positive session of the coordinate system (right-up) the agriculture, value added in % of GDP in 2010, agriculture, value added in % of GDP in 2020, value of food imports over total merchandise exports (%) between 2009-2011, value of food imports over total merchandise exports (%) between 2019-2021, and change of total populations for the researched period according to the component-1 at horizontal line X, which their economic variables increase or little decrease in countries namely Lebanon, UAE (United Arab Emirates), India, Jordan, Egypt and Syria. Also, the economic variables as in percent of agricultural GVA (gross value-added) produced by irrigated agriculture in 2010 and in 2020 and per capita food supply variability (kcal/capita/day) in 2020, which are according to the component-2 increase or little decrease at vertical line Y in the same six countries.

In the second session of the coordinate system (left-up) in countries namely Kuwait, Saudi Arabia, Iraq, Qatar, Bahrain, Oman the above-mentioned their economic variables of horizontal line X decrease or only little increase, while the economic variables of vertical line Y increase or little decrease in cases of the mentioned countries. In the third session of the coordinate system (right-down) in countries namely Iran, Yemen, Sudan, Somalia the above-mentioned their economic variables at horizontal line X increase or little decrease, but at vertical line Y their economic variables as features decrease or little increase.

In the fourth negative session of the coordinate system (left-down) in countries namely Morocco, Algeria, Tunisia, Türkiye, South Sudan, Libya the economic variables decrease or little increase at horizontal line X, while at vertical line X their economic variables (features) also decrease or little increase. The component-1 including the five economic variables have the same changing rate at horizontal line X of the other following Figures-2-3-4 in the countries of the study.

In Figure-2 in the first positive session of the coordinate system (right-up) the economic variables as human development index (HDI) in 2020, the food availability average protein supply (g/capita/day) (3-year average) in 2009-2011 and in 2018-2020 and per capita food supply variability (kcal/capita/day) in 2010 belonging to component-3 (FoodP119, FoodP2010, HDI8, FoodPeCa1013) increase or little decrease in countries namely Jordan, Iran, UAE (United Arab Emirates), Egypt and Syria at vertical line Y. In the second session of the coordinate system (left-up) component-3 including four economic variables (FoodP119, FoodP2010, HDI8, FoodPeCa1013) increase or little decrease in countries namely Saudi Arabia, Algeria, Kuwait, Morocco, Tunisia and Türkiye at vertical line Y. In the third session of the coordinate system (right-down) component-3 decrease or little increase in countries namely India, Lebanon, Yemen, Sudan, Somalia at vertical line Y. In the fourth negative session of the coordinate system (left-down) also, economic variables of component-3 decrease or little increase in countries namely Iraq, Bahrain, South Sudan, Libya, Qatar, Oman at vertical line Y.

In Figure-3 in the first positive session of the coordinate system the economic variables as % of total country area cultivated in 2010 and in 2020 belonging to the component-4 (ToCoAcu204, ToCoAcu103) increase or little decrease in countries namely India, Lebanon, Sudan, Syria at vertical line Y.

In the second session of the coordinate system (left-up) economic variables of the component-4 also increase or little decrease in countries namely Morocco, Iraq, Tunisia, Türkiye at vertical line Y.

In the third session of the coordinate system (right-down) economic variables of the component-4 decrease or little increase in countries namely Iran, Jordan, UAE (United Arab Emirates), Yemen, Egypt, Somalia at vertical line Y.

In the fourth negative session of the coordinate system (left-down) economic variables of the component-4 also decrease or little increase in countries namely Saudi Arabia, Kuwait, Algeria, Bahrain, South Sudan, Libya, Qatar, Oman at vertical line Y.

In Figure-4 in the first positive session of the coordinate system the economic variables (IrAgWatUE15, GDPpCap7) of componenet-5 namely change of irrigated agriculture water use efficiency in 2020 (2010=100) in percent, US\$/m³ and change of GDP per capita in percent in 2020 (2010=100) current US\$/inhabitant increase or little decrease in countries namely Iran, India, UAE (United Arab Emirates), Sudan, Egypt and Somalia at vertical line Y. In the second session of the coordinate system (left-up) economic variables (IrAgWatUE15, GDPpCap7) of componenet-5 also increase or little decrease in countries namely Morocco, Algeria, Tunisia, Türkiye, Qatar and Oman at vertical line Y.

In the third session of the coordinate system (right-down) economic variables (IrAgWatUE15, GDPpCap7) of componenet-5 decrease or little increase in countries namely Jordan, Lebanon, Yemen and Syria at vertical line Y. In the fourth negative session of the coordinate system (left-down) also the economic variables (IrAgWatUE15, GDPpCap7) of componenet-5 decrease or little increase in countries namely Saudi Arabia, Kuwait, Iraq, Bahrain, South Sudan and Libya at vertical line Y.

The Table-2 clearly shows some main other correlations among the economic variables of the selected countries. The crude-oil exporting countries mostly are with large sized dessert areas non adequate for the agricultural production; therefore, they are pressed to use irrigated agricultural production technology. These countries as UAE, Kuwait, Oman, Qatar, Saudi Arabia, and Bahrain realised 100% of agricultural gross value-added produced by irrigated agriculture in 2010 and in 2020, but in case of Bahrain this was 93% closed to 100% in both years. These countries could only realise agricultural production by irrigation system because of the unfavourable geographical conditions. Also, a very highly level portion of their export values was from revenues of crude oil exporting, therefore percent of value of food imports over total merchandise exports was mostly some percents, less than 10%. But this share has little increased for the period of 2010-2020, which also shows that these crude oil exporting countries have more food import dependence, which was caused by considerable increase of their populations, less soil fertility, longer drought period and more expensive agricultural inputs.

For example, in Saudi Arabia percent of value of food imports over total merchandise exports was 5% in 2010 and this increased to 8% in 2020 by increasing food import dependence, while populations increased by 27% for the same period. In Oman the increasing rate of populations was by 67% at top level in selected countries in the same time, while their food import dependence increased from 6% to 9% in the same period. Generally, in other crude oil exporting countries the conditions were the same unfavourable. But in spite of increasing populations and food import dependence in these crude oil exporting countries the average protein supply (g/capita/day) (FoodP119; FoodP2010) was considerable 87 and 89 g/capita/day in Saudi Arabia, 83 g/capita/day in UAE, 84 and 86 g/capita/day in Oman, and even in cases of Bahrain and Qatar increased by two times from 31 g/capita/day in 2010 and to 62 g/capita/day in 2020. Only in Kuwait this decreased from 107 in 2010 to 102 g/capita/day in 2020, which was not considerable. In this field Kuwait was the second biggest in field of average protein supply after Türkiye by 111 g/capita/day in 2020.

Also, in Egypt 100% of agricultural GVA produced by irrigated agriculture and 97% in Lebanon in 2020, as the highest level after crude oil exporting countries. But their food import dependence was 45% in Egypt and 52% in Lebanon, which shows that the irrigated agriculture could not ensure enough food supply for their increasing populations. The populations increased by 23% in Egypt and by 38% in Lebanon, which last one was pressed by the refugees from neighbour Syria after the civil war in 2010s. Fortunately, the average protein supply was 95 g/capita/day in Egypt and 69 g/capita/day in Lebanon by the end of 2020.

Within selected countries in Somalia the increasing food import dependence was 472% value of food imports over total merchandise exports at top level, in Yemen 259% and in Syria 127%. Based on results of increasing food import the average protein supply was 18 g/capita/day in Somalia, while the populations decreased by 25% for the researched period, and 76 g/capita/day in 2020 in Syria accompanying with decreasing populations by 18% because of civil war.

In spite that the agricultural GVA produced by irrigated agriculture was 41% in Syria and 55% in Yemen in 2020, which was not so low level, but this was only 12% in Somalia. Generally, this irrigated agricultural production resulted low level of food supply for three countries.

As suggested by FAO (2017c), the water use efficiency (WUE) is defined as the value added per unit of water withdrawn over time (showing the trend in water use efficiency over time) and is calculated in US\$ per cubic meter of abstracted water as the sum of the three main sectors (agriculture, industry and services) weighted according to the proportion of water withdrawn by each sector over the total withdrawals. From his point of view the selected 22 countries have averagely implemented 38% for the period of 2010 -2020. Türkiye resulted 186%, this was 172% in Qatar, 126% in Iran and 100% in UAE. This means that these four countries realised considerable investment for developing irrigation system within this period.

According to **India** 51% of total country area cultivated in 2010 and in 2020, which was the top level in cases of selected countries, of which average measure was less than 12% of total country areas in both years. Only three countries Türkiye, Tunisia and Syria had about or little more 30% of their total country areas cultivated. Also, India had 71 and 72% of agricultural GVA produced by irrigated agriculture in 2010 and in 2020, which were very serious result comparably to large measure of area of the country. The share of agriculture value added in GDP was 17% and 16% in 2021 and in 2020, which were highly within the selected countries. Change of GDP per capita had increased by 36% in India, which was less than 57% in Iran and 38% in Egypt by the end of 2020. Even GDP per capita in crude oil exporting countries considerably declined by 65% in Libya, by 36% in Kuwait, by 34% in Oman, by 24% in Qatar

and by 25% in Algeria. The GDP per capita only increased by 7% in UAE and by 4% in Saudi Arabi. The average level of change of GDP per capita declined by 3.4% in all of these selected countries. The value of food imports over total merchandise exports in percent (3-year average) was 5% in 2010 and 6% in 2020, which was positive result for India signing less food import dependence from abroad. This positive result was accompanying with 63% increase in field of irrigated agriculture water use efficiency in percent in US\$/m³ based on developing water irrigation investment for the period of 2010-2020. In spite that average protein supply increased from 58 g/capita/day in 2010 to 66 g/capita/day in 2020, the per capita food supply variability decreased from 43 kcal/capita/day in 2010 to 21 kcal/capita/day in 2020 mostly by half decline, which shows that the food self-sufficiency considerably decreased in India, in spite that the number of populations had only increased by 12%. This emphasizes the need for increasing more efficient agricultural food production in India in order to implement balanced food demand-supply market conditions.

CONCLUSIONS AND RECOMMENDATIONS

The study overviews main very strong correlations among some economic variables in cases of selected countries in MENA region with India in the period of 2010 and 2020. The very strong correlations were between agriculture, value added (in % of GDP) in period of 2010-2020 and value of food imports over total merchandise exports (%) (3-year average) in the same period, and also between average protein supply (g/capita/day) (3-year average) and value of food imports over total merchandise exports (%) (3-year average) in 2020. These correlations provide proof that the increasing of agriculture, value added in percent of GDP was not enough in order to ensure adequate balanced food demand-supply ratio for consuming markets of selected countries. Therefore, the value of food imports over total merchandise exports should increase even by three times more within the researched period in order to ensure enough food supply variability (kcal/capita/day) and average protein supply (g/capita/day) per capita for increasing populations. The increasing trend really was in case of agricultural value added by 1.2% in the selected countries in the period of 2021-2020, but the food imports should also be needed for increasing more food self-sufficiency. It can be declared that the considerable increase of imported food products led to more one-side increasing food import dependence. The basic difficulty, as basic contradiction is that the increasing rate of agricultural production has been less than the increasing rate of the populations of these countries for the researched period. In spite that the food import also could increase food self-sufficiency of these selected countries, but this did not decrease their food import

dependence coming abroad. For the researched period this MENA region and India have sharply increased their food import dependence. The solution for decreasing food import and food dependence based on the food import is to develop the innovation of agricultural and food production mostly in fields of mechanization, irrigation system and chemical materials included in input, as pesticide and fertilizer accompanying with possible less increasing trend of populations of these selected countries.

REFERENCES

- [1] BUCCHIGNANI E - MERCOGLIANO P - PANITZ H J - MONTESARCHIO M (2018): Climate change projections for the Middle East–North Africa domain with COSMO-CLM at different spatial resolutions. *Advances in Climate Change Research*, Volume 9, Issue 1, March 2018, Pages 66-80. Available at <https://www.sciencedirect.com/science/article/pii/S1674927817300552>
- [2] FAO AQUASTAT (2023): Rome, 2023, National statistical books <https://www.fao.org/faostat/en/#country/4>, <https://www.fao.org/faostat/en/#country/13>
- [3] FAO, IFAD, UNICEF, WFP, WHO & UNESCWA. 2023: Near East and North Africa – Regional Overview of Food Security and Nutrition: Statistics and trends. Cairo. ISBN 978-92-5-138210-3 [FAO] c FAO, 2023, <https://doi.org/10.4060/cc8039en>
- [4] FAO (Food and Agriculture Organization of the UN) (2017a), Middle East and North Africa Regional Overview of Food Security and Nutrition, Building Resilience for Food Security and Nutrition in Times of Conflict and Crisis, FAO Publications, Cairo, <http://www.fao.org/3/I8336EN/i8336en.pdf>.
- [5] FAO (Food and Agriculture Organization of the UN) (2017b), “Regional Review on Status and Trends in Aquaculture Development in the Near East and North Africa – 2015, FAO Fisheries and Aquaculture Circular, No. 1135/6, FAO Publications, Rome.
- [6] FAO (2017c). Integrated Monitoring Guide for SDG 6. Step-by-step monitoring methodology for indicator 6.4.1 on water-use efficiency. Version 2017-03-10.
- [7] FAO (Food and Agriculture Organization of the UN) (2018), FAOSTAT Database <http://www.fao.org/faostat/en/#data>. StatLink <https://doi.org/10.1787/888933742454>
- [8] FAO, ESCWA (Food and Agriculture Organization of the UN; Economic and Social Commission on West Asia) (2018), Arab Horizon 2030, ESCWA Publications, Beirut.
- [9] [Field A P](#) (2020): *Discovering Statistics Using IBM SPSS Statistics*. Publisher: [SAGE Publications, Incorporated](#) p 915, ISBN 9789351500827, 9351500829
- [10] [Horváth D - Mitev A](#) (2023): *Alternatív kvalitatív kutatási kézikönyv. Alinea Kiadó, 2023*, p 394, ISBN: 9786155669682 (Alternative qualitative researching handbook, Publisher Alinea)
- [11] IFAD (2016): IFAD Strategic Framework 2016-2025. Enabling inclusive and sustainable rural transformation. Rome, Italy, ISBN 978-92-9072-651-7, p 39, Available at <https://www.ifad.org/documents/38714170/40237917/IFAD+Strategic+Framework+2016-2025.pdf/d43eed79-c827-4ae8-b043-09e65977e22d?t=1521824856000>
- [12] IFAD (2019): Sustainable Transformation for Agricultural Resilience in Upper Egypt 2019-2029. Describe of the project: The programme's goal is to contribute to improved living standards of smallholder farmers and poor and vulnerable women and youth in the rural areas of Upper Egypt. Its objective is to improve the income and resilience of smallholder and landless families. <https://www.ifad.org/en/web/operations/-/project/2000002202>
- [13] [Lofgren, H. - Richards, A.](#) (2003): "Food security, poverty, and economic policy in the Middle East and North Africa", Food, Agriculture, and Economic Policy in the Middle East and North Africa (Research in Middle East Economics, Vol. 5), Emerald Group Publishing Limited, Leeds, pp. 1-31. DOI: 10.1016/S1094-5334(03)05005-2 [https://doi.org/10.1016/S1094-5334\(03\)05005-2](https://doi.org/10.1016/S1094-5334(03)05005-2)
- [14] [Mitev A - Sajtos L](#) (2007): SPSS kutatási és adatelemzési kézikönyv [Alinea Kiadó, 2007](#), P 402, ISBN: 9789639659087 (SPSS researching and data analysing handbook, Alinea Publisher)

- [15] MCO (MassChallenge Organization, 2024): Sustainable Food Systems. Founded in 2009 in Boston, MA, MassChallenge's mission is to equip bold entrepreneurs to disrupt the status quo and create meaningful change. Available at <https://masschallenge.org/sustainable-food-systems/>
<https://masschallenge.org/articles/agriculture-innovation/>
- [16] OECD-FAO (2018): Chapter 2. The Middle East and North Africa: Prospects and challenges, pp. 68-107. In OECD-FAO AGRICULTURAL OUTLOOK 2018-2027 © OECD/FAO 2018
- [17] RUCKSTUHL, S - WARD C (2017), Water Scarcity, Climate Change and Conflict in the Middle East: Securing Livelihoods, Building Peace, I.B. Tauris and Company, London.
- [18] The Investopedia Team (2023): What Are the Criticisms of the Human Development Index (HDI)? Reviewed by KELLY R. C., Fact checked by ROHRS SCHMITT K. Available at <https://www.investopedia.com/ask/answers/042815/are-there-critics-human-development-index-hdi.asp#citation-4>
- [19] World Bank (2018), Beyond Scarcity: Water Security in the Middle East and North Africa, MENA Development Report, World Bank, Washington, D.C.
<https://openknowledge.worldbank.org/handle/10986/27659>.



VIII. International Symposium-2024

HEAVY METAL LOADS IN THE SLURRY AREA OF THE PAKS NUCLEAR POWER PLANT

Ágnes BÁLINT^{1*}, Dávid Czekmeister², Xuechu WANG², Csaba
MÉSZÁROS²

¹Institute of Environmental Engineering and Natural Sciences, Óbuda University, Budapest,
Hungary, e-mail: balint.agnes@uni-obuda.hu

²Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary, e-mail:
czekmeisterd@gmail.com; victorwxch@gmail.com; Meszáros.Csaba@uni-mate.hu

Abstract:

The Paks Nuclear Power Plant Ltd. has been working for several years on delimitating heavy metal contamination in the groundwater of its confined area and identifying possible sources. This study attempted to estimate the potential pollution leaking from the plant. Samples were taken at three sites (groundwater monitoring wells, Danube basin probes and Danube sludge), and concentrations of 6 heavy metals (lead, cadmium, zinc, copper, manganese, and iron) were measured. The samples were digested with a Milestone 1200 mega microwave digester in preparation for the measurement. The heavy metal concentrations of the samples were determined by atomic absorption spectroscopy using ATI UNICAM 939 AAS and Jobin-Yvon 24 ICP-OES. A statistical evaluation of the results was performed using a one-factor analysis of variance using SPSS 14.0 for the Windows software package. All the wells in the area reach the contamination limit of 0.2 mg/dm³ for zinc and copper.

Further investigations are needed to find out the cause of the high pollution. The samples also contain high concentrations of bismuth, beryllium, manganese, aluminium, and iron. For these substances, no limit values are set in Regulation 6/2009. The presence of bismuth can also be assumed to be due to the activities of the Dunaújváros ironworks.

Statistical analysis shows no significant difference between the northern and southern samples, except for manganese. The southern sample, taken from under the power plant, has a lower manganese concentration. Where concentrations above the contamination limits have been measured, measurements should be repeated to check their reliability.

Keywords: Atomic absorption spectrometry (AAS), Heavy metals, Inductively coupled plasma atomic emission spectrometry (ICP AES), Nuclear power plant

INTRODUCTION

Nowadays, environmental protection and the reduction of pollution [1] are very important issues. More and more are heard on radio, television and in the press. But in our everyday lives, we experience the direct signs of pollution, such as bad air, smog in big cities, polluted rivers and streams, forests full of

litter, or animals dying because of pollution [2]. The greenhouse effect, the ozone hole, and global warming [3] are often discussed; everybody knows these are real threats. Still, the reality is that if pollution is not reduced to the global level as soon as possible, the consequences for our planet will be immeasurable.

Environmental protection covers many areas, one of the most important of which is the environmentally sound operation of nuclear power plants [4] and the avoidance of accidents such as the Chernobyl disaster [5]. Many people are concerned about the safety of nuclear power plants, whether they pollute the soil, water and air, and whether nuclear waste is safely stored and disposed of.

Hungary's sole industrial-scale nuclear power plant, located at Paks [6], is a key player in the responsible management and reduction of liquid waste. Their efforts in this area, which also involve the reuse of recoverable components, are of paramount importance from both an environmental and an economic perspective [7-8].



Figure 1: Paks Nuclear Power Plant Ltd

The Paks Nuclear Power Plant Ltd. (Figure 1) has been working for many years on delimitating heavy metal contamination in its confined area's groundwater and identifying possible sources [9]. The nuclear power plant experts care about keeping the environment clean [10]. Their main objective is to produce electricity safely, in an environmentally friendly way and at competitive prices, a commitment that aligns with the readers' interest in environmental protection and the reduction of pollution. To achieve their vision, they continuously improve their environmental protection activities and comply with environmental regulations and rules. Measurements and analyses have been carried out and will be presented in this paper. To improve their environmental activities, they continuously improve their Environmental Management System (EMS), implemented by the MSZ EN ISO 14001 standard. PAKS Ltd has had a certified Environmental Management System (EMS) by the MSZ EN ISO 14001:1997 standard since 15 November 2002.

As the paper's topic is heavy metal pollution, the effects of the heavy metals under study on humans, animals and plants will be presented [11]. Since the beginning of the industrial revolution, toxic heavy metals have been increasingly introduced into the environment. The contamination of soil, groundwater and surface water with heavy metals can cause serious environmental damage [12] and threaten the health and habitats of living organisms. Most environmental problems [13] are caused by contamination with cadmium (Cd), lead (Pb), chromium (Cr), copper (Cu), zinc (Zn), nickel (Ni) and mercury (Hg). Some heavy metals (e.g. Cu, Zn) are concentrated in the upper layer of the soil, while others show no dependence on soil depth [14]. Heavy metals can be bound by soil colloids [15]. The soil acts as a buffer up to a certain limit, binding the heavy metals and thus dampening their effect, and can then become a pollutant itself [16-17]. For example, heavy metals mobilise and appear in soil solution and groundwater with increasing soil acidification [17]. From there, the heavy metals are taken up by soil micro-organisms and plant roots and enter the food chain, posing a significant threat to humans and animals [18]. A serious problem is that very large amounts of heavy metals can accumulate in some plants

without any visible signs of toxicity, and this can adversely alter the mineral composition of food and feed crops, posing a potential threat to human and animal health [19].

Many people are concerned about the safety of nuclear power plants, whether they pollute the soil, water, and air, and whether nuclear waste is safely stored and disposed of.

Hungary's only industrial-scale nuclear power plant is in Paks, where the power plant Paks II is also planned.

This study examines the environmental impact of treating industrial wastewater and its pollutants. The plant's operations inevitably generate liquid waste. Management, reduction, and reuse of recoverable components are very important from an environmental and economic point of view.

The Paks Nuclear Power Plant Ltd. has been working for several years on the delimitation of heavy metal contamination in the groundwater of its confined area and the possible sources of this contamination.

The nuclear power plant's experts care greatly about keeping the environment clean. The main objective of their operations is the safe generation of electricity in an environmentally friendly way and at competitive prices. To achieve their vision, they continuously improve environmental protection activities and comply with environmental standards and regulations.

The impact of the power plant on water, its water systems, water protection regulations and their applications.

Aim of the study:

- ✓ To determine the sampling sites' heavy metal load (zinc, cadmium, manganese, lead, copper, iron).
- ✓ To assess the risk of heavy metal contamination.

MATERIALS AND METHODS

1. Groundwater classification

Joint Decree No. 6/2009 (IV. 14) KvVM-EüM-FVM on the limit values for protecting the geological environment and groundwater against pollution has been compared with the measurement results of the Decree [20].

The pollution level is assessed or categorised according to the concentration of the pollutant. The national regulations are A - background and B - pollution limit values.

Individual groundwater bodies may be assessed differently according to their location, vulnerability and potential use.

2. Sampling: The sampling points are shown in Figure 2.



Figure 2: Soil water samples Danube water and silt samples

2.1. sampling: Danube River basin probes

Sampled probes: PK1 HMSZ; PK 2/1 HMSZ; PK 2/3 HMSZ

Groundwater sampling was performed according to MSZ 1484-3 21464:1998 (MSZ ISO 5667-1:1993, MSZ ISO 5667-2:1993, MSZ EN ISO 5667-3:1998).

Before sampling, three times the water corresponding to the well volume is removed by pumping, and only then is the actual sampling done. This ensures the water stagnation is removed from the well and the groundwater is sampled.

Samples are taken in 1-litre plastic bottles, soaked in a 1+9 dilution of nitric acid solution for 24 hours before sampling and then rinsed three times with distilled water. Immediately after sampling, the samples were transported to the Paks Nuclear Power Plant Metals Laboratory for rapid filtration (it is not feasible to filter such many samples on site) and preservation. The samples were filtered through a membrane filter with a pore diameter of 0.45 µm and preserved with 1.0 ml of 1+1 dilution of nitric acid per 100 ml. Since the measurements were performed in Gödöllő, the samples could be stored at +4 °C for 24 h; they were frozen during transport and until use.

pH and conductivity were measured at the time of sampling.

2.2. Sampling: Sludge storage monitoring wells

Sampling sites: Z1; Z2; Z02/A; Z5; T72; T65; T66; V4

Groundwater was sampled according to the standard MSZ 21464:1998 (MSZ ISO 5667-1:1993, MSZ ISO 5667-2:1993, MSZ EN ISO 5667-3:1998).

2.2. Sampling was carried out as described above for the Danube River basin sampling.

2.3. Sampling: Danube sludge samples

Sampling location: north of the power plant's cold-water intake and south of its hot-water intake.

Sampling was carried out in plastic, metal-free containers according to MSZ 21470.

The samples were taken in a plastic container previously prepared according to MSZ 1484-3 (as described above).

3. Sample preparation

The preparation of the sludge samples was carried out by standard MSZ 21470-1:1998.

3.1. Digestion in a Milestone 1200 mega microwave digester

Method of Teflon bomb digestion:

Teflon bomb digesting is a rapid process in a closed vessel at high temperatures and pressures. Its popularity is due to its simplicity, speed and high efficiency.

It is also used to digest plants and analyse other material systems, metals, minerals, ores, biological materials, soils, etc. For example, a sample prepared for nitric acid-hydrogen peroxide digestion is heated by microwave current. With this method, the organic matter is, in principle, converted into carbon dioxide, metals and non-metals into nitrates, and Si into dissolved silica [21].

The temperature and the time of destruction can be programmed. The amount of acid required for destruction and the sample to be destroyed are adjusted to the volume of the destruction vessel. Absorption loss during destruction is very low. The analytically purest solutions are usually used. General safety rules should be observed during the test [22].

4. Main methods for determining heavy metals

4.1. Flame Atomic Absorption Spectrometry (FAAS)

The calibration solution series required for analytical studies by the atomic absorption method should be prepared from a concentrated stock solution, usually at a concentration of 1000 mg metal ions/dm³. Care must be taken throughout the analysis to ensure the apparatus's and solutions' purity [23].

Heavy metals have been tested: Zn, Mn, Cu, Fe, Cd, and Pb.

4.2. Inductively coupled plasma atomic emission spectrometry (ICP AES)

Inductively coupled plasma atomic emission spectrometry (ICP-AES) is one of the most contemporary instrumental analytical methods. Heavy metals were measured in the samples: Co, Bi, Be, Zn, Al, Fe, Mn, Cd, Pb, Ni, Ba, Cr, Cu and Ag.

The elements under investigation can be determined:

- ✓ Simultaneously (in a simultaneous system, on integrated wavelength measurement channels).
- ✓ Sequentially (in a scanning system, on variable wavelengths) [21].

5.1. Digestion of water samples

The digestion programme for the water samples is shown in Table 1.

Recipe for the digestion:

- 5 cm³ 65% nitric acid
- 1 cm³ 30 % hydrogen peroxide

Table 1: Digestion programme for water samples

Number of steps	Time required (min)	Operation
1	5	Digestion, 250 watts
2	2	Ventilation
3	5	Digestion, 400 watts
4	5	Digestion, 250 watts
5	7	Digestion, 700 watts
6	5	Ventilation

The samples arrived at the laboratory prepared, as described in the sampling section. Preparation consisted only of heating to room temperature. Approximately 5g of the samples (i.e., about 5 cm³) were weighted into the Teflon flasks, nitric acid and hydrogen peroxide were added, and the flasks were sealed. I then put them in the digester for about half an hour and cooled them for about 30 minutes after the program was finished.

Once the samples had cooled, the Teflon bombs were opened. The digested suspension was filtered into a 25 cm³ standard flask and made up to 25 cm³ with distilled water. The samples were stored in a refrigerator until use.

5.2. Digestion of sediment samples

Foreign matter - plant parts, shells, etc. – have been removed from the still-wet samples, crushed in a mortar, and sieved through a 0.2 mm sieve.

Recipe for digestion:

- 5 cm³ 65% nitric acid
- 2 cm³ 30% hydrogen peroxide

The digestion programme for the sediment samples is shown in Table 2.

Table 2: Digestion programme for sediments samples

Number of steps	Time required (min)	Operation
1	5	Digestion, 250 watts
2	2	Ventilation
3	5	Digestion, 400 watts
4	5	Digestion, 250 watts
5	7	Digestion, 700 watts
6	5	Ventilation

Approximately 0.5 g of the previously sieved sludge samples were weighed into the Teflon bombs. Hydrogen peroxide and nitric acid were added to the samples, and the Teflon bomb was sealed and placed in the digester for about half an hour.

After the digestion, the bombs were placed in a water bath for 30 minutes and, after cooling, were unloaded under a hood. The digested suspension was filtered into a 25 cm³ standard flask and made up to 25 cm³ with deionised water. The samples were stored in a refrigerator until use.

6. Determination of dry matter content of sediment samples from air-dry samples

Sludge samples were poured into large Petri dishes and dried at room temperature.

The dry solids content of the air-dried sludge sample was determined according to MSZ-08-0205-1978 [24].

7. Determination of the pH of sediments

The measurement was performed according to the standard MSZ-08-0206/2-1978.

8. The pH value of water samples was determined according to the standard pH (20°C) measured by potentiometry 2 - 14 pH according to MSZ 1484-22:2009.

STATISTICAL ANALYSIS

Analysis of variance was performed using the statistical software package SPSS 14.0 for Windows. The following questions were examined in the analysis of the data:

1. Does the concentration of heavy metals in groundwater samples depend on the sampling location (P=5%)? Which groundwater samples are significantly different?

The answer to this question was sought using a one-factor analysis of variance [25].

The factors of the analysis of variance were:

Number of samples: 9 groundwater samples

Does the concentration of heavy metals in Danube water samples depend on the sampling location (P=5%)? Is there a significant difference between the samples?

To answer this question, a comparative analysis of variance was performed.

The factors of variance analysis were:

Number of samples: 3 Danube water samples

Does the concentration of heavy metals in sediment samples depend on the sampling location (P=5%)? Is there a significant difference between the samples?

Comparative analysis of variance was performed to answer this question.

The factors of variance analysis were:

Number of samples: 2 sediment samples

RESULTS AND DISCUSSION

1. pH measurement results

1.1. Danube sludge samples

The pH value of the soil solution is determined according to the method of determining the soil chemistry [2]. Depending on the purpose of the soil test, the chemistry of the solution prepared with

water (H₂O) or potassium chloride solution (KCl) is measured, and the resulting values provide information on the pH of the soil. For the same soil, the pH of the KCl solution will be lower, i.e. more acidic than that of the aqueous solution. In contrast, the pH in water is higher than in the KCl solution because the K⁺ ions in potassium chloride exchange some of the ions that cause acidity on the surface of the soil colloids (exchangeable acidity). Both values give a qualitative characterisation of the chemistry. When reporting the pH values, the value measured in water is distinguished by the notation pH(H₂O), and the result of the measurement in KCl solution is distinguished by the notation pH(KCl). Table 3 shows the pH values measured in the Danube sediments. Soils are considered slightly alkaline if pH(H₂O): 7.2 - 8.5 and pH(KCl): 7.1 - 7.9. Table 3 shows that the sediment falls into this category, i.e. weakly alkaline.

Table 3: pH measured in Danube sludge samples

Danube sludge samples		pH _{KCl}
Northern sludge samples	7.97±0.18	7.80±0.01
Southern sludge samples	7.68±0.16	7.79±0.03

2. 1. Water samples

Table 4 shows the pH values measured by sensors in groundwater monitoring wells and the Danube basin.

The pH of the water samples, as shown in Table 4, ranges between 7.12 and 7.61, which can be considered weak alkaline. One sample exception is V4, which has a pH of 8.48 and is slightly more alkaline.

Table 4: pH measured in Groundwater monitoring wells and Danube riverbed sensors

Groundwater monitoring wells/ Danube riverbed sensors	pH
Z01	7.59
Z02	7.37
Z02/A	7.45
Z5	7.12
V4	8.48
T65	7.20
T66	7.45
T72	7.61
PK1	7.01
PK 2/1	7.61
PK 2/3	7.50

1. Atomic absorption measurements

1.1. Zn²⁺ concentration

1. Groundwater monitoring well

Figure 3 shows the concentration of Zn²⁺ in groundwater monitoring wells. The average concentration of the water samples is 0.46 mg/dm³. The contamination limit value for zinc in groundwater is set in Joint Decree 6/2009 (IV. 14.) KvVM-EüM-FVM [20] for the geological medium, and groundwater is 0.2 mg/dm³, which is exceeded in groundwater samples, i.e. contaminated.

One well (Z02) shows an outlier result, indicating that the previous contamination persists. The conclusion was confirmed by analysing variance, as there is a significant difference between the

sampling sites. The details of the variance analysis for zinc in the groundwater samples are presented in Table 5.

Table 5: Variance table of Zn concentrations in soil water monitoring wells
Independent variable: Zn concentration in soil water monitoring wells

Source	Sum of Squares	df	Mean Square	F	p	LSD _{5%}
Corrected model	2.924 ^a	8	.365	21.829	.000	
Intercept	3.307	1	3.307	197.542	.000	
Sampling area*	2.924	8	.365	21.829	.000	0.2927
Error	.151	9	.017			
Total	6.382	18				
Corrected total	3.074	17				

a. $R = .951$ ($R_{\text{corrected}} = .907$)

* Zn concentration in different groundwater monitoring wells

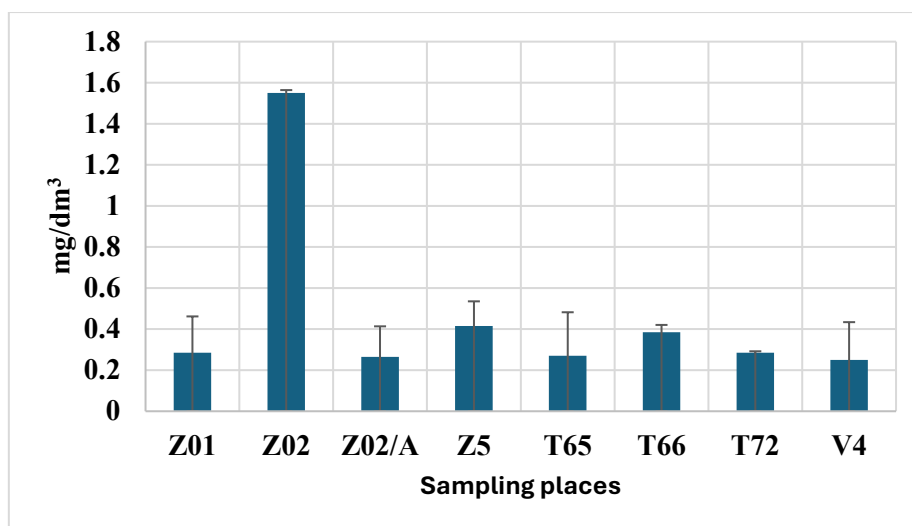


Figure 3: Zn²⁺ concentration in groundwater monitoring wells

1.1.2. Danube riverbed sensors

Figure 4 shows the concentration of Zn²⁺ in Danube riverbed sensors. The water samples' average concentration (Figure 3) is 0.30 mg/dm³. The contamination limit value for zinc in surface water is 0.2 mg/dm³ according to the joint decree 6/2009 (IV. 14.) KvVM-EüM-FVM [20], which is exceeded by the water samples of the Danube under the warm water canal, based on which PK2/1, PK2/3 are contaminated.

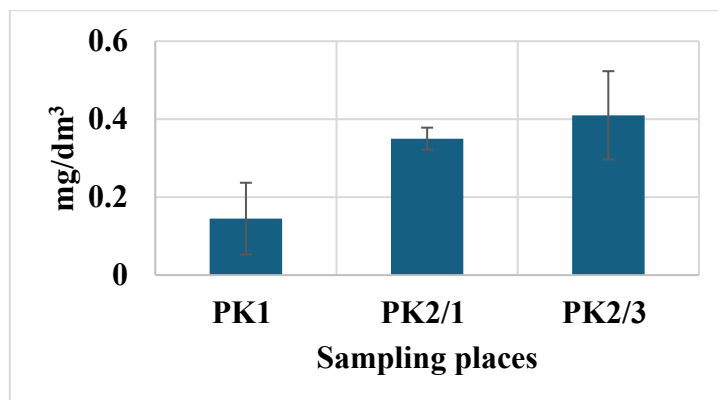


Figure 4: Concentration of Zn^{2+} in Danube riverbed sensors

No significant difference was found between the samples. Table 6 presents detailed data on the analysis of variance for zinc in the Danube water samples.

Table 6: Variance table of Zn concentrations in Danube riverbed sensors

Independent variable: Zn concentration in Danube riverbed sensors

Source	Sum of Squares	df	Mean Square	F	p	LSD _{5%}
Corrected model	.015 ^a	2	.007	.321	.748	
Intercept	.735	1	.735	32.151	.011	
Sampling area*	.015	2	.007	.321	.748	0.4815
Error	.069	3	.023			
Total	.818	6				
Corrected total	.083	5				

a. $R = .176$ ($R_{\text{corrected}} = -.373$)

* Zn concentration in different Danube riverbed sensors

1.1.3. Sediment samples

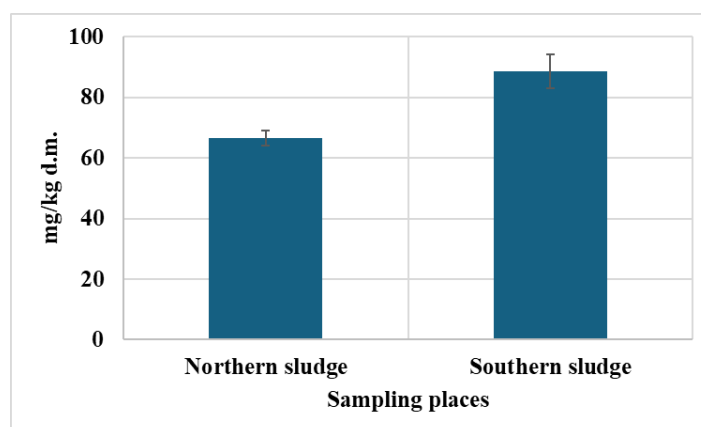


Figure 5: Zn^{2+} concentration in sediment samples from the Danube

Figure 5 shows the concentration of Zn^{2+} in sediment samples of the Danube. The sediment samples' average concentration is 77.60 mg/dm^3 dry matter (d.m.). The contamination limit for zinc in geological media is 200 mg/kg dry matter according to the Joint Decree 6/2009 (IV. 14.) KvVM-EüM-FVM [20], which is not exceeded by the sediment samples and is therefore not contaminated. It is important to note, however, that the southern sediment sample contains one and a half times more zinc, and it would be worth investigating whether this could be related to the zinc load of the nuclear power plant sludge. Further sampling would be required to determine this accurately.

The conclusions drawn were confirmed by the analysis of variance, as there is a significant difference between the two sampling sites.

Detailed data from the analysis of variance for zinc in the Danube sediment samples are presented in Table 7.

Table 7: Variance table of Zn concentrations in Danube sediment samples

Independent variable: Zn concentration in Danube sediment samples						
Source	Sum of Squares	df	Mean Square	F	p	LSD _{5%}
Corrected model	562.124	1	562.124	590.347	.002	
Intercept	25552.902	1	25552.902	26835.845	.000	
Sampling area	562.124	1	562.124	590.347	.002	4.1988
Error	1.904	2	.952			
Total	26116.931	4				
Corrected total	.083	5				

1.2. Mn^{2+} concentration

1.2.1. Groundwater monitoring well

Figure 6 shows the concentration of Mn^{2+} in the groundwater monitoring well. The average concentration of the water samples (Figure 5) is 0.82 mg/dm^3 . The joint Decree 6/2009 (IV. 14.) [20] The Ministry of Agriculture, Forestry, Environment and Water Management's recommendation on the heavy metal content of groundwater does not set a limit value for manganese. However, it can be concluded that the pollution level measured in previous years is still present. Analysis of variance shows that there is no significant difference between the sample sites. The details of the variance analysis for manganese in the groundwater samples are presented in Table 8.

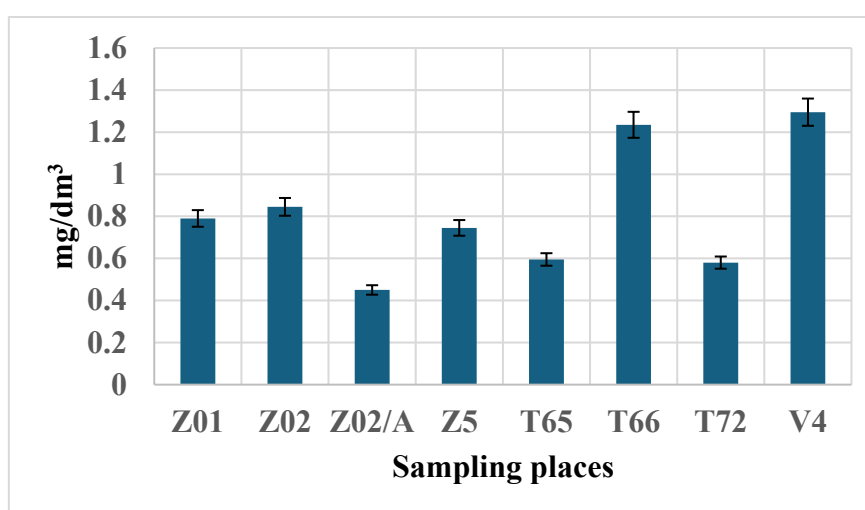


Figure 6: Mn^{2+} concentration in groundwater monitoring wells

Table 8: Variance table of Mn concentrations in groundwater monitoring wells

Independent variable: Mn concentrations in groundwater monitoring wells

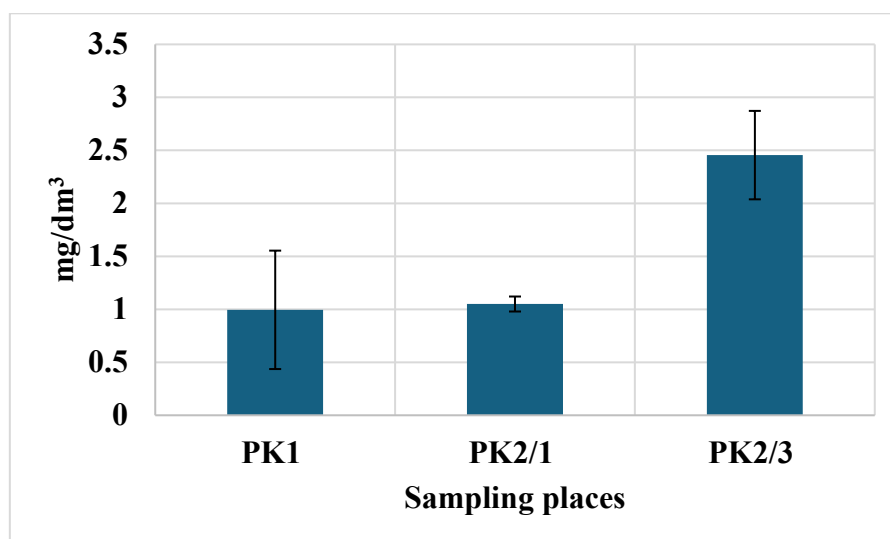
Source	Sum of Squares	df	Mean Square	F	p	LSD _{5%}
Corrected model	1.599(a)	7	.228	.550	.777	
Intercept	10.728	1	10.728	25.831	.001	
Sampling area*	1.599	7	.228	.550	.777	1.4863
Error	3.323	8	.415			
Total	15.650	16				
Corrected total	4.921	15				

(a) $R = .325$ ($R_{\text{corrected}} = -.266$)

* Mn concentrations in groundwater monitoring wells

1.2.2. Danube riverbed sensors

Figure 7 shows the concentration of Mn^{2+} in Danube riverbed sensors. The concentration of the water samples averages 1.5 mg/dm^3 . The joint Decree 6/2009 (IV. 14.) of the Ministry of Agriculture, Forestry, Environment and Water Management [20] on the heavy metal content of groundwater does not set up a limit value for manganese. Analysis of variance shows no significant difference between the samples. The details of the variance analysis for manganese in the water samples are given in Table 9.

Figure 7: Mn^{2+} concentration in Danube riverbed sensorsTable 9: Variance table of Mn^{2+} concentrations in Danube riverbed sensorsIndependent variable: Mn^{2+} concentrations in Danube riverbed sensors

Source	Sum of Squares	df	Mean Square	F	p	LSD _{5%}
Corrected model	.983(a)	2	.492	.603	.603	
Intercept	13.193	1	13.193	16.165	.028	
Sampling area*	.983	2	.492	.603	.603	2.875
Error	2.448	3	.816			
Total	16.625	6				
Corrected total	3.432	5				

(a) $R = .287$ ($R_{\text{corrected}} = -.189$)* Mn^{2+} concentrations in Danube riverbed sensors

1.2.3. Sediment samples

Figure 8 shows the concentration of Mn^{2+} in Danube sediment samples. The sediment samples have an average concentration of 183.99 mg/kg dry matter. Analysis of variance indicates that the difference between the samples is significant. Table 10 gives details of the variance analysis for the manganese content of the sediment samples.

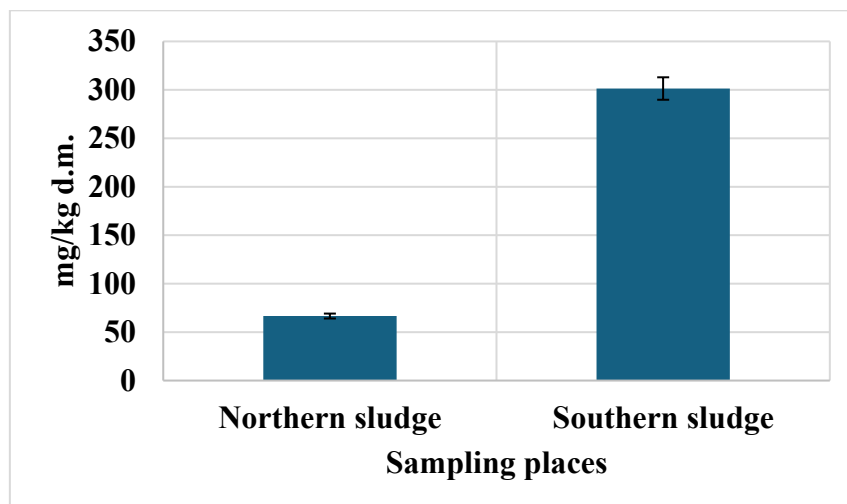


Figure 8: Mn^{2+} concentration in sediment samples from the Danube

Table 10: Variance table of Mn^{2+} concentrations in sediment samples from the Danube
Independent variable: Mn^{2+} concentrations in sediment samples from the Danube

Source	Sum of Squares	df	Mean Square	F	p	LSD _{5%}
Corrected model	1457.366(a)	1	1457.366	26.050	.036	
Intercept	426323.936	1	426323.936	7620.389	.000	
Sampling area*	1457.366	1	1457.366	26.050	.036	32.1826
Error	111.890	2	55.945			
Total	427893.192	4				
Corrected total	1569.256	3				

(a) $R = .929$ ($R_{\text{corrected}} = .893$)

* Concentrations in sediment samples from the Danube

1.3. Cu^{2+} concentration

1.3.1. Groundwater monitoring well

Figure 9 shows the concentration of Cu^{2+} in the groundwater monitoring well. The concentration of the water samples averages 2.30 mg/dm³. The groundwater contamination limit for copper content is considered contaminated according to Joint Decree No. 6/2009 (IV. 14.) "KvVM-EüM-FVM" [20].

The analysis of variance shows no significant difference between the samples. The detailed variance analysis data for the sediment samples' copper content are presented in Table 11.

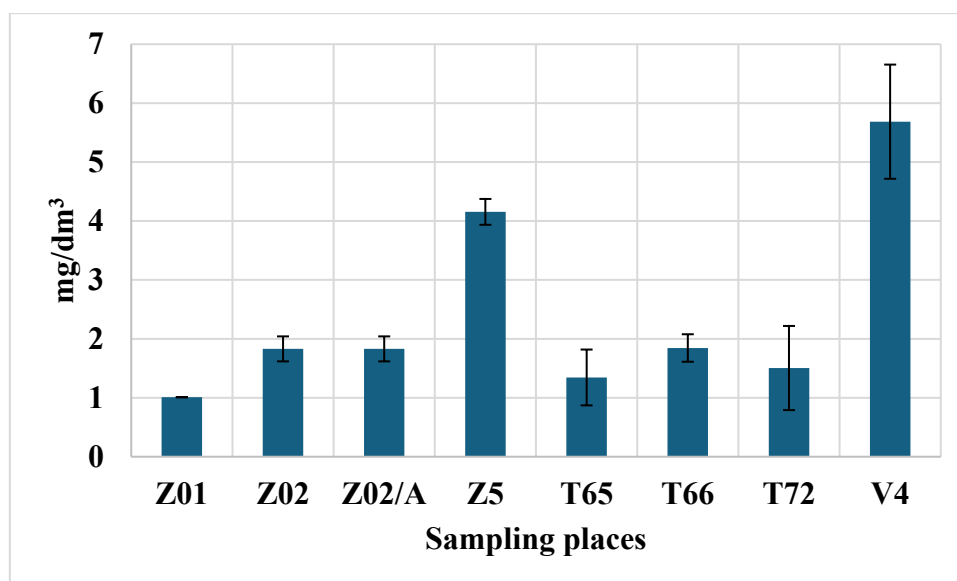


Figure 9: Cu²⁺ concentration in groundwater monitoring wells

Table 11: Variance table of Cu²⁺ concentrations in groundwater monitoring wells
Independent variable: Cu²⁺ concentrations in groundwater monitoring wells

Source	Sum of Squares	df	Mean Square	F	p	LSD _{5%}
Corrected model	26.726(a)	7	3.818	2.343	.128	
Intercept	70.052	1	70.052	42.998	.000	
Sampling area*	26.726	7	3.818	2.343	.128	2.944
Error	13.034	8	1.629			
Total	109.812	16				
Corrected total	39.759	15				

(a) $R = .672$ ($R_{\text{corrected}} = .385$)

* Cu²⁺ concentrations in groundwater monitoring wells

1.3.2. Danube riverbed sensors

Figure 10 shows the concentration of Cu²⁺ in Danube riverbed sensors. The concentration of the water samples averages 1.62 mg/dm³. The groundwater contamination limit for copper content is contaminated according to Joint Decree No. 6/2009 (IV. 14.) "KvVM-EüM-FVM" [20] is 0.2 mg/dm³.

The measured values are, therefore, not considered to be contaminated.

The analysis of variance shows no significant difference between the samples. Table 12 presents detailed variance analysis data for the sediment samples' copper content.

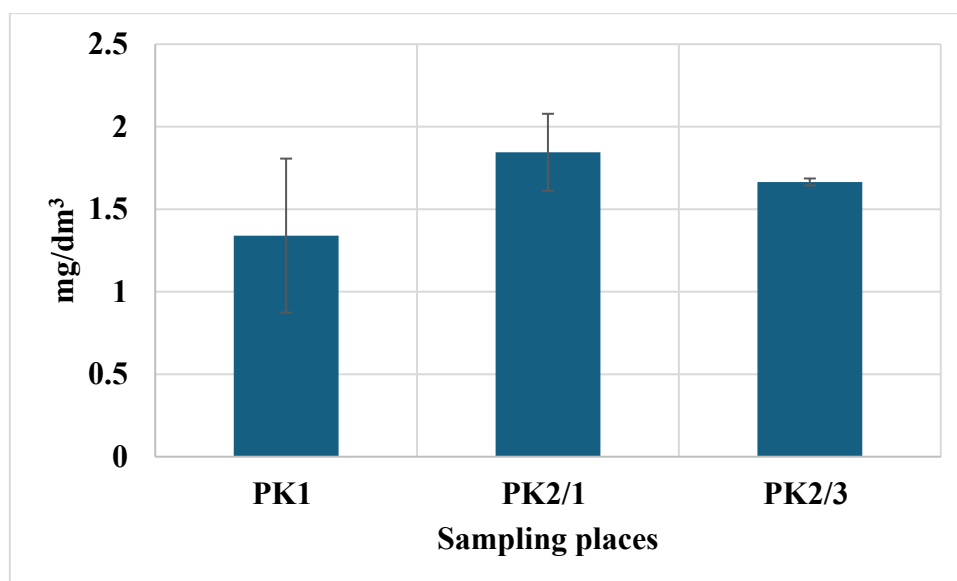


Figure 10: Cu²⁺ concentration in Danube riverbed sensors

Table 12: Variance table of Cu²⁺ concentrations in Danube riverbed sensors

Independent variable: Cu²⁺ concentrations in Danube riverbed sensors

Source	Sum of Squares	df	Mean Square	F	p	LSD _{5%}
Corrected model	.468(a)	2	.234	.900	.494	
Intercept	12.627	1	12.627	48.530	.006	
Sampling area*	.468	2	.234	.900	.494	1.6235
Error	.781	3	.260			
Total	13.876	6				
Corrected total	1.249	5				

(a) R = .375 (R_{corrected} = -.042)

*Cu²⁺ concentrations in Danube riverbed sensors

1.3.3. Sediment samples

The Cu concentration values in the sludge samples were below the detection limit.

1.4. Fe²⁺ concentration

1.4.1. Groundwater monitoring well

Figure 11 shows the concentration of Fe²⁺ in the groundwater monitoring well. The average concentration in the water samples is 0.30 mg/dm³. The Joint Decree No. 6/2009 (IV. 14.) "KvVM-EüM-FVM" [20] on the heavy metal content of groundwater does not set a limit value for iron.

The analysis of variance shows no significant difference between the sampling sites. Table 13 presents the analysis of variance for the iron content in the groundwater samples.

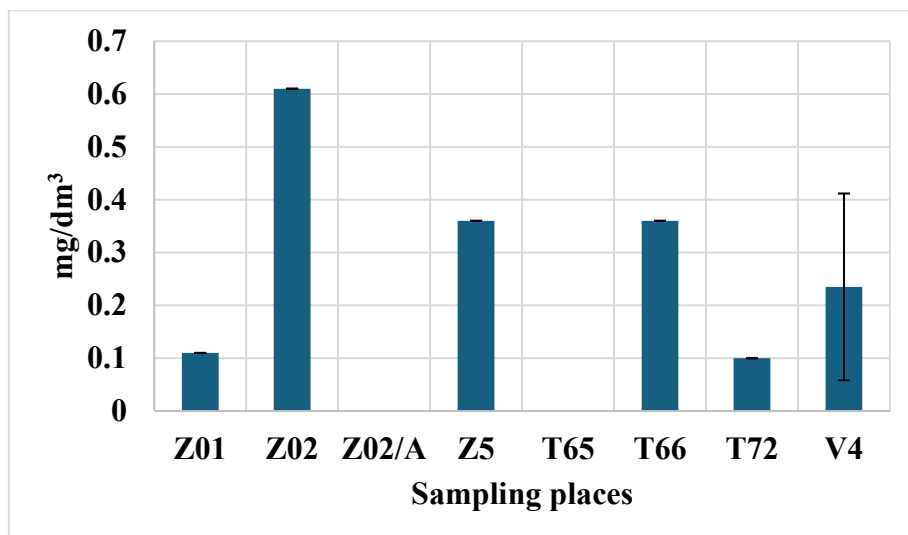


Figure 11: Fe²⁺ concentration in a groundwater monitoring well

Table 13: Variance table of Fe²⁺ concentrations in a groundwater monitoring well
Independent variable: Fe²⁺ concentrations in a groundwater monitoring well

Source	Sum of Squares	df	Mean Square	F	p	LSD _{5%}
Corrected model	.185(a)	7	.026	.587	.752	
Intercept	.252	1	.252	5.612	.045	
Sampling area*	.185	7	.026	.587	.752	0.4886
Error	.360	8	.045			
Total	.797	16				
Corrected total	.544	15				

(a) R = .339 (R_{corrected} = -.239)

* Fe²⁺ concentrations in a groundwater monitoring well*

1.4.2. Danube riverbed sensors

Figure 12 shows the concentration of Fe²⁺ in Danube riverbed sensors.

The concentration of the water samples averages 0.65 mg/dm³. The Joint Decree No. 6/2009 (IV. 14.) "KvVM-EüM-FVM" [20] on the heavy metal content of groundwater does not set a limit value for iron. The analysis of variance shows no significant difference between the samples. Table 14 details the variance analysis for the iron content of the water samples.

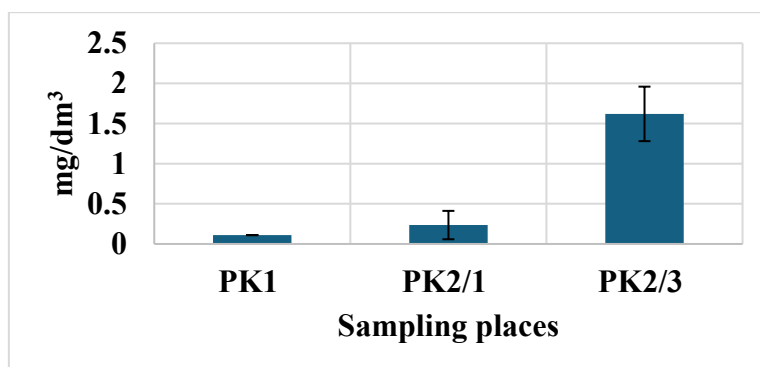


Figure 12: Fe²⁺ concentration in Danube riverbed sensors

Table 14: Variance table of Fe^{2+} concentrations in Danube riverbed sensors
Independent variable: Fe^{2+} concentrations in Danube riverbed sensors

Source	Sum of Squares	df	Mean Square	F	p	LSD _{5%}
Corrected model	4.449(a)	2	2.225	5.848	.092	
Intercept	4.910	1	4.910	12.908	.037	
Sampling area*	4.449	2	2.225	5.848	.092	1.963
Error	1.141	3	.380			
Total	10.501	6				
Corrected total	5.591	5				

(a) $R = .796$ ($R_{\text{corrected}} = .660$)

* Fe^{2+} concentrations in Danube riverbed sensors

1.4.3. Sediment samples

Figure 13 shows the concentration of Fe^{2+} in Danube sediment.

The average concentration of the sediment samples is 11055.63 mg/dm³. 10/2000 on the heavy metal content of geological media. The Joint Decree No. 6/2009 (IV. 14.) "KvVM-EüM-FVM" [20] on the heavy metal content of groundwater does not set a limit value for iron. The analysis of variance shows a significant difference between the samples. Table 15 details the variance analysis for the iron content of the water samples.

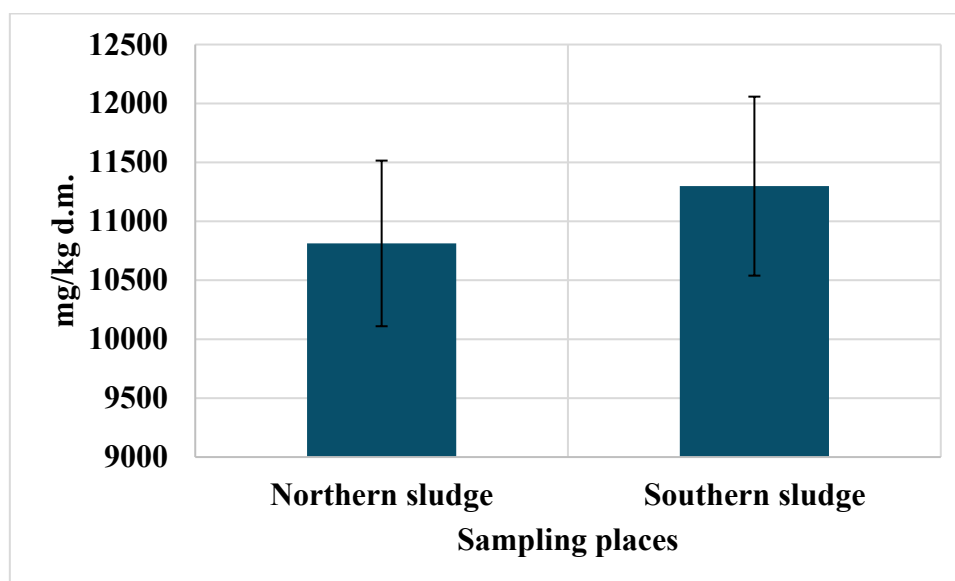


Figure 13 shows the concentration of Fe^{2+} in the Danube sediment

Table 15: Variance table of Fe^{2+} concentrations in the Danube sediment

Independent variable: Fe^{2+} concentrations in the Danube sediment

Source	Sum of Squares	df	Mean Square	F	p	LSD _{5%}
Corrected model	243885.06(a)	1	243885.057	3.013	.225	
Intercept	525482744.37	1	525482744.37	6491.457	.000	
Sampling area*	243885.057	1	243885.06	3.013	.225	1224.18
Error	161899.78	2	80949.89			
Total	52588529.21	4				
Corrected total	405784.84	3				

(a) $R = .601$ ($R_{\text{corrected}} = .402$)

* Fe^{2+} concentrations in the Danube sediment

1.5. Heavy metal concentrations measured below the detection limit

- ✓ Cadmium concentrations in the wells tested. None of the samples from the 3 areas tested showed cadmium concentrations above the detection limit.
- ✓ Lead concentrations in the wells tested. None of the samples from the 3 areas tested showed lead concentrations above the detection limit.

1.6. Measurement of heavy metal concentrations in Danube sediment samples by ICP-OES

Table 16: Heavy metal content in sediment samples (mg/kg in dry matter)

ICP-AES	Co	Bi	Be
Northern sludge	11834.95±230.33	10016.28±191.94	4961.99±330.14
Southern sludge	12350.69±38.39	10586.31±76.78	4828.99±533.59
	Al	Fe	Mn
Northern sludge	13707.91±345.49	12269.26±307.10	324.92±8.83
Southern sludge	12622.14±1113.25	12486.41±76.78	277.42±3.84

Atomic absorption measurements have shown that sediment samples from the Danube contain high concentrations of certain heavy metals. To quickly and accurately determine what contaminants are present and in what concentrations, ICP analysis was used to determine the concentrations of different heavy metals.

The samples were analysed for concentrations of cobalt, bismuth, beryllium, zinc, aluminium, iron, and manganese. In addition, cadmium, lead, nickel, barium, chromium, copper and silver were not present in detectable concentrations.

A contamination limit of 30 mg/kg dry matter is set for cobalt, which both samples exceed many times. As the concentrations in the northern and southern samples are almost identical, contamination from the nuclear power plant can be excluded. The Dunaújváros ironworks is likely the source of the pollution. Further investigations are needed to determine the cause of the high pollution (due to the low number of sediment samples).

The samples also contain high concentrations of bismuth, beryllium, manganese, aluminium and iron. For these substances, Joint Decree No. 6/2009 (IV. 14.) "KvVM-EüM-FVM" [20] on the cobalt content of geological media does not set any limit values for the contamination of geological media and groundwater.

Statistical analysis (Tables 16-21) showed no significant difference between the northern and southern sediment samples, except for manganese (Table 21). The manganese concentration is significantly lower in the southern sample, taken from under the power plant.

Table 16: Variance table of Al^{3+} concentrations in the Danube sediment measured by ICP-OES
Independent variable: Al^{3+} concentrations in the Danube sediment measured by ICP-OES

Source	Sum of Squares	df	Mean Square	F	p	LSD _{5%}
Corrected model	1178907.894(a)	1	1178907.89	1.735	.318	
Intercept	693271477.709	1	693271477.71	1020.499	.001	
Sampling area*	1178907.894	1	1178907.89	1.735	.318	3546.35
Error	1358691.297	2	679345.65			
Total	695809076.9	4				
Corrected total	2537599.191	3				

(a) $R = .465$ ($R_{\text{corrected}} = .197$)

* Al^{3+} concentrations in the Danube sediment measured by ICP-OES

Table 17: Variance table of Be^{2+} concentrations in the Danube sediment measured by ICP-OES
Independent variable: Be^{2+} concentrations in the Danube sediment measured by ICP-OES

Source	Sum of Squares	df	Mean Square	F	p	LSD _{5%}
Corrected model	17690.982(a)	1	17690.982	.090	.793	
Intercept	95863251.176	1	95863251.176	486.973	.002	
Sampling area*	17690.982	1	17690.982	.090	.793	1909.01
Error	393711.001	2	196855.501			
Total	96274653.159	4				
Corrected total	411401.983	3				

(a) $R = .043$ ($R_{\text{corrected}} = -.435$)

* Be^{2+} concentrations in the Danube sediment measured by ICP-OES

Table 18: Variance table of Bi^{3+} concentrations in the Danube sediment measured by ICP-OES
Independent variable: Bi^{3+} concentrations in the Danube sediment measured by ICP-OES

Source	Sum of Squares	df	Mean Square	F	p	LSD _{5%}
Corrected model	324936,424(a)	1	324936,424	15,207	,060	
Intercept	424466498,381	1	424466498,381	19864,864	,000	
Sampling area*	324936,424	1	324936,424	15,207	,060	628,95
Error	42735,405	2	21367,703			
Total	424834170,210	4				
Corrected total	367671,829	3				

(a) $R = .884$ ($R_{\text{corrected}} = .826$)

* Bi^{3+} concentrations in the Danube sediment measured by ICP-OES

Table 19: Variance table of Co^{2+} concentrations in the Danube sediment measured by ICP-OES
Independent variable: Co^{2+} concentrations in the Danube sediment measured by ICP-OES

Source	Sum of Squares	df	Mean Square	F	p	LSD _{5%}
Corrected model	265991.100(a)	1	265991.100	9.757	.089	
Intercept	584945324.905	1	584945324.905	21456.251	.000	
Sampling area*	265991.100	1	265991.100	9.757	.089	710.42
Error	54524.468	2	27262.234			
Total	585265840.472	4				
Corrected total	320515.568	3				

(a) $R = .830$ ($R_{\text{corrected}} = .745$)

* Co^{2+} concentrations in the Danube sediment measured by ICP-OES

Table 20: Variance table of Fe^{2+} concentrations in the Danube sediment measured by ICP-OES
Independent variable: Fe^{2+} concentrations in the Danube sediment measured by ICP-OES

Source	Sum of Squares	df	Mean Square	F	p	LSD _{5%}
Corrected model	73681.737(a)	1	73681.737	1.471	.349	
Intercept	615534298.795	1	615534298.8	12285.235	.000	
Sampling area*	73681.737	1	73681.737	1.471	.349	963.1
Error	100207.168	2	50103.584			
Total	615708187.700	4				
Corrected total	173888.905	3				

(a) $R = .424$ ($R_{\text{corrected}} = .136$)

* Fe^{2+} concentrations in the Danube sediment measured by ICP-OES

Table 21: Variance table of Mn^{2+} concentrations in the Danube sediment measured by ICP-OES
Independent variable: Mn^{2+} concentrations in the Danube sediment measured by ICP-OES

Source	Sum of Squares	df	Mean Square	F	p	LSD _{5%}
Corrected model	2256.502(a)	1	2256.502	48.688	.020	
Intercept	362805.946	1	362805.946	7828.240	.000	
Sampling area*	2256.502	1	2256.502	48.688	.020	29.291
Error	92.692	2	46.346			
Total	365155.140	4				
Corrected total	2349.193	3				

(a) $R = .961$ ($R_{\text{corrected}} = .941$)

* Mn^{2+} concentrations in the Danube sediment measured by ICP-OES

1.7. Several problems

"A soil and groundwater monitoring system has been installed at the nuclear power plant to monitor the condition of soils and groundwater. Before 1995, two soil contamination cases were detected near the confined space (oil) and the dismantled paint waste storage (metals). In both cases, decontamination was carried out. Since 1996, an environmental damage assessment and several environmental reviews have been conducted at the site. The power plant has remediated the identified and assessed contamination, identified the causes and considered the experience in the reconstruction work [27]". In 1999, further contamination was found, with bubbles forming in several places on the chemical pool cover, from which water was released under pressure. At the same time as the pool was insulated, the soil contamination beneath the pool was investigated.

Two horizontal drillings, each 25 m long, were drilled horizontally in the sub-basin soil layer (perpendicular to the south (drilling V1) and west (drilling V2) sides of the pool). The samples were analysed for copper, nickel, iron, manganese, lead, zinc and chloride, which revealed that the metal concentration values of the soil sample from the V2 horizontal drilling were higher than the metal concentration values obtained from the analytical analysis of the soil sample taken from the 1 m depth of the most contaminated soil sample from the ZG02 sampling drilling, which was drilled nearby to the Z02 well. Consequently, it was found that the isolation of the basin was damaged in several places, and the analysis of core samples from the horizontal drilling showed that samples from drilling V2 contained higher concentrations of the metals tested than samples from drilling V1.

Calculations were carried out to determine the risk of contamination. Considering the minimum flow rate of the cold-water channel, the groundwater flow rate, and the heavy metal concentrations in the warm-water channel, it was concluded that the pollution does not risk the Danube ecosystem. Depending on the soil's buffer capacity and the pollution's dispersion, it will reach the river in about 2-8 years [27].

CONCLUSIONS AND RECOMMENDATIONS

A soil and groundwater monitoring system has been installed at the nuclear power plant to monitor the condition of soils and groundwater. Before 1995, two contamination cases were detected near the confined space (oil) and the dismantled paint waste storage (metals). In both cases, decontamination was carried out. Since 1996, an environmental damage assessment and several environmental reviews have been conducted at the site. The power plant has remediated the identified and assessed contamination, identified the causes and considered the experience in the reconstruction [28].

The measurements described in this paper show Zn contamination. Further investigations are needed to identify the cause.

Further investigation of the Danube sediment is also necessary, as 2 samples were taken, which should be increased to identify the cause of the heavy metal load (Dunaújváros Ironworks and Paks Nuclear Power Plant).

ACKNOWLEDGEMENT

The authors thank Józsefné Göttli for her help, expertise, and advice in obtaining the measurements. The authors would like to thank Peter Nagy, György Maján of the Danube Basin Probe, and János Kardos and Zoltán Kész of GEPOARD Ltd. for their help in groundwater sampling.

Our thanks go to all the laboratory assistants, Lászlóné Kiss, Jánosné Dudás and Lajosné Ács, for their help in the laboratory work.

The authors thank Dr. Habil. Márk Horváth, thank you for your help with ICP measurements.

REFERENCES

- [1] Hanfi, M. Y., Mostafa, M. Y., & Zhukovsky, M. V. (2020). Heavy metal contamination in urban surface sediments: sources, distribution, contamination control, and remediation. *Environmental monitoring and assessment*, 192, 1-21.
- [2] Mohite, V. T. (2022). Pollution and pollution control. In *Emerging trends in environmental biotechnology* (pp. 11-21). CRC Press.
- [3] Yoro, K. O., & Daramola, M. O. (2020). CO₂ emission sources, greenhouse gases, and the global warming effect. In *Advances in carbon capture* (pp. 3-28). Woodhead Publishing.
- [4] Sadiq, M., Shinwari, R., Usman, M., Ozturk, I., & Maghyereh, A. I. (2022). Linking nuclear energy, human development and carbon emission in BRICS region: do external debt and financial globalisation protect the environment? *Nuclear Engineering and Technology*, 54(9), 3299-3309.
- [5] Zhukova, E. (2020). Nuclear disaster as chronic crisis: accounts of radiation embodiment by survivors of the Chernobyl nuclear disaster from Belarus born before, in and after 1986. *Health*, 24(5), 589-605.
- [6] Héjj, D. (2022). The Paks nuclear power plant and Hungary's attitude to the European Green Deal. *Polish-Hungarian Cooperation for Energy Security in the Context of Energy Transition and Economy Competitiveness*, 68.
- [7] <https://atomeromu.mvm.hu/en/FelelosVallalat/Kornyezetvedelem> (View at: 08.07. 2024)
- [8] Kurniawan, T.A., Othman, M.H.D., Singh, D., Avtar, R., Hwang, G.H., Setiadi, T., Lo, W.H. (2022). Technological solutions for long-term storage of partially used nuclear waste: A critical review. *Annals of Nuclear Energy*, 166, 108736, <https://doi.org/10.1016/j.anucene.2021.108736>
- [9] Jantner, J. (1999). Az ipari hulladékvíz rendszer – Tanfolyami jegyzet ügyeletes mérnökök számára. (The industrial wastewater system - Course notes for engineers on duty.) PA Rt., Paks
- [10] Paksi Atomerőmű Zrt. (2022). A Paksi Atomerőmű Környezetvédelmi jelentése 2022. évről, Szerk. Sallai, O., Paks (Paks Nuclear Power Plant Environmental Report 2022, Ed.)
- [11] Bharti, R., & Sharma, R. (2022). Effect of heavy metals: An overview. *Materials Today: Proceedings*, 51, 880-885.
- [12] Wang, Z., Luo, P., Zha, X., Xu, C., Kang, S., Zhou, M., Nover, D., Wang Y. (2022). Overview assessment of risk evaluation and treatment technologies for heavy metal pollution of water and soil. *Journal of Cleaner Production*, 379(2), 134043, <https://doi.org/10.1016/j.jclepro.2022.134043>

- [13] Vardhan, K.H., Kumar, P.S., Panda, R.C. (2019). A review on heavy metal pollution, toxicity and remedial measures: Current trends and future perspectives. *Journal of Molecular Liquids*, 290, 111197, <https://doi.org/10.1016/j.molliq.2019.111197>
- [14] Wan, L., Lv H., Qasim, W., Xia, L., Yao, Z., Hu, J., Zhao, Y., Ding, X., Zheng, X., Li, G., Lin, S., Butterbach-Bahl, L. (2022). Heavy metal and nutrient concentrations in top- and sub-soils of greenhouses and arable fields in East China – Effects of cultivation years, management, and shelter. *Environmental Pollution*, 307, 119494, <https://doi.org/10.1016/j.envpol.2022.119494>
- [15] Li, Q., Wang, Y., Li, Y., Li, L., Tang, M., Hu, W., Chen, L., Ai, S. (2022). Speciation of heavy metals in soils and their immobilization at micro-scale interfaces among diverse soil components, *Science of The Total Environment*, 825, 153862, <https://doi.org/10.1016/j.scitotenv.2022.153862>
- [16] Rashid, A., Schutte, B.J., Ulery, A., Deyholos, M.K., Sanogo, S., Lehnhoff, E.A., Beck, L. (2023). Heavy Metal Contamination in Agricultural Soil: Environmental Pollutants Affecting. *Crop Health. Agronomy* 13, 1521, <https://doi.org/10.3390/agronomy13061521>
- [17] Kicińska, A., Pomykała, R., Izquierdo, M. (2021). Changes in soil pH and mobility of heavy metals in contaminated soils. *European Journal of Soil Science* 73(1): e13203, <https://doi.org/10.1111/ejss.13203>
- [18] Angon, P.B., Islam, Md.S., Shreejana K.C., Das, A., Anjum, N., Poudel, A., Suchi, S.A., (2024). Sources, effects and present perspectives of heavy metals contamination: Soil, plants and human food chain. *Heliyon*, 10(7), e28357, <https://doi.org/10.1016/j.heliyon.2024.e28357>
- [19] Simon, L. (1998). Talajszennyeződés, Talajtisztítás, GATE, Mezőgazdasági Főiskolai Tanszék, Nyíregyháza. (Soil Pollution, Soil Cleaning, GATE, Department of Agriculture, College of Agriculture)
- [20] <https://net.jogtar.hu/jogszabaly?docid=a0900006.kvv> - Wolters Kluwer (View at 26.07.2024.)
- [21] Rácz, P., Bódis, K., Farsang, A. (2002). Study on the element – movements in the Velence mountains. In: A Faz, R Ortiz, A. R. Mermut (ed.) *International symposium on sustainable use and management of soils and semiarid regions*, Murcia, Spanyolország, 2002.09.22-2002.09.26.
- [22] Bányai, É., Pólos, L. (1987) *Analitikusok kézikönyve*, Műszaki Kiadó, Budapest (Analysts' Handbook, Technical Publishing House)
- [23] Burger, K. (1992) *A mennyiségi analízis alapjai, Kémiai és műszeres analízis*, Semmelweis Kiadó, Budapest (Fundamentals of Quantitative Analysis, Chemical and Instrumental Analysis, Semmelweis Publishers)
- [24] Kádár, I., (1998). *Kármentesítési kézikönyv 2. A szennyezett talajok vizsgálatáról*. Környezetvédelmi Minisztérium, 1998. (Remediation manual 2. On the investigation of contaminated soils. Ministry of Environment)
- [25] Sváb, J. (1981). *Biometriai módszerek a mezőgazdasági kutatásban*, Mezőgazdasági Kiadó, Budapest (Biometric methods in agricultural research)
- [26] <https://talajreform.hu/tudasbazis/a-ph-ertekek-ertelmezese-egy-talajvizsgalatban/> (View at 26.07.2024.)
- [27] ETV-Erőterv Rt. (2006). *Paksi Atomerőmű üzemidő hosszabbítása – Környezeti hatástanulmány*. (Paks Nuclear Power Plant Life Extension - Environmental Impact Assessment.)



VIII. International Symposium-2024

SECURING THE BIOSPHERE FOR FUTURE GENERATIONS USING AI

Neha Singh Raghuvanshi^{1*}, Arpita Johri², Mudit Saxena³

¹ABES Engineering College, Ghaziabad, UP, India.

Abstract:

In the endeavour to protect the biosphere for future generations, leveraging the potential of artificial intelligence (AI) emerges as a ground-breaking approach. AI technologies offer unprecedented abilities to monitor, assess, and address environmental challenges that endanger ecosystems globally. Through sophisticated algorithms and data-driven insights, AI facilitates comprehensive environmental surveillance, monitoring shifts in biodiversity, identifying pollution levels, and recognizing critical threats like deforestation and the impacts of climate change. Additionally, AI-driven conservation strategies prioritize regions of significant ecological importance, optimize efforts for habitat restoration, and combat illegal wildlife activities using real-time data analysis and predictive modelling. Precision agriculture, climate modelling, and disaster response also benefit from AI's predictive capabilities, promoting sustainable practices and resilience to environmental hazards. Embracing AI advances sustainable development, increases public awareness, and enables stakeholders to collaborate effectively in safeguarding the biosphere. By harnessing AI's innovation and collective action, humanity can fulfil its duty to preserve and safeguard the planet, ensuring a resilient and sustainable future for generations to come

Keywords: AI, conservation, sustainable future, generations, research

INTRODUCTION

In a time marked by swift technological progress and escalating environmental dilemmas, safeguarding the biosphere for forthcoming generations emerges as an imperative duty. Humanity faces the daunting challenges of climate change, biodiversity loss, and resource depletion, prompting the recognition of artificial intelligence (AI) as a crucial tool in our arsenal. With its prowess in data analysis, pattern recognition, and predictive modelling, AI holds vast potential to transform our comprehension, management, and protection of the biosphere. By employing AI technologies, we can delve deeper into ecological systems, forecast environmental trends more accurately, and devise more efficient strategies for conservation and sustainability. AI-driven solutions present unparalleled opportunities, from monitoring wildlife populations and tracking deforestation in remote areas to optimizing energy usage and combating pollution in urban settings.

One of AI's primary strengths lies in its ability to process extensive datasets and derive significant insights in real-time. Utilizing advanced sensors, satellite imagery, and various data sources, AI algorithms can scrutinize environmental data at scales and speeds surpassing human capabilities. This enables us to discern subtle alterations in ecosystems, recognize emerging threats to biodiversity, and

evaluate the efficacy of conservation efforts with unmatched precision.[1] Moreover, AI-powered predictive modelling empowers us to anticipate environmental shifts and their subsequent impacts, facilitating proactive measures to safeguard vulnerable species and ecosystems before irreversible harm occurs.

Additionally, AI fosters the innovation of solutions to pressing environmental issues. [2] For instance, machine learning algorithms can optimize resource allocation in agriculture, yielding higher productivity with a reduced environmental footprint. Similarly, AI-driven simulations can forecast the outcomes of diverse policy interventions, aiding policymakers in making well-informed decisions to bolster sustainability and resilience. Furthermore, AI-powered robotics and drones enable the automation of tasks such as habitat restoration and marine debris clean-up, complementing human endeavours and broadening our capacity for environmental stewardship.

Nevertheless, the effective utilization of AI in biosphere conservation raises ethical, social, and technical concerns that warrant meticulous attention. Issues pertaining to data privacy, algorithmic bias, and the concentration of power among a select few technology giants emphasize the necessity for robust governance frameworks and inclusive decision-making processes. Additionally, ensuring equitable access to AI technologies and fostering local capacity for their implementation are indispensable in preventing the exacerbation of existing disparities in environmental management and conservation.

In conclusion, safeguarding the biosphere for future generations necessitates a multifaceted approach that harnesses the transformative potential of AI while confronting its associated challenges. By leveraging AI technologies to enrich our comprehension of ecological systems, devise innovative solutions to environmental dilemmas, and empower diverse stakeholders in conservation endeavours, we can forge a more sustainable and resilient future for all life on Earth. At this pivotal juncture in human history, the integration of AI into environmental conservation offers a beacon of hope in our collective quest to preserve the planet for generations to come.

APPLICATION OF AI IN MANAGING ENVIRONMENTAL ISSUES AND ADVANCE SUSTAINABILITY

Securing the biosphere for future generations through the utilization of artificial intelligence (AI) involves tapping into the potential of AI technologies to tackle environmental issues and advance sustainability.

1. Environmental Surveillance: The significance of artificial intelligence (AI) in environmental surveillance is increasingly paramount, as it plays a crucial role in monitoring and managing ecosystems, forecasting environmental changes, and mitigating human impact on the environment.[3] Through sophisticated data analysis, pattern recognition, and predictive modelling, AI provides environmental scientists and policymakers with the tools needed to make informed decisions and take proactive measures to safeguard natural resources. AI-driven satellite imagery analysis can swiftly detect and monitor deforestation across expansive regions in real-time. For instance, Global Forest Watch utilizes AI algorithms to deliver timely updates on changes in forest cover, empowering authorities and conservationists to promptly address illegal logging activities. By integrating satellite data with machine learning algorithms, it becomes feasible to pinpoint areas at heightened risk of deforestation and prioritize conservation efforts accordingly.

Conservation organizations and researchers are employing AI to enhance the tracking and monitoring of wildlife populations. [4] Notably, the non-profit organization Wildbook utilizes AI and computer vision algorithms to identify individual animals from images and videos uploaded by researchers and citizen scientists. This technology has been instrumental in projects like Wildbook for Whale Sharks, aiding in the tracking and protection of endangered whale shark populations globally.

AI is transforming the monitoring of air and water quality by analyzing extensive sensor data in real time. IBM's Environmental Intelligence Suite, for example, integrates IoT sensors, AI, and predictive analytics to monitor air quality in urban and industrial areas. By identifying patterns and anomalies in pollution levels, authorities can swiftly implement measures to mitigate environmental risks and

safeguard public health. AI-driven climate models enable scientists to forecast the impacts of climate change with heightened precision. Collaborations such as Google's DeepMind with climate researchers have led to the development of AI models that simulate intricate climate processes more efficiently. These models assist in predicting extreme weather events, sea-level rise, and other climate-related phenomena, thereby aiding policymakers in formulating adaptation strategies and reducing vulnerability to climate change. AI-based systems are deployed to combat illegal, unreported, and unregulated (IUU) fishing activities. For instance, Ocean Mind utilizes AI algorithms to analyze vessel tracking data, satellite imagery, and other data sources to detect suspicious fishing behaviour. By flagging vessels potentially engaged in illegal fishing, these systems aid authorities in enforcing regulations and safeguarding marine ecosystems.

In urban areas, AI technologies are utilized to optimize the management of green spaces and enhance urban biodiversity. For example, the City of Melbourne in Australia utilizes AI algorithms to analyse data from urban forests and green spaces, assisting city planners in identifying areas for conservation and prioritizing maintenance efforts.

2. Conservation and Rehabilitation: The pivotal role of artificial intelligence (AI) in conservation and rehabilitation endeavours cannot be overstated, as it offers innovative solutions to tackle the challenges confronting ecosystems and endangered species.[5] Through sophisticated data analysis, pattern recognition, and predictive modelling, AI facilitates the implementation of more efficient and effective conservation strategies. AI-driven technologies are indispensable for monitoring and safeguarding endangered species. For instance, in the context of the Amur tiger population in Russia, AI-enabled camera traps analyse images to identify individual tigers, enabling conservationists to track their movements and evaluate population trends. By harnessing AI, conservationists acquire valuable insights into the behaviour and habitat utilization of endangered species, thereby facilitating targeted conservation efforts.

AI is increasingly deployed to combat poaching and illegal wildlife trade. SMART (Spatial Monitoring and Reporting Tool), an AI-powered software developed by the Wildlife Conservation Society, assists park rangers in tracking and analysing patrol data to pinpoint poaching hotspots and allocate resources more efficiently. Similarly, in Africa, AI-equipped drones with thermal imaging cameras can detect poachers in remote areas, enabling swift responses to illicit activities and safeguarding vulnerable wildlife populations. AI technologies contribute to habitat restoration initiatives by optimizing planting strategies and monitoring ecosystem health. For instance, in the Brazilian Amazon rainforest, AI algorithms analyze satellite imagery to identify suitable areas for reforestation and prioritize restoration efforts.[6] Additionally, AI-driven drones equipped with seed-dispersal mechanisms autonomously plant trees in hard-to-reach areas, expediting the restoration process and enhancing biodiversity. AI-driven approaches are utilized to alleviate conflicts between humans and wildlife, especially in regions where human endeavours infringe upon natural habitats. Through data analysis concerning wildlife behaviours, movement patterns, and habitat preferences, AI algorithms can anticipate areas prone to conflicts and propose pre-emptive actions to mitigate interactions between humans and wildlife. As an illustration, systems powered by AI can notify farmers about the presence of animals that raid crops, enabling timely interventions to prevent crop loss and alleviate conflicts.

AI is revolutionizing marine conservation through technologies such as underwater robotics and acoustic monitoring.[7] In the Great Barrier Reef, autonomous underwater vehicles (AUVs) equipped with AI algorithms survey coral reefs and assess their health, providing crucial data for conservation efforts. Moreover, AI-powered acoustic monitoring systems detect and classify marine species based on their vocalizations, enabling researchers to monitor biodiversity and safeguard marine ecosystems. AI technologies play a pivotal role in monitoring wildlife health and detecting disease outbreaks. For instance, in cases of bats vulnerable to white-nose syndrome, AI algorithms analyze acoustic data to detect changes in bat calls indicative of infection, facilitating early intervention. Similarly, AI-powered image analysis aids in diagnosing diseases in wildlife based on visual cues, enabling timely veterinary care and conservation interventions.

AI assists conservationists in adapting to the impacts of climate change by predicting habitat shifts and identifying resilient species. [8] In Madagascar, AI models forecast potential changes in lemurs' habitats

due to climate change, guiding conservation efforts to protect critical habitats and establish migration corridors. Leveraging AI, conservationists can devise adaptive management strategies to mitigate the effects of climate change on biodiversity. These case studies underscore the transformative potential of AI in conservation and rehabilitation endeavours, showcasing its ability to bolster wildlife protection, habitat restoration, anti-poaching measures, and disease surveillance. By harnessing AI technologies, conservationists can deepen their understanding of the intricate challenges facing ecosystems and endangered species, ultimately contributing to the preservation of biodiversity and the sustainability of our planet.

3. Precision Agriculture: The pivotal role of artificial intelligence (AI) in precision agriculture cannot be overstated, as it brings about a paradigm shift in traditional farming methods by significantly enhancing efficiency, productivity, and sustainability.[9] Through AI-powered technologies, farmers are empowered to make informed, data-driven decisions, thereby optimizing resource utilization and maximizing crop yields while minimizing environmental impact. Utilizing AI algorithms, a plethora of data from diverse sources such as satellite imagery, sensors, and weather forecasts is analyzed to furnish actionable insights to farmers. By scrutinizing data pertaining to soil health, crop growth, and weather patterns, AI systems discern patterns and trends, thereby enabling farmers to make well-informed decisions regarding planting schedules, irrigation practices, and crop protection strategies.

Moreover, AI facilitates predictive modeling to anticipate factors such as crop growth, disease outbreaks, and pest infestations. By amalgamating historical data with real-time observations, AI algorithms forecast crop yields, identify potential risks, and offer recommendations for optimal management practices. This proactive approach aids farmers in mitigating losses and optimizing inputs, thus fostering a more sustainable and profitable agricultural landscape. In addition, AI enables the implementation of precision farming techniques such as variable rate application (VRA) of inputs such as fertilizers, pesticides, and water. By leveraging AI-driven algorithms to analyze soil and crop data, farmers can customize input applications to specific zones within their fields, thereby optimizing resource allocation while minimizing environmental impact. This targeted approach not only enhances crop yields but also reduces input costs and mitigates pollution.

Furthermore, AI-powered autonomous vehicles and drones are reshaping farm operations, enabling tasks such as planting, spraying, and harvesting to be executed with unparalleled precision and efficiency. [10] Equipped with sensors and AI algorithms, these machines navigate fields, identify obstacles, and adapt to changing conditions in real time, thereby lowering labour costs and enhancing productivity. Moreover, AI-based monitoring systems track crop health and growth throughout the growing season, enabling farmers to promptly identify early signs of stress, disease, or nutrient deficiencies. By analyzing data from remote sensing technologies such as satellites and drones, AI algorithms generate comprehensive maps of field conditions and provide recommendations for targeted interventions such as irrigation adjustments or pest control measures. Lastly, AI optimises the agricultural supply chain by forecasting demand, optimising logistics, and refining inventory management. By analyzing market trends, weather forecasts, and production data, AI algorithms optimize planting decisions, streamline distribution routes, and minimize waste, ensuring efficient and sustainable delivery of crops to markets.

4. Natural Disaster Management: Artificial intelligence (AI) is assuming a progressively pivotal role in the management of natural disasters, introducing inventive solutions to fortify preparedness, response, and recovery endeavours. [11] Through sophisticated data analysis, predictive modelling, and real-time surveillance, AI empowers authorities to mitigate the impact of calamities and safeguard lives. A fundamental facet of AI in disaster management lies in its capability to scrutinize extensive datasets from diverse origins, encompassing satellite imagery, meteorological forecasts, and social media updates, thereby furnishing early warnings and situational awareness. AI algorithms adeptly identify patterns and irregularities indicative of imminent disasters, such as shifts in weather patterns or seismic disturbances, enabling prompt issuance of alerts and evacuation directives. Furthermore, AI-driven predictive modelling forecasts the trajectory and severity of disasters, facilitating more efficient allocation of resources and formulation of contingency plans.

Amid emergencies, AI technologies enable instantaneous monitoring and decision-making by analyzing live data streams from sensors, drones, and other Internet of Things (IoT) devices deployed in disaster-prone regions. AI-driven systems adeptly pinpoint areas susceptible to flooding, landslides, or wildfires and offer recommendations for evacuation routes or resource deployment. Additionally, AI-powered chatbots and virtual assistants extend aid to emergency responders and affected communities by disseminating information on shelters, medical facilities, and emergency services. Post-disaster, AI expedites the assessment and recovery process by analyzing satellite imagery to gauge damage, prioritize rescue operations, and allocate resources effectively. Moreover, AI-driven algorithms scrutinize social media data to identify areas warranting urgent assistance and coordinate humanitarian aid initiatives. In essence, AI is reshaping natural disaster management by furnishing timely insights, refining response endeavours, and bolstering resilience in the face of escalating frequency and severity of disasters.

5. Sustainable Development: Artificial intelligence (AI) plays a crucial role in driving sustainable development forward, providing inventive solutions to tackle intricate challenges spanning diverse sectors. Through the application of data analysis, predictive modelling, and optimization algorithms, AI streamlines resource management, fosters environmental preservation, and fuels socio-economic advancement. [12] A notable illustration demonstrating AI's impact on sustainable development is exemplified in the deployment of AI-powered smart grids for energy management. These smart grids harness AI algorithms to scrutinize energy consumption patterns, fine-tune distribution processes, and seamlessly integrate renewable energy sources like solar and wind power into the grid. By dynamically adjusting energy provision in response to demand fluctuations and resource availability, smart grids curtail wastage, mitigate carbon emissions, and advocate the adoption of renewable energy sources, thereby bolstering sustainable energy generation and consumption.

AI empowers precision agriculture practices aimed at optimizing resource utilization, minimizing environmental footprints, and bolstering food security. By analyzing data derived from sensors, satellites, and weather forecasts, AI algorithms furnish insights into soil conditions, crop development, and pest occurrences, enabling farmers to implement precise interventions and enhance crop yields sustainably. For instance, in the Farm-View initiative in Kenya, AI-driven drones equipped with multispectral cameras monitor crop health and water stress, empowering farmers to make informed decisions regarding irrigation practices, thus elevating agricultural productivity while conserving precious water resources. AI-driven solutions are revolutionizing transportation systems, rendering them more sustainable and efficient. Ride-sharing platforms, for instance, leverage AI algorithms to optimize route planning, alleviate congestion, and curtail emissions by matching riders heading in similar directions. Similarly, AI-powered autonomous vehicles hold the promise of transforming urban mobility by reducing traffic accidents, enhancing fuel efficiency, and propelling the transition towards electric and shared transportation models.

Additionally, AI augments environmental monitoring and conservation endeavours by analyzing data from satellite imagery, sensor networks, and ecological models to evaluate biodiversity, monitor deforestation, and gauge water quality. Equipped with real-time insights and predictive analytics, AI empowers policymakers, conservationists, and communities to make informed decisions and undertake pre-emptive measures to safeguard ecosystems and biodiversity, thus contributing to the attainment of long-term sustainable development objectives. In summation, AI acts as a catalyst for sustainable development, underpinning data-driven decision-making, optimizing resource allocation, and nurturing innovation across diverse sectors.

6. Environmental Education and Awareness: AI technologies enrich environmental education and public awareness campaigns by offering interactive learning experiences, tailored recommendations, and real-time environmental insights. AI-driven chatbots and virtual assistants engage with the public, address inquiries, and promote behavioural shifts conducive to sustainability objectives.

By harnessing AI innovations and fostering collaboration across industries, communities, and governments, we empower stakeholders to confront environmental challenges, safeguard biodiversity, and pave the way for a sustainable future for generations to come.

CONCLUSION:

In conclusion, the utilization of artificial intelligence (AI) stands as paramount in ensuring the preservation of the biosphere for future generations. Through its capabilities in advanced data analysis, predictive modelling, and the development of innovative solutions, AI presents unparalleled opportunities to comprehend, oversee, and safeguard the ecosystems of our planet. By harnessing AI technologies, we can delve deeper into understanding environmental dynamics, foresee and alleviate emerging threats, and formulate sustainable approaches for conservation and stewardship. At this critical juncture in human history, the integration of AI into environmental endeavours signifies a beacon of hope, paving the path towards a more resilient and sustainable future for all life on Earth.

REFERENCES

1. VoPham, T., Hart, J.E., Laden, F. et al. Emerging trends in geospatial artificial intelligence (geoAI): potential applications for environmental epidemiology. *Environ Health* 17, 40 (2018).
2. Interdisciplinary Perspectives: Fusing Artificial Intelligence with Environmental Science for Sustainable Solutions. (2024). *Journal of Artificial Intelligence General Science (JAIGS)* ISSN:3006-4023, 1(1), 1-12.
3. Xiaoheng Zhang, Kunliang Shu, S. Rajkumar, V. Sivakumar, Research on deep integration of application of artificial intelligence in environmental monitoring system and real economy, *Environmental Impact Assessment Review*, Volume 86, 2021.
4. Sarkar D, Chapman CA. The Smart Forest Conundrum: Contextualizing Pitfalls of Sensors and AI in Conservation Science for Tropical Forests. *Tropical Conservation Science*. 2021;14.
5. Ditría Ellen M., Buelow Christina A., Gonzalez-Rivero Manuel, Connolly Rod M., Artificial intelligence and automated monitoring for assisting conservation of marine ecosystems: A perspective, *Frontiers in Marine Science*, 9, 2022.
6. Kim, J.; Lim, C.-H.; Jo, H.-W.; Lee, W.-K. Phenological Classification Using Deep Learning and the Sentinel-2 Satellite to Identify Priority Afforestation Sites in North Korea. *Remote Sens*. 2021, 13, 2946.
7. Gulustan Dogan, Doorva Vaidya, Megdalia Bromhal, Nelofar Banday, Artificial intelligence in marine biology, *A Biologist's Guide to Artificial Intelligence*, Academic Press, 2024, 241-254.
8. Walter L., Tony W., Serafino A., Gustavo J., Abdul-L., Johannes M., Artie W., Marina Kovaleva, F., Fátima A., Zeus G., Newton R., Antonis S., Asaf T., Krishna M., Odhiambo G., Deploying artificial intelligence for climate change adaptation, *Technological Forecasting and Social Change*, Volume 180, 2022.
9. S. A. Bhat and N. -F. Huang, "Big Data and AI Revolution in Precision Agriculture: Survey and Challenges," in *IEEE Access*, vol. 9.
10. D. Shadrin, A. Menshchikov, A. Somov, G. Bornemann, J. Hauslage and M. Fedorov, "Enabling Precision Agriculture Through Embedded Sensing With Artificial Intelligence," in *IEEE Transactions on Instrumentation and Measurement*, vol. 69, no. 7, pp. 4103-4113.
11. John G., Artificial intelligence technologies for robot assisted urban search and rescue, *Expert Systems with Applications*, Volume 11, Issue 2, 1996, 109-124.
12. Vinuesa, R., Azizpour, H., Leite, I. et al. The role of artificial intelligence in achieving the Sustainable Development Goals. *Nat Commun* 11, 233 (2020).



VIII. International Symposium-2024

LANDSCAPE SCALE STUDY OF HYDROMORPHOLOGICAL CHANGES OF BÜKKÖS STREAM (SZENTENDRE) AND THEIR EFFECTS ON NATURAL STATE

Igor DUKAY

Hungarian University of Agriculture and Life Sciences, Institute for Wildlife Management and Nature Conservation, Gödöllő, Hungary, dukayigor@gmail.com

Abstract:

Hydromorphological characteristics of waterbodies have remarkable effects on natural state of wetlands, therefore protection and rehabilitation of them, protection and repair of their role in the green and blue infrastructure network has also hydromorphological aspects. My study area is the Bükkös stream which flows into the Danube at Szentendre (Hungary). As a first step I collected and compared the available hydromorphological and natural data of the stream, then I reconstructed the natural and after intervention state of the streambed and the valley, based on topographical and archive military maps, orthophotos, satellite pictures and local historical documents. I created an image of the current natural state based on field studies, documents, habitat maps. During examination I could see that stream was affected by huge antropogenic effects (flood protection interventions, deforestation). The largest riverbed regulations happened in the 20th century, when the streambed was straightened and deepened, and its lowest sections received concret protection. The maintenance works are still affecting the riverbed and its wildlife. Despite all these effects, the woody vegetation was able to regenerate along the stream, and the fish fauna of the Bükkös has an outstanding nature conservation value. In both cases significant factors are that the stream has huge bed length drop, it carries lot of sediments, it has ecological connection with the Danube, furthermore, after riverbed regulations the attitude of the society was changed, the importance and financial sources of maintenance are reduced.

Keywords: Bükkös stream (Szentendre, Hungary), habitat regeneration, hydromorphology, protected fish species

INTRODUCTION

As a result of various human activities, biodiversity is declining, species are disappearing, its populations are declining, and habitats are being lost and degraded. The decline of wetlands and their associated species is on an enormous scale, with the regulation of lake and riverbeds, the draining of marshes and swamps, the falling of floodplain forests, the construction of dams, the concrete lining of streambeds and other activities becoming more common.

In the context of climate change, drought vulnerability has increased, and flash floods have become more frequent. Drought is a major risk for small water bodies and their wildlife. And flash floods can lead to new physical interventions to increase technical safety.

At the same time, the urban environment and urban heated islands are placing increasing pressure on human health, which could be mitigated by the creation of green lanes along watercourses.

The transformation of stream beds to eliminate and reduce flooding, to cope with increasing urbanisation and for agricultural and industrial purposes began in the 19th century and covered almost the whole of Hungary. The regulation of the riverbed means the straightening, deepening and uniformisation of the previously free-flowing riverbed. Its purpose is to quickly drain water that is considered excess and harmful and to meet the water needs of production. Habitat considerations have not been taken into account when the waterbodies are planned and managed. Maintaining a channelised riverbed also leads to the destruction of the reintroduced wildlife. Even regular riverbeds are being transformed by erosion and accumulation. Failure to mow banksides can also result in the creation of woody habitats.

The morphological variation of the riverbed is due to the alternation of pool and riffle-type parts. In natural watercourses they are formed by meanders. In a regulated bed, pools, which are necessary for larger fish species and larger spawning fish, cannot usually form. Pools would also provide refugium during periods of water scarcity. Additional habitats and spawning places are also lacking. Migration is interrupted by steps and cross dams.

The two sides of the riverbed are steep, often mown, and no woody vegetation can develop in the riverbed. This results in a lack of riparian and shade-tolerant plant species, a lack of animal species associated with woody habitats, higher water temperatures in the absence of shade and lower self-cleaning capacity of the water. In addition, the riparian woody vegetation lane could often be the only extensive climate enhancing activity in the urban areas. The society with this resignation from the ecosystem services and green infrastructure role of woody lanes.

Some species may be extirpated throughout the entire catchment of the regulated stream or found only in small refugia. Emigration from these areas is only possible if ecological connections are maintained. Even if species are able to establish in the urban or agricultural landscape, they are at risk from maintenance works (mowing, felling, dredging). To assess the objectives set out above, the original and current morphological, floristic and faunistic status of the stream needs to be assessed. Landscape-scale changes can be understood from landscape-scale studies (historical maps, descriptions).

By examining the current morphological characteristics of the stream bed, fish fauna and vegetation, it is possible to find out when and how the stream was regulated and what its current biota is. More detailed comparisons can be made using sample sections.

Faunistic regeneration is influenced by ecological connectivity, for example the presence or inhibition of longitudinal passage for fish, and distance from the Danube is certainly an important factor. The studies will be carried out between 2022 and 2026.

The natural state of the stream is threatened by dredging, mowing and localised river protection measures, especially in the urban and suburban stretches, even though the Bükkös stream has been under local protection since 1993 [1], it is part of an ecological corridor, and its valuable biota is well known.

The stream is home to a Carpathian Basin endemic fish species, the Carpathian barbel (*Barbus carpathicus*), which is a rare, highly protected species and species of Community importance. Other protected species of fish, amphibians, reptiles and birds are also present in the stream and its surroundings. Ecological considerations are mandatory under the EU Water Framework Directive and the Floods Directive [2] [3]. It is well known that urban forest habitats have a major impact in reducing the effects of climate change.

Our hypotheses:

1. high naturalistic fish populations can be established in urban concretelined stream sections, if hydromorphological characteristics and maintenance works allow.
2. an urban section may also develop a landscape vegetation type, with the occasional occurrence of protected plant species.
3. By understanding and protecting the conditions that meet the ecological needs of plant and fish species, solutions can be found to help restore habitat in urban environments.

MATERIALS AND METHODS

The Bükkös stream is in Hungary, north from Budapest (Capital of Hungary). It originates in the Visegrád Mountains and flows into the Danube at Szentendre. It is 16 km long. The main study area is the lower 4 km long section of the Bükkös stream, which section flows through urban and suburban areas. The upper 12 km long section flows in the forested hill area.

The morphology of the stream bed and valley and its changes were researched based on archival maps, orthophotos, satellite images, pictorial and written sources [4] [5] [6] [7] [8] [9] [10] [11] [12] [13] [14] [15] [16] [17] [18] [19] [20] [21] [22] [23] [24] [25] [26] [27] [28] [29] [30]. The historical maps were analysed for their landscape use history based on [31]. We have also based our work on landscape studies on a national scale [32] [33].

The bed morphology studies were carried out by field observation of certain features (concrete bed fill, its extent, presence or absence of pool and riffle type habitats, longitudinal permeability). For the morphological-based study of fish fauna, 10 reaches were selected, seven of which are in the lower 4 km of the stream. In the lowest 1.5 km long section, 5 sections were selected to that the spontaneous changes of the streambed and fish fauna can be examined in space and time in urban environment.

Based on fish faunistic protocol [34], 150 m long sections were delineated using an electric fishing machine on 21 September 2023. The species and length of fish caught were recorded in each section. Names of fish species were determined by [35] [36]. Based on [37], we have considered the combined morphological and fish faunistic results obtained so far.

Streamside vegetation types were identified during field surveys between May 2023 and June 2024, based on [38]. Botanical species lists were recorded by habitat. A habitat map was produced. For the upper reaches, the DINPI habitat map and forestry records were used as a guide. We studied the available botanical descriptions of the valley and the regeneration of alder forests in other streams [39] [40] [41].

Based on landscape history, river and valley morphology, vegetation and fish fauna, the entire stream valley was divided into nine sections. We considered, for example, the longitudinal drop of the bed, the type of interventions on the bed and vegetation, and the reduction of human impact.

RESULTS AND DISCUSSION

Based on landscape history, floristics and morphology, nine sections have been delimited, which can be seen in Table 1. The list of the fish species caught during this fish faunistic study are given in Table 2. We caught 19 fish species and one hybrid. The number of the protected and highly protected fish are 8. There were 4 non-native fish species. Fig.1 shows the number of fish species, non-native and protected species, the number of individuals and the distance from the mouth of each stream section.

Table 1: Sections of the Bükkös stream.

Number and name of sections	Short description of the section
1. The section from the source to the Sikarosi forestry house	In summer outdrying, natural, forested stream valley section, with large longitudinal drop. In the 18th and 19th centuries, sections of it were deforested and pastures were created.

2. The section from the Sikarosi forestry house to the first sediment trap dam at Dömörkapu	Rarely dry section with relatively large longitudinal drop. The forest of the valley bottom was also cut out then re-established. It may have been affected by river channelisation. One fish species lives in the stream section.
3. The section from first sediment trap dam to the Anna valley bridge (the last sediment trap)	Narrow stream section with large longitudinal drop. The forest also cut out then spontaneously formed. It is fragmented by some sediment traps and a natural waterfall. Recolonized by a few fish species.
4. The section from Anna valley bridge to Kékibányai bridges	Also previously used as pasture, then regulated and reforested. Habitat of some fish species.
5. The peri-urban section from Kékibányai bridges to Jobbágy street	A section with a similar history to the previous one, but where industrial, agricultural, sporting and residential areas emerged in the 20th century. Good fish habitat. It has a few Danubial fish species and semi-natural parts.
6. Upper suburban section, from Jobbágy street to Szegedi street	Dredged and reforested section with urban impacts. There are also parts close to nature.
7. Lower suburban section, from Szegedi street to Dunakanyar boulevard (Road 11)	Concrete lined section with preserved old trees and new specimen. It has valuable fish fauna by sediment deposition.
8. The section of the Downtown, from Road 11 to Korzó bridge	Concrete lined section in good technical condition. From this case and from the regular mowing it is in poor natural condition. It has two short parts which are good fish habitats. The floods of Danube influence its hydromorphology and fish fauna.
9. The estuary section, under Korzó bridge	Reforested from the 1970's. Spontaneous riverine floodplain forest re-established, not stream side alder forest. Good fish habitat with lot of Danube fish species.

Table 2: Fish species caught in September 2023. Protected and highly protected species are indicated in bold. Invasive species are underlined. (Sources of English and Scientific name are [33] [34].)

English name	Scientific name
Bleak	<i>Alburnus alburnus</i>
Barbel	<i>Barbus barbus</i>
Barbel x Carpathian barbel	<i>Barbus</i> sp.
Carpathian barbel	<i>Barbus carpathicus</i>
Chub	<i>Squalius cephalus</i>
Common dace	<i>Leuciscus leuciscus</i>
Common nase	<i>Chondrostoma nasus</i>
Eurasian minnow	<i>Phoxinus phoxinus</i>
European bitterling	<i>Rhodeus amarus</i>
European perch	<i>Perca fluviatilis</i>
Gudgeon	<i>Gobio gobio</i>
Ide	<i>Leuciscus idus</i>
<u>Prussian carp</u>	<i>Carassius gibelio</i>

<u>Pumpkinseed</u>	<i>Lepomis gibbosus</i>
Schneider (Riffle minnow *)	<i>Alburnoides bipunctatus</i>
Roach	<i>Rutilus rutilus</i>
Vimba bream	<i>Vimba vimba</i>
<u>Round Goby</u>	<i>Neogobius melanostomus</i>
Stone loach	<i>Barbatula barbatula</i>
<u>Stone moroko</u>	<i>Pseudorasbora parva</i>

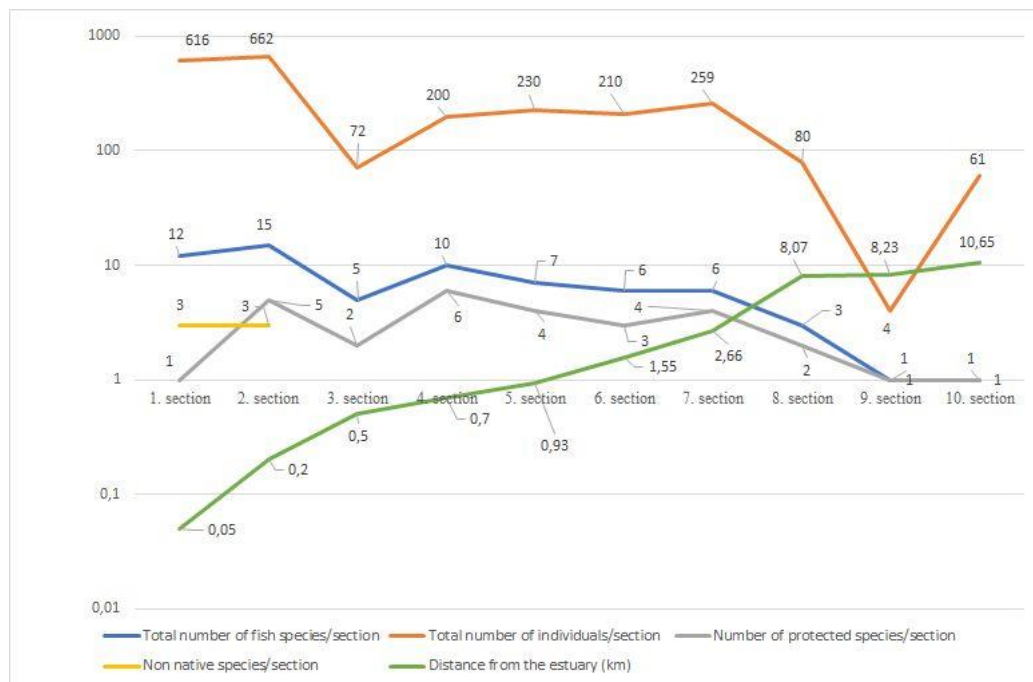


Figure 1: The evolution of number of non-natives, protected (and highly protected) fish species and total number of species in each section in relation to the distance from the estuary.

CONCLUSIONS AND RECOMMENDATIONS

The map-based, large-scale landscape morphological studies have provided a comprehensive picture of how the stream sections were lined in each period, and what interventions were made, e.g. mills, mill ditches, deforestation, and how the streamside vegetation zone was restored between the mid-1700s and the late 1900s.

Satellite images and aerial photographs provide a more accurate description of the spontaneous reforestation of the streambed from the 1950s to the present, but detailed floristic data are not available, so we can only conclude from photographs and aerial photographs taken between 1910 and 1950 that the alder forest in the urban and suburban section has re-established. The reestablishment of this species and its dominant habitat type in recent decades has been prevented mainly by mowing to maintain the floodplain in the 700 m long inner-city section.

According to a forestry informant, the streamside alder grove may have occurred higher up the valley than its current range limit. However, the lower reaches are clearly dominated by Danube floodplain forest species, with alder not even occurring as a colour element in the forest around the estuary. The species mixed with willows on the above section of the estuary, but only in cracks in the concrete bed. Historical descriptions of the drainages and field surveys have helped to refine the picture of the transformation of the stream valley, but many details remain unknown.

The fish faunistic survey again confirmed the Danube effect, but more sampling sites than in previous studies have allowed a more detailed understanding of the patterns of occurrence of Danube species. Similarly, a more refined picture of the distribution of invasive and specifically stream fish species was obtained. The results also suggest that Danube species occur above longitudinal impassability barriers in the lower few kilometres of the river, suggesting that they become intermittently impassable at higher water levels. Non-native and invasive species are typically

found in the section close to the Danube, with small numbers of species and individuals. Previous records indicate that additional non-typical stream and non-native species are known to occur upstream through stockings. Based on the surveys, it is safe to assume that the fish population is very rich in the urban, concrete lined sections just where the builded bed has become natural due to deposited sediment.

The Danube also plays a role in sediment deposition in the two lower stretches (where Danubian silt is deposited on the gravel brought by the stream). On the upper sections, the gravel mass is deposited in the bed brought by the stream floods. The open, unvegetated and unmowed gravel and concrete surfaces allow (or would allow) alder to recolonise. Their presence also implies a slight alteration of the banks, which is expected to be a very important environmental factor for the valuable stream fish fauna.

ACKNOWLEDGEMENT(S)

I am grateful to Ákos Malatinszky and to members of the research team carrying out the fish fauna survey.

REFERENCES

- [1] Szentendre Város Önkormányzat Képviselő-testületének 25/2018. (XI.19.) önkormányzati rendelete Szentendre Város zöldfelületeinek használatáról és a természeti értékek helyi védelméről. pp. 16.
- [2] DIRECTIVE 2000/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2000 establishing a framework for Community action in the field of water policy. Official Journal of the European Communities. European Union. 22.12.2000. pp. 72.
- [3] DIRECTIVE 2007/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2007 on the assessment and management of flood risks. Official Journal of the European Union. European Union. 6.11.2007. p. 8.
- [4] First Military Survey. Arcanum Adatbázis Kft. Last download: 2024.06.25. <https://maps.arcanum.com/hu/map/firstsurvey-hungary>
- [5] Second Military Survey. Arcanum Adatbázis Kft. Last download: 2024.06.25. <https://maps.arcanum.com/hu/map/secondsurvey-hungary>
- [6] Third Military Survey. Arcanum Adatbázis Kft. Last download: 2024.06.25. <https://maps.arcanum.com/hu/map/thirdsurvey25000>
- [7] Military Survey of Hungary (1941). Arcanum Adatbázis Kft. Last download: 2024.06.25. <https://maps.hungaricana.hu/en/MOLTerkeptar/1443/view/?bbox=2596%2C-5524%2C7867%2C-3073>
- [8] The Habsburg Empire – Cadastral maps 19th Century. Arcanum Adatbázis Kft. Last download: 2024.06.25. <https://maps.arcanum.com/hu/map/cadastral>
- [9] Specialis delineatio controversiae metalis inter possessione... [S 11 - No. 42/1.] Hungaricana Közgyűjteményi Portál. Last download: 2024.06.24. <https://maps.hungaricana.hu/en/MOLTerkeptar/1443/view/?bbox=2596%2C-5524%2C7867%2C-3073>
- [10] Ortophoto, Number 1959-0756-7399. (vajon így kéne megadni?) Lechner Nonprofit Kft. Last download: 2024.06.25. <https://www.fentrol.hu/hu/legifoto/69081>
- [11] Hungary in the 1960s, from the CORONA spy satellite. Arcanum Adatbázis Kft. Last download: 2024.06.25. <https://maps.arcanum.com/hu/map/corona-hungary>
- [12] Ortophoto, Number 1971-0121-0768. Lechner Nonprofit Kft. Last download: 2024.06.25. <https://www.fentrol.hu/hu/legifoto/116550>
- [13] Ortophoto, Number 1971-0125-9407. Lechner Nonprofit Kft. Last download: 2024.06.25. <https://www.fentrol.hu/hu/legifoto/116609>
- [14] Ortophoto, Number 1984-0057-2124. Lechner Nonprofit Kft. Last download: 2024.06.25. <https://www.fentrol.hu/hu/legifoto/272555>
- [15] Ortophoto, Number 1984-0005-4544. Lechner Nonprofit Kft. Last download: 2024.06.25. <https://www.fentrol.hu/hu/legifoto/272317>

- [16] Orthophoto, Number 1988-0021-2667 Lechner Nonprofit Kft. Last download: 2024.06.25. <https://www.fentrol.hu/hu/legifoto/199752>
- [17] SZÁVOSZT-VASS Dániel: Laktanya alá temetett sziget. Dunai szigetek. 2014. Last download: 2024.06.25. <https://dunaiszigetek.blogspot.com/2014/07/laktanya-ala-temetett-sziget.html>
- [18] DÓKA Klára: Szentendre története írásos emlékekben. Pest Megyei Múzeumi Füzetek XIII. Pest Megyei Múzeumok Igazgatósága. 1981. p. 29. Szentendre.
- [19] DÓKA Klára: Szentendre vízügyi múltjából, I: A lecsapolások, ármentesítések történetéről. Szentendrei Műsor. 1982. május. Pest megyei Művelődési Központ és Könyvtár. 1982. pp. 33–37. Szentendre.
- [20] DÓKA Klára: Szentendre vízügyi múltjából, II: A patakrendezések története. Szentendrei Műsor. 1982. június. Pest megyei Művelődési Központ és Könyvtár. 1982. pp. 23–27. Szentendre.
- [21] DÓKA Klára: Szentendre vízügyi múltjából, III. Régi malmok és vízvezetések. Szentendrei Műsor 1982. július. Pest megyei Művelődési Központ és Könyvtár. 1982. pp. 38–39. Szentendre.
- [22] DEIM Pál: Mivé lettél, Bükkös-patak I. Szentendre és Vidéke. 1987. december. Szentendre Városi Tanács. 1987. pp. 4–5. Szentendre.
- [23] DEIM Pál: Mivé lettél, Bükkös-patak II. Szentendre és Vidéke 1988. január. Szentendre Városi Tanács. 1988. pp. 4–5. Szentendre.
- [24] DEIM Pál: Mivé lettél, Bükkös-patak III. Szentendre és Vidéke 1988. február, Szentendre Városi Tanács. 1988. pp. 8–9. Szentendre.
- [25] KALMÁR János: Az Izbég-patak völgye. Magánkiadás. 1935. p. 24. Szentendre.
- [26] KATONA Gyuláné: A Szentendrei Katolikus Egyház és Plébánia története 1002–1992. HUNGA-COORD Kiadói Kft., 1992. p. 317. Szentendre.
- [27] SILIP Sándor.: Emlékeztető a Szentendre Városi Tanács VB. termében 1977. október 20-án a Bükkös-patak rendezése tárgyában tartott egyeztetési eljárásról. 1977. pp. 2.
- [28] SOPRONI Sándor: Szentendre a rómaiak korában. Szentendrei füzetek II-III. Pest Megyei Könyvtár, 1987. pp. 74. Szentendre
- [29] SZŐCS József: 61.317/1976. számú, dr. Virág Árpádnak (Országos Vízügyi Hivatal, főosztályvezető helyettes) címzett levél. Tárgy: Bükkös-patak fenntartási munkái. Kelt: 1976. IV. 2. pp. 4.
- [30] KRACHLER Ágoston: Feljegyzéseim az 1900-as évekből. In: Török Katalin (ed.): Izbégi füzetek I., Fejezetek Izbég múltjából. Izbégi Településfejlesztő Társaság és Alapítvány. 1990. pp. 18–27. Szentendre
- [31] MOLNÁR János, BIRÓ Marianna: A néhány száz évre visszatekintő, botanikai célú történeti tájökológiai kutatások módszertana. In: Szilassi P., Henits L. (szerk.): Földrajzi Tanulmányok 5. Tájköltség értékelési módszerei a 21. században. JATEPress, 2010. pp. 151–180. Szeged.
- [32] CSORBA Péter, ÁDÁM Szilvia, BARTOS-ELEKES Zsombor, BATA Teodóra, BEDE-FAZEKAS Ákos, CZÚCZ Bálint, CSIMA Péter, CSÜLLÖG Gábor, FODOR Nándor, FRISNYÁK Sándor. et al. 2018: Landscapes. In: KOCSIS, K.; GERCSÁK, G.; HORVÁTH, G.; KERESZTESI, Z.; NEMERKÉNYI, Zs. (eds.): [National atlas of Hungary: volume 2. Natural environment](https://www.nemzeti-atlasz.hu/MNA/National-Atlas-of-Hungary_Vol2_Ch10.pdf). Budapest, Hungary: Geographical Institute, Research Centre for Astronomy and Earth Sciences. 2018. 183 p. pp. 112-129. Budapest https://www.nemzeti-atlasz.hu/MNA/National-Atlas-of-Hungary_Vol2_Ch10.pdf
- [33] NAGY Anita, MALATINSZKY Ákos, PÁNDI Ildikó, KRISTÓF Dániel, PENKSZA Károly: Development of habitat groups for comparisons at landscape level I. Hung. J. Landscape Ecology 5(2): 363-369. 2007. Gödöllő.
- [34] SALLAI Zoltán, VARGA Ildikó, ERŐS Tibor: Halközösségek monitorozása Magyarország különböző típusú állóvizeiben és vízfolyásokban (2001-2018). In: Váczi O., Varga I. & Bakó B. (szerk.) 2019: A Nemzeti Biodiverzitás-monitorozó Rendszer eredményei II. – Gerinces állatok. Körös-Maros Nemzeti Park Igazgatóság. p. 157-179. Szarvas.

- [35] HARKA Ákos, SALLAI Zoltán: Magyarország halfaunája. Képes határozó és elterjedési útmutató. Nimfea Természetvédelmi Egyesület. p. 269. 2004. Szarvas.
- [36] Froese, R. and D. Pauly. Editors. 2024. FishBase. World Wide Web electronic publication. www.fishbase.org (02/2024)
- [37] DUKAY Igor: Mederkotrás munkálatok hatása a Bükkös-patak halközösségére. In: Előadások és posztterek összefoglalói. XIII. Magyar Haltani Konferencia, Debrecen, 2017. március 23–24.
- [38] BÖLÖNI János, MOLNÁR Zsolt, KUN András (eds.): Magyarország élőhelyei. A hazai vegetációtípusok leírása és határozója. ÁNÉR 2011. MTA ÖBKI, 2011. p. 441. Vácrátót.
- [39] HORÁNSZKY András.: Die Wälder des Szentendre-Visegráder Gerbirges. A Szentendre–Visegrádi hegység erdői. A magyar tájak növénytakarója 4. kötet. Akadémiai Kiadó, 1964. pp. 37–39., 246., 254., 265. Budapest.
- [40] BARANYAI-NAGY Anikó, BARANYAI Zsolt: A patakmenti égerligetek tájtörténeti kutatása a Soproni-hegység területén. Tájökológiai Lapok. 9(2): 375–403. 2011.
- [41] RENATUR 2005 Bt.: Szentendre helyi védett területvédelmi területeinek felülvizsgálata. 2008. pp. 73.
- https://szentendre.hu/wp-content/uploads/2023/07/2008_felulvizsgalat_RENATUR.pdf



VIII. International Symposium-2024

HIP IMPLANT OPTIMIZATION USING LATTICE STRUCTURES

Rashwan ALKENTAR, Tamás MANKOVITS

University of Debrecen, Faculty of Engineering, Debrecen, Hungary,
rashwan.alkentar@eng.unideb.hu, +36305579620

Abstract

Due to the continuous increment in the total hip arthroplasties over the past few years, and for the purpose of reducing the number of revision surgeries, the optimization of hip implants has become a real necessity in the biomedical industry. The research aims at optimizing the hip implant design by manipulating the porosity of the hip implant while trying to keep the strength at the required levels. Young's modulus of the implant is reduced to a level that matches the hosting bone in the human body, which reduces the risk of the stress shielding phenomenon. Compression tests and Finite Element analysis will be conducted on three types of latticed implants with matching porosity to figure out which kind of lattice structure is most suitable to biomedical use. Titanium alloy Ti6Al4V grade 23 will be used as the main material for the hip implants 3D printing process. The three implants will be 3D printed using EOS M 290 3D printing machine. Ansys software will be used to perform the finite element analysis to validate the results.

Keywords: Hip implant, ANSYS, Finite element analysis, Lattice structures

Lattice structures are usually made up of struts connected to each other to formulate a latticed volume, which allows the distribution of material flow in an effective manner on the basis of the suitable design [1]. Many researchers have sought to use this kind of feature to optimize the structures of the hip implant. Mian attempted to optimize the properties of lattice structures to better suit biomedical applications by optimizing the strut's parameters [2]. Other investigations manipulated the parameters of lattices in order to achieve the toughest structure, or to enhance the bone ingrowth process and to adjust the stiffness [3].

In our research, a hip implant design was selected that was 3D scanned in the biomechanics lab of the University of Debrecen, and the CAD file was generated to be further optimized. The original hip implant design belongs to a forty-year-old lady who went through a hip implant surgery and now needs a revision surgery. The material used with the design is Ti6Al4V alloy as a raw material, which has proven the best option for hip implants due to its corrosion-resistant properties, low weight, and high strength.

Ansys 2022 R2 version was used to perform the finite element analysis on the hip implant design. A compression test simulation was performed within the finite element analysis and later the validation of the results will be performed using a lab compression test after 3D printing the optimized design of the hip implant. The test was performed under the ISO 7206-4-2002 standards of hip implant testing.

The optimization process was executed via the application of lattice structure to the stem part of the hip implant, where this part is latticed with the Lattice infill type of lattice. Three designs were executed where 1 mm, 3 mm, and 5 mm shells of the middle part of the stem were latticed. This process helps reduce the total Young's modulus of the implant and increase the bone ingrowth between the hosting bone and the implant. The following Figure 1 shows the bulk original implant and the three variations done via the latticed optimization.

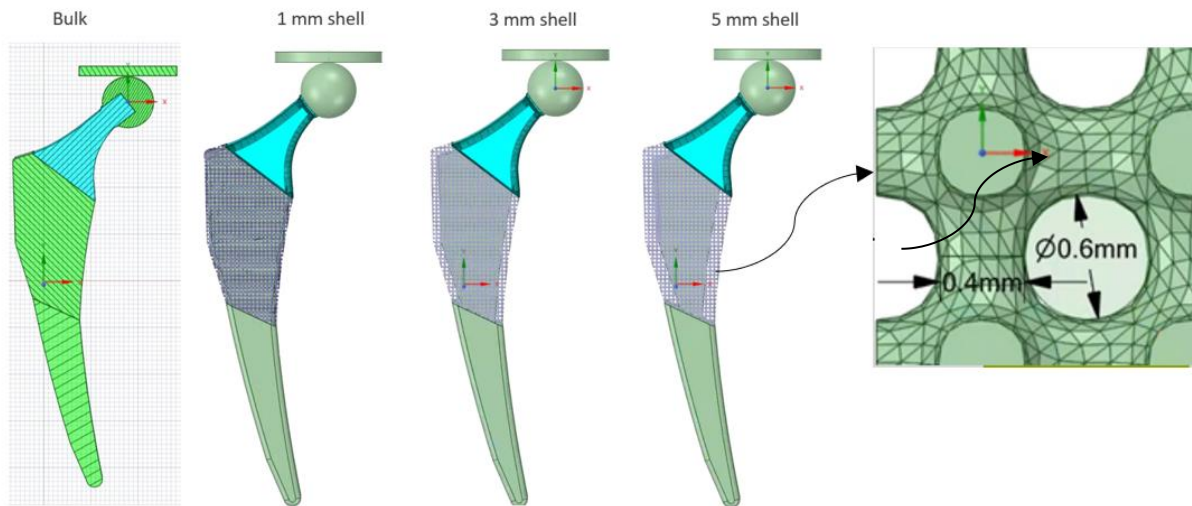


Figure 1. Hip implant lattice optimization variations.

The following figure 2 shows the testing setup for the simulation process based on the above-mentioned standards.

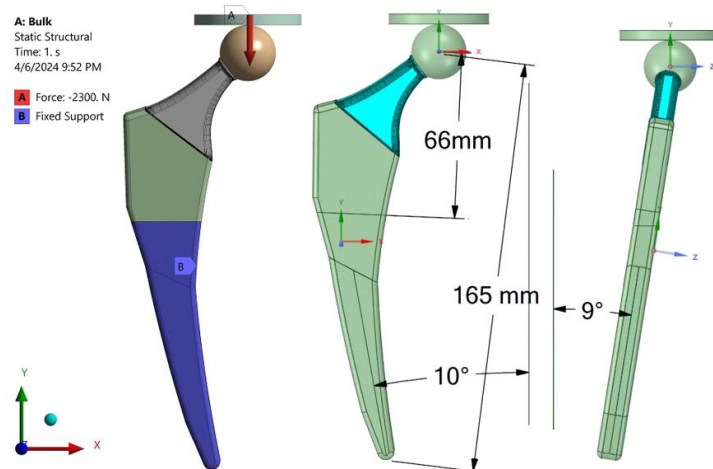


Figure 2. Hip implant testing setup.

Via the manipulation and optimization of the lattice structure's parameters, the research aims to find the optimum latticed design for the hip implant with a bone matching Young's modulus.

REFERENCES

- [1] S. Lee, Z. Zhang, and G. X. Gu, "Generative machine learning algorithm for lattice structures with superior mechanical properties," *Mater. Horizons*, vol. 9, no. 3, pp. 952–960, 2022, doi: 10.1039/D1MH01792F.
- [2] H. S. Abdulhadi and A. Mian, "Effect of strut length and orientation on the elastic mechanical response of modified body-centered cubic lattice structures," *Proc. Inst. Mech. Eng. Part L J.*

Mater. Des. Appl., vol. 233, no. 11, pp. 2219–2233, Apr. 2019, doi: 10.1177/1464420719841084.

- [3] S. Arabnejad, B. Johnston, M. Tanzer, and D. Pasini, “Fully porous 3D printed titanium femoral stem to reduce stress-shielding following total hip arthroplasty,” J. Orthop. Res., vol. 35, no. 8, pp. 1774–1783, Aug. 2017, doi: <https://doi.org/10.1002/jor.23445>.



VIII. International Symposium-2024

UTILIZATION OF THE POULTRY INDUSTRY BY-PRODUCTS PAW WASTE FOR THE PRODUCTION OF AN ALTERNATE MATERIAL OF EXOTIC LIKE LEATHER: WASTE TO THE HEALTH.

Zerihun Teshome^{*1}, Tamrat Tesfaye^{1,2}, and Tsion Belay¹

¹Leather Processing and Products Research and Innovation Centre, Ethiopian Institute of Textile and Fashion Technology, Bahir Dar, Ethiopia

²Textile Chemistry Research and Innovation Centre, Ethiopian Institute of Textile and Fashion Technology, Bahir Dar, Ethiopia

³Biorefinery Research Centre, Ethiopian Institute of Textile and Fashion Technology, Bahir Dar, Ethiopia

Corresponding author: zerihunteshome2006@gmail.com

ABSTRACT

Chicken paw skin was available in enormous quantities, which would be considered waste in the Ethiopian poultry industry. Due to a lack of awareness and technology in Ethiopia, chicken paw skin was neither consumed as food by people nor converted into leather and leather products by tanneries. This study aimed to investigate the possibility of poultry waste beneficiation by characterizing poultry wastes and converting them into valuable leather products through different chemical treatments and eco-friendly tanning methods without using polluted chemicals sodium sulfide. Additionally during this study, organoleptic properties such as tensile strength, tear strength, visual assessment, and water absorption properties of leather and leather products were made from poultry paw wastes analyzed. This study obtained that leather produced from poultry paw wastes has a unique grain structure, good strength, and an attractive look, and also shows good physical properties, with tensile strength, elongation, and tear strength of 244.6N, 29%, and 28.6N, respectively, finally this study concludes that's leather produced from poultry paws paw wastes mainly used for leisure small and medium leather products which seems like rare exotic animals like crocodile, snake and alligator which have demanded on leather markets. This study also indicates the promise of the potential of poultry paw skins use as a raw material for highly fashionable leather, which is used for medium-sized leather products with low manufacturing costs, and the feasibility of using poultry paw waste for leather and leather products production.

Keywords: poultry wastes; exotic leather; Unique grain structure; Chicken leather; Tanning

INTRODUCTION

Poultry farming wastes containing excreta, bedding material, waste feed, dead birds, broken eggs, legs,

feathers, and offal could emerge as major environmental pollutants. The major wastes, like poultry, feathers, offal, and litter, have different fields of application. Generally, chicken leg parts are neither consumed by people nor converted into high-value products; most of them go to waste, and hence there is a scope to use chicken leg skins as a potential raw material for the leather industry. The waste from poultry causes adverse side effects on our environment. The various components of the raw offal can be summarized as follows, total offal (heads, feet, intestine): 15.8%, Blood: 3.5%, Feathers: 6%, and Moisture: 9.0% Total: 34.3%. The waste released from poultry farms causes a bad smell and is highly toxic to the environment (Karthikeyan et al., 2017). This was a challenge for most developing countries like Ethiopia, so valorization of this waste for high-value applications was mandatory to create a clean environment. Ethiopia was one country currently working poultry farms to create jobs for young people and secure food, the total chicken population found in Ethiopia was estimated to be 56.5 million, with native chickens representing 96.9%, hybrid chickens at 0.54%, and exotic breeds at 2.56% (FAS/Addis Ababa, 2017). Ethiopia's annual chicken meat production is currently about 50,000 metric tons, with yearly imports of about 1,000 metric tons. The country's chicken industry, which is still in its infancy, holds considerable growth potential, especially when considering that the average per capita poultry consumption of 0.5 kg is among the lowest in the world. Most chicken production done in Ethiopia is by backyard farms using indigenous breeds (FAS/Addis Ababa, 2017). Estimated more than 350 commercial chicken farms in Ethiopia, which are located in a 100-kilometer-long corridor that runs south of Addis Ababa. Most of these farms are very small, with a capacity ranging from 50 to 1,000 birds, while just 35 farms are considered medium (1,000–10,000 birds) or large-scale operations (> 10,000 birds) by Ethiopian standards (FAS/Addis Ababa, 2017). The biggest broiler chicken meat producers ELFORA and ALEMA Farm are vertically integrated operations, with flock sizes ranging between 40,000 and 60,000 chickens, most of which are high-yielding exotic varieties from Europe and South Africa (FAS/Addis Ababa, 2017). poultry meat production rose at 5.5% per year. Growth is projected to accelerate going forward. The Government of Ethiopia's Climate Resilient Green Economy (CRGE) strategy targets increasing the share of chicken meat in total meat consumption from 5 to 27% by 2030, to substitute red meat from high-emitting ruminants. Waste released from poultry farms such as poultry feathers, being rich sources of keratin, proteins, and amino acids, can be converted into valuable products such as feather meal, biodiesel, biodegradable plastics, and fertilizer (Kelleher et al., 2002). This paper discusses the potential utilization and suitability of chicken leg waste released from those poultry farms to manufacture exotic leather; leather made from chicken leg waste was prepared and then characterized to ascertain its leather product quality to provide new insight into the valorizations of chicken leg waste for use in cow-less leather manufacturing.

MATERIALS AND METHODS

2Materials

Chicken paw: 200 pieces of chicken legs were kindly supplied by ELFORA and ALAMA Poultry Processing Farms, Bishoftu, Ethiopia.

Chemicals: Sodium sulfide, Lime, Caustic Soda, Formic acid, Pre-tanning syntan, Wattle, Sulfated Vegetable Oil, Myrobalan, Wetting Agent, Borax, Oxalic acid, Chrome syntan, Sodium formate Sodium bicarbonate, Ammonium chloride, Sulphuric acid, Acrylic Resin, Acid Dye, Vernaminol ASN (synthetic fat liquor), Basyntan DI (Phenolic syntan), Basyntan FB 6 (Resin Syntan), Balmol ~+SXE (synthetic fat liquor), Balmol BL II (semi synthetic), Lipsol LQ (synthetic fat liquor), Lipsol BSFR (synthetic fat liquor), Acrylic Resin, Acid Dye, Vernaminol ASN (synthetic fat liquor), Basyntan DI (Phenolic syntan), Basyntan FB 6 (Resin Syntan).

Methods

Collection of the chicken leg from ELFORA poultry farm

Around 200 pieces of chicken legs were collected from ELFORA /ALAMA local poultry processing farms which were found in Bishoftu Town, Ethiopia. During the collection of chicken paw skin using a

plastic kit was important for holding. Chicken paw legs were washed before being put into the kit and finally kit was closed to protect bacteria growth until preservation.



Figure 1. Wash chicken paw skin before package (a) and chicken paw skin packed after washed

Cleaning and skin removal from chicken paw

During chicken paw collection, the paw leg was held in a plastic kit. Chicken paw legs are washed before being put into a plastic kit and the kit is closed to protect bacteria growth until preservation. Pre-treatment was done by washing with tap water to protect bacterial growth until preservation and to remove materials that were not chicken paw; this included offal, diluted blood, grease, sand, feces, and wastewater. Pre-treated chicken paws were stored in a zipped plastic bag for further processing. Pre-treatment was done to remove bloodborne pathogens during slaughtering and microorganisms present in chicken paws. In this study, flaying of the skin from the chicken paw was done using a sharp cutter. The flaying was done from top to bottom, approaching with care, and finally, the skin was pulled out from the meat and bone manually by force.



Figure 2. Chicken paw skin removal from chicken paw

2.2.2. Preservation of chicken paw skin

Preservation was done to protect freshly flayed paw skins from attack by micro-organisms and render them storable for a prolonged period. The basic idea of preservation is to keep the chicken paw skins in good condition without putrefaction until they are processed. Preservation of chicken paw skin was carried out within 2-3 hours using the methods mentioned in the preceding sections because the chicken paw was easily affected by bacteria due to its protein composition. The preservation of chicken paw skin was done by a different method.

Preservation of chicken paw skin by sun-drying: Flayed chicken paw skin was preserved using sun drying technique for 3-4 hrs.

Wet salt preservation method: In this method, flayed chicken paw skins were treated in wet salt. During application, salts on chicken paw skin were controlled by controlling the ratio of chicken paw weight to the weight of salts. After the wet salt was prepared and applied to the paw skin on the flesh side, the skin was covered with a plastic sheet. Then the prepared paw skin was piled with other animals' skins, flesh side to flesh side, grain side to grain side. Preserved chicken paw skin was stored on dry pace with wood, which was far from land, 5-10 mm at room temperature. The treated and prepared paw skin was laid on aluminum and was stored in woody material, which was 10 mm away from the land in a controlled laboratory environment.



Figure 3. Preservation of chicken paw skin by salts

The weight loss was obtained according to Equation 1:

$$\text{Weight loss} = \frac{W_1 - W_2}{2} \quad [1]$$

Where

W_1 = weight in g of paw skin before preservation

W_2 = weight in g of paw skin preservation

The flayed chicken paw skins were immersed in a brine solution containing 40-50% brine, and all concentrations were calculated based on the weight of the skin. The paw skins were placed into a water jar and were covered by a clean plastic sheet. They were run for 1 hour, and the skins were checked for bacteria attack.

Preservation of chicken paw skin by the freezing method, freezing preservation technique of chicken paw skin preserved paw chicken at low temperatures, which is not suitable for the growth of microorganisms such as bacteria. During freezing preservation techniques, chicken paw skin was washed with clean water to remove dirt and debris such as blood and soil. Weight loosed by chicken paw skin by calculating as above.



Figure 4. Preservation of chicken paw skin (a)freezing and (b)brine solution

Proximate analysis

This refers to the determination of the major constituents of chicken paw skin. For chicken paw leather, the following components were determined: total ash, nitrogen content, moisture content, and fat content. All tests were conducted in triplicate.

Moisture content: The moisture content (%) of the chicken paw skins was determined with the EN ISO 4884:2005 (Reference). The moisture content is calculated by Equation 3:

$$\text{Calculate the moisture content as \% moisture} = \frac{x-y}{x} \times 100 \quad [3]$$

Where:

x=mass of the sample

Y=mass of dried sample

The nitrogen content and hide substance of the paw skins were measured with the Kjeldahl method and ASTM D2868 (ASTM D2868, 2017) test procedures, respectively. The nitrogen content was calculated using Equation 4, and the hid substance was calculated using Equation 5.

$$\text{Nitrogen content, percent by weight} = \frac{4xVxN}{W} \quad [4]$$

Where:

V = volume in ml of acid used in the titration (after correction for the blank value),

N= normality of the Sulphur or hydrochloric acid, and

W = weight in g of the material taken for the test

$$\text{Hide substance, percent by weight} = 5.62 * X \quad [5]$$

Where:

X = nitrogen content, percent by weight

Total ash content of chicken skin

A known weight of chicken paw skin sample (W_1) was carbonized at 800 °C until the weight of the residue was constant, cool, and weighed according to ISO 5868-1969. The ash content is calculated by Equation 6: Total ash, percent by weight = $\frac{W_1}{W_2} \times 100$ [6]

$$\text{Total ash, percent by weight} = \frac{W_1}{W_2} \times 100 \quad [6]$$

Where:

W_1 = weight in g of the sulfated ash, and

W_2 = weight in g of the material taken for the test

The fat content of chicken paw skin

The fat content of the raw chicken paw skin sample was estimated as per the standard IUC method SLC 4.7. The sample is continuously extracted with dichloromethane. The solvent is then evaporated from the extract, which is then dried at 110 °C.

Chemical durability of common chemicals

Degradation is a reduction in one or more physical properties of a polymer material due to contact with a chemical. Certain materials may become hard, stiff, or brittle, or they may grow softer, weaker, and swell to several times their original size (Mylsamy and Rajendean, 2010). Measurement of the chemical durability of chicken paw skin was measured as the mass loss over time of samples stored in cold water, hot water, strong acid (1% (HCl), pH 2–3), and weak acid (1%-Formic acid) concentration and pH 5–6 (pH), and strong alkali (5% NaOH; pH 10–12) and weak alkali (2–5 Na₂CO₃%, pH 8–9). 5 g of chicken paw skin was placed in covered Petri dishes, completely submerged in liquid, and allowed to soak at room temperature. For the determination of hot water solubility, 5 g of chicken paw skin samples were transferred to a 250 ml round-bottom flask, to which was added 100 mL of hot distilled water and then heated in a boiling water bath. A reflux condenser was attached, and the sample was heated for up to 24 hours. Continuous top-up of the heating water. Samples were collected for testing after 1 hr., 2 hr, and 24 hr. of contact time. The samples were dried for 24 hours at room temperature and weighed to calculate any changes in weight due to soaking. Chemical durability was calculated by Equation 7.

$$\text{Chemical Durability} = \frac{\text{Over dried initial weight of the specimen}}{\text{Oven dry weight of test specimen after soaking}} \times 100 \quad [7]$$

Chicken paw leather processing method

Figure 1 shows a schematic process flow of chicken paw skin leather preparation. The flayed chicken paw skins were soaked with 200% water followed by liming using 3% lime. 30% of water was added next to this. De-liming was carried out with 2% ammonium sulfate. Next to de-liming, bating was carried out with 2% of bated powder added and run for 60 minutes. Finally, wash the pelt with 200% of water for 30 minutes to start the degreasing process with 80% of water. 1% degreasing agents were then run through the drums for 30 minutes. This process was followed by pickling and tanning with 100% water and 10% salts. 1% sulfuric acid (in 10% water) After 1 hour jog for 1 hour. For the next 2 days, add 0.2% sulfuric acid (in 5% of water). Sodium formate 1% for 30 minutes (in 10% water), sodium bicarbonate 1% for 3x10 min + 60 min (in 10% water). drained, rinsed, and piled overnight. The next day, neutralization began with 100% water and 1% Vernatan AKM (Syntan Neutralizer). sodium formate (0.75%), sodium bicarbonate (0.75%). re-tanned with 100% water, 4% acrylic resin, 2 % acid dyes, 3% Vernaminol ASN, 4% Basyntan DI, 4% Basyntan FB, 3% Balmol SXE% with 3% Balmol BL II (semi-synthetic), 4% Lipsoil LQ (synthetic fat liquor), 5% Lipsoil BS. fixing by using 1.5% formic acid for 30 minutes and finally drain, wash, and pile overnight. Next day, dry, stake by hand, and trim.

Physical properties of chicken paw skin, leather

The thickness of chicken paw skin leather: The thickness of chicken paw leather was stated in mm units to be regarded as standard. This test method was designed to measure the thickness of the final chicken paw leather. The samples were prepared according to ISO: 5868-1983 (ISO: 5868-1983,1983). 0.1 mm, having a flat presser foot 10.2 ± 0.6 mm in diameter and a flat anvil 10.2 ± 0.6 mm in diameter. The spring should exert a force of 450 g on the foot when the gauge reads 0.8 mm and 900 g when the gauge reads 4.8 mm.

Chicken paw skin leather: The size of chicken paw skin leather was measured as per the ASTM D1516-05 test procedure (ASTM D1516-05,2005). This test method covers the determination of the width of specimens as well as regularly shaped units and pieces of chicken skin leather. The values stated in mm units are to be regarded as standards. This test method is designed to measure the width of specimens before and after they are subjected to various tests that may change the width. A test

procedure where such measurements could be used was to change the area of square pieces when measuring the resistance of a chemical solution.

Area of chicken paw skin leather: To measure the area of the chicken paw skin leather, the test samples were laid on a flat surface. Then the graduated sheets were laid smoothly on top of the chicken paw skin. To estimate the area of the chicken paw skin, the number of square centimeters required to cover the skin was counted. Calculate the measured area of each unit to the nearest $0.25D^2$. The total area is the sum of the individual areas in the test samples.

The methods are intended for the determination of tensile strength, temporary and permanent elongation at a specified load, modulus, and elongation at the break of chicken paw leather. The samples were prepared according to ASTM D2209-00 (ASTM D2209-00, 2015). Calculate the area of the cross-section of each specimen by multiplying its width by its thickness. Set the jaws of the tensile strength machine 20 mm apart for chicken skin and foot test pieces, respectively. Clamp the test piece in the jaw so that the edges of the jaw lie along the lines when it is clamped. The grain surface of the test piece should lie in one plane. Run the machine until the test piece breaks and take the highest load reached as the breaking load. Then the tensile strength was calculated by dividing the breaking load by the area of the cross-section of the test piece and expressing the result in kilograms' force per square centimeter (kg f/cm^2). The temporary elongation at the specified load was calculated by taking the difference between the original length and the length at the specified load and expressing this difference as a percentage of the original length.

The tear strength of chicken paw leather: In this test, the load required in kilograms to tear a chicken leather having a thickness of one centimeter was measured. The test samples were prepared according to ISO 3377-2 (ISO 3377-2, 2015). Slip the test piece over the turned-up ends of the holders of the tensile testing machine, so that they protrude through the slot with the widths of the turned-up ends parallel to the straight edges of the slot. Press the test piece down firmly onto the holder. Run the machine until the test piece is torn apart. Record the highest load reached during tearing as the tear strength.

Colorfastness of dyed chicken paw leather: The mechanical colorfastness assessment for upper footwear manufacturing has been carried out as per the ISO 1164 test method (ISO 1164, 1993).

Water absorption properties of chicken paw leather: Testing for water absorption characteristics of chicken paw skin leather for the upper part of footwear application was carried out as per the ISO 5403 testing method (ISO 5403, 2002).

Morphological analysis of chicken paw leather by using SEM: To study the effect of tanning on the structural characteristics of the leathers produced, scanning electron microphotographs of chrome-tanned and directly tanned crust were compared. The samples measuring 5mm x 2mm were cut from the crust leather using fresh stainless-steel blades. The samples were mounted both vertically and horizontally on aluminum stubs using an adhesive. These were then coated with gold using an Edwards E-306 sputter coater. The stubs were introduced into the specimen chamber of an FEI-Quanta 200 scanning electron microscope. The stubs mounted on the stage could be tilted, rotated, and moved to the desired position and orientation. The micrographs of the cross-section were obtained by operating the microscope at 10 kV.

RESULTS AND DISCUSSIONS

Preservation of chicken paw skin

The effectiveness of various preservation techniques for chicken paw skin was compared. All methods were assessed whether they killed the putrefying bacteria (bactericide) made the media inconvenient for the growth of bacteria or stopped the activity of bacteria. Figure 5 shows the preservation method used for this study. If the salt is fine, it penetrates the chicken paw skin and affects the structural protein used

to produce leather the coarse salt is not stable permanently on the skin and fails down and covers only a specific place creating a chance for the growth of micro-organisms such as bacteria. The size of salt which was used for the preservation of chicken paw skin was 2mm-3mm. After one week, it was found that the frozen skins were in good condition, but the brined and air-dried skins were too hard and difficult to rehydrate. This could be due to the very hard structure of the epidermis.



Figure 5. Effectiveness preservation techniques of chicken paw

Proximate analysis

Total ash, nitrogen content, moisture content, and fat content of chicken paw skin were measured. Results for proximate analysis of chicken paw skin fractions are displayed in Figure 3. As indicated in Figure 3, all samples contain large amounts of moisture content (65–68.65%), significant amounts of protein content (21–30%), and small amounts of ash content. The presence of high natural fat content on chicken paw skin is an indication of the need for further processing. Therefore, the degreasing process is needed to remove this fat before further processing.

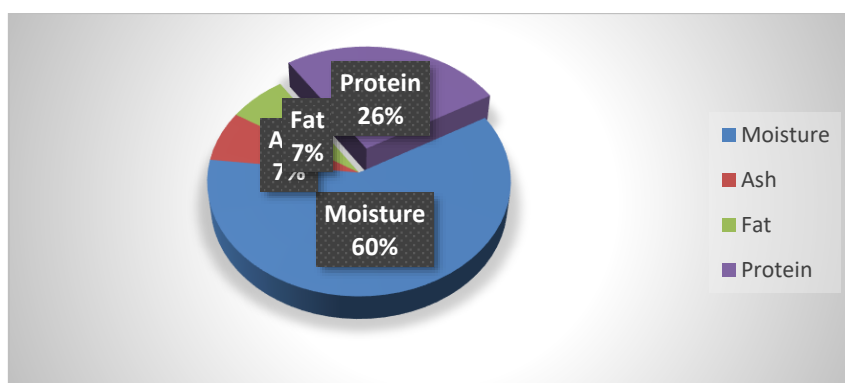


Figure 6. Proximate analysis of feather fractions

Chemical durability of chicken paw skin in common chemicals

Degradation is a reduction in one or more physical properties of a polymer material due to contact with a chemical. Certain materials may become hard, stiff, or brittle, or they may grow softer, weaker, and swell to several times their original size (Mylsamy and Rajendean, 2010). The chemical resistance characteristics of chicken paw skins to common chemicals are illustrated in Figure 4.

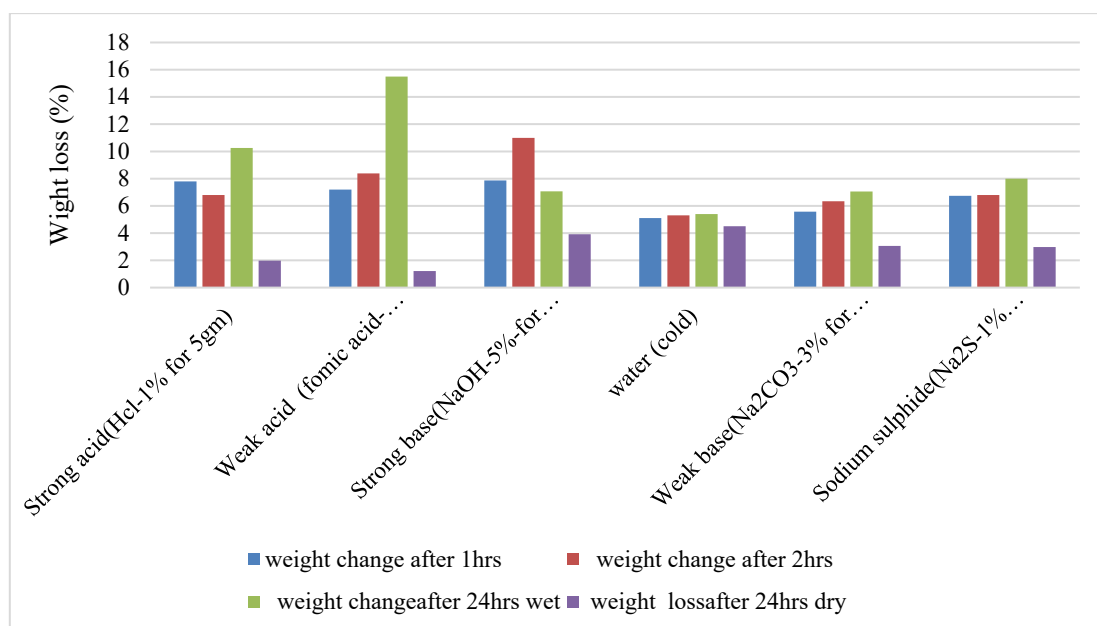


Figure 7. Chemical resistance of chicken paw skin to common chemicals

Chemical durability in alkaline solutions.

Strong Base: Upon soaking in alkali (strong), the chicken paw skin dissolved rapidly and completely. Figure 4 clearly shows that the chicken paw skin swells after 24hrs and the color is changed to white from the original samples. However, the paw skin grain separates from the flesh parts. When chicken paw skin is dissolved in 5%NaOH after 24 hrs., the skin weight increases in wet form, and when the chicken is dried at 100°C after 24 hrs, the chickens lose their weight but not much. The outer covers were removed, and the grain parts dissociated in solution.

Weak Base: Upon soaking in an alkali (weak alkali), the chicken paw skin cannot dissolve rapidly and completely in the solution. Figure 4 clearly shows that the chicken paw skin does not swell after 24 hours, and the color is not changed from the original samples. However, the paw skin does not lose grain parts, and the texture of exotic animals is characterized after soaking. When chicken paw skin dissolved in 3% Na₂CO₃ after 24 hrs. The skin weight increased not too much in wet form and when the chicken was dried at 100°C after 24hrs, the chickens lost their weight and became brittle. This property indicates that chicken paw skin can be categorized as animal skin.

Chemical durability in acidic solutions.

Strong acids: The chicken paw skin has good resistance to mild strong acids, and they are not dissolved completely. In strong acid, the chicken paw skin suffered damage and high weight loss. Figure 4 shows high mass losses were recorded relative to the results of chicken paw skin fractions soaked in de-ionized water. Concentrated HCL, indicates that strong acids damage chicken paw skin: the bonds connecting the subunits in chicken skin are destabilized by acidic media, with a corresponding high loss in tensile strength (Munawar et al., 2007).

Weak acid: Upon soaking in weak acid, the chicken paw skin dissolved rapidly and completely. Figure 4 clearly shows that the chicken paw skin dissociates rather than swells after 24hrs and the color is changed to white from the original samples. However, the paw skin grain separates from the flesh parts. When chicken paw skin was dissolved in 1% formic acid after 24 hrs. The skin weight increased in wet form and when the chicken was dried at 100°C after 24hrs, the chicken lost their weight too much. The outer covers were removed, and the grain parts dissociated in solution.

Chemical durability of other chemicals

The most common reagents used in leather processing are used for hair and fats. They are not strongly alkaline or acidic, and thus, can be safely used on the chicken paw skin, with low effect on the structure and tenacity. When reacted with concentrated sodium hypochlorite, the feather fractions were bleached, but after prolonged exposure, the feather fractions weakened and disintegrated. This indicates that unhairing agents' solutions like sodium sulfide should only be used when cold and diluted, and only for short periods. Soaking in hot water removes the grain parts from the flesh. The different chicken paw skins are damaged in hot water, and the grain parts are damaged.

Chicken paw leather processing method

The chicken paw skin leather processing method is depicted in Figure 5, and it resembles the conventional leather processing method. However, ice was used instead of sodium sulfide to remove the scale from the chicken paw skin. Chicken skin with wet blue showed good shrinkage temperature up to 103°C in this study. Chicken paw skin leather was dyed using acid dye to achieve good color matching and good fixation. Moreover, different fat-liquors used for the fat-liquoring process have shown different properties. LIPSOIL LPE fat-liquor was given good softness and good penetration.



Figure 8. The general sequence of the chicken paw leather tanning method

Physical properties of chicken paw skin, leather

Chicken paw leather has a unique and beautiful grain with a uniform grain pattern in nature. These characteristics give special character to chicken paw leather which cannot be found on other animals' skins and hides. Chicken paw leather with an attractive grain structure can be used to produce fashionable leather goods and shoes. Chicken may not be the most thought of leather item, but chicken leather is quite thick and works well for a range of applications, from wallets to shoes. This leather can be very elegant, and its texture gives the items an exotic look. Luxury items made from chicken leather are desired throughout the world. Conditioning chicken leather is vital to keeping it soft and beautiful. Chicken leather needs a moisturizer to make up for the fact that natural oils are no longer protecting the skin. Without regular conditioning, the leather will dry out and become brittle, leading to cracks and damage. Leather honey offers a natural, non-toxic leather conditioner that effectively conditions chicken leather.

Organoleptic properties of chicken paw leather

Table 1 illustrates the organoleptic properties of chicken paw leather. As is seen in Table 1, the grain pattern of Cr-tanned finished chicken paw leather is 8 and its fullness is 7. This result is according to the previous study.

Table 1. Organoleptic properties of chicken paw leather (on sample 20).

No	Properties	Cr-tanned finished chicken paw leather
1	Grain Pattern	8
2	Uniformity of color	8
3	Feel	8
4	Fullness	7
5	General Appearance	8

The thickness of chicken paw skin leather

The thickness of chicken paw leather varied from species to species, sex, and age, but the difference was not very significant (Table 2).

Table 2. The thickness of chicken paw skin and leather

Properties	The thickness of chicken legs' skin and leather									Ages
	Small			Medium			Large			(day)
	Wet skin	dry skin	Chicken Leather	Wet skin	Dry skin	Chicken Leather	Wet skin	dry skin	Chicken Leather	50-60
Thickness	2.5-3mm	2-25mm	0.5-0.6mm	3.12-3.8mm	3.12-3.5mm	0.6-0.8mm	3.5-3.8mm	3.25-3.8mm	1.0-1.5mm	

Size chicken paw skin and leather

The size of chicken paw leather was var8ying from species to species, sex, and age, the difference was to some extent significant (Tables 3 and 4).

Table 3. Size chicken paw skin and leather

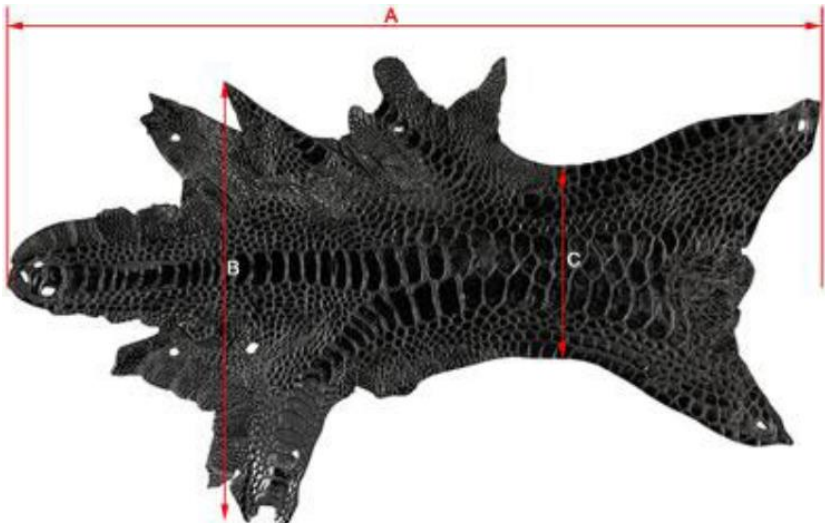
Properties	Size of chicken legs skin and leather									Ages (day)
	Small			Medium			Large			
	Wet skin	dry skin	Chicken Leather	Wet skin	Dry skin	Chicken Leather	Wet skin	dry skin	Chicken Leather	50- 60
Length	7-9cm	7.25- 9.2 cm	8-10cm	12- 13cm	11.5- 12.5cm	12- 12.5cm	13- 20cm	15- 18cm	18-20cm	
Width	2-3cm	1.8- 2.8cm	2-5-3cm	3-4cm	2.8- 3.8cm	3.5- 3.8cm	3.5- 4.5cm	3.25- 4cm	4-5cm	

Table 4. Average Physical characteristics of chicken leg leather

Properties	Chicken paw leather
Length	15-20 cm
Width	3-5 cm
thickness	0.6-1.3mm

Area of chicken paw skin leather

Chicken skin did not have a similar structure to animal leather due to its area. Use of the area measuring machine was not possible for chicken paw leather. To calculate or to know the area of chicken leather, the following method was employed in this study (Figure 6).



Size A-average 14cm

Size B-average 8cm

Size C-average 3.5cm

Figure 6. Full scale image of tanned chicken paw leather

First, calculate the average of width chicken paw skin.

$$w = \frac{\text{size B} + \text{size C}}{2}$$
$$= 11\text{cm}$$

Area of chicken leather was=Length x Width
=14cmx 11cm =154 cm²

Tensile strength of chicken paw skin leather

The strength properties of chicken leg crust leathers are given in Table 5, pieces of finished leathers were subjected to tensile strength analysis. The mean of 15 values is given in Table 5.

Tear strength of chicken paw leather

The ISO 3377-2: 2002(E) test method ascertained that the minimum average tear load of leather upper of typical footwear should be greater than 50 N (Table 5).

Table 5. Physical testing data

Parameter	Unit	T(S)	Results
Tensile strength	N	4.2	244.6
Elongation	%	-	29.56
Tear strength	N	-	28.8

Colorfastness of dyed chicken paw leather

The performance requirement for color fastness according to ISO 1164: 1993 is W₃ (greyscale) after 150 cycles dry and 50 cycles wet. Comparing the test results with the standard requirement demonstrates that inferring the felt pad grade, the finished paw leather shows good results.

Water absorption properties of chicken paw leather

According to the ISO 5403:2002 standards, the performance requirement of water resistance for the leather upper shoe using the volume-volume ratio is 30 percent maximum for two hours (Table 6). Therefore, depending on this, expected chicken paw leather was achieved under requirements and the standards.

Table 6. Mechanical testing for chicken paw leather

Type of test	Types of tests	Unit	Result
Colorfastness	Dry 150 cycles	Grade	4/5
	Wet 50 cycles	Grade	3/5
Water absorption	2hr	%	32
	24hr	%	37

Morphological analysis of chicken paw leather by using SEM

SEM cross-sections of chrome-tanned chicken leg leathers at magnifications of 100, x, and 500x are given in Figure 7. In the pictures, chrome-tanned leathers, the fiber bundles are compact and compressed. The SEM image of the surface of chrome-tanned chicken leg leather percentage elongation of chicken leg leather was good. This property would be considered as an advantage, where the leathers for making goods need a minimum value of percentage elongation.

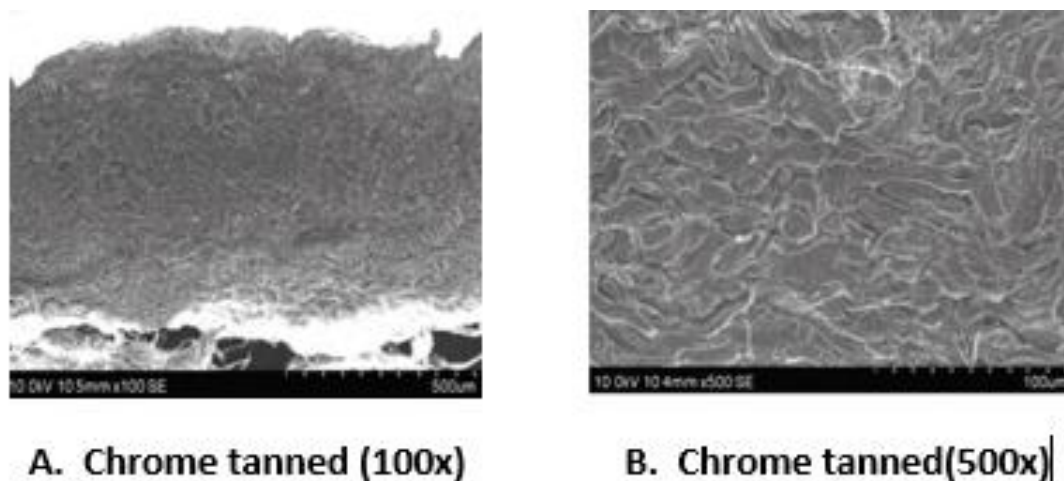


Figure 7. Scanning electron microphotographs of chicken leg leather

Water vapor permeability

Breathability was a characteristic that allowed moisture and air to permeate through the leather. This property is particularly important for shoes; as the foot sweats, it produces moisture that moves through the leather to the outside, keeping the inside of the shoe drier and more comfortable. With a lower moisture level. Waterproof leathers that are engineered to maintain breathability while protecting from wet conditions will provide outstanding combined performance. Chicken paw leather had good water vapor permeability up to 32, therefore, it indicates that chicken paw skin was also suitable for the upper of shoes.

CONCLUSIONS

Poultry waste is polluting the environment it is not converted into valuable products and is not managed in the correct ways. This waste needed innovations to techniques to convert to valuable products, this was a challenge for developing countries like Ethiopia other African countries, and Asian countries. In Ethiopia, there is a large potential for poultry production capacity and manpower, this was an opportunity to produce chicken paw leather from poultry wastes. Introducing technology or methods for increasing the chemical and mechanical properties of paw leather was also one of the important parts that this study answered. These properties of chicken paw leather depend on the physical and chemical treatments and mechanical operations during the manufacturing process. skin obtained from poultry paws contains about 68% moisture, 30% protein, and small amounts of ash fat. On the other hand, this study shows good alternatives for leather production from poultry paw wastes to introduce fashionable leather products in leather markets leather provides versatile and elegant skin for the production of leather products, such as court shoes, bags, and wallets which have high demand on markets. Generally, what the research showed in this study was that chicken paw leather obtained from poultry waste has good physical strength, good chemical resistance, and a fashionable texture, and alternative leather materials are used to produce different types of small and medium leather products and have a potential for main source leather products.

Conflict of interest

The authors declare that they have no known conflict of interest associated with this publication

Authors Contributions

All the authors have contributed to the conceptualization, investigation, data collection, and analysis in the study and have read and approved the final manuscript.

ACKNOWLEDGMENTS

The authors would like to acknowledge the Ethiopian Institute of Textile and Fashion Technology, Bahir Dar University for the financial and laboratory facilities support in successful completion of the research work. The authors also would like to thank Leather Industry Development Institute for the laboratory facilities support.

REFERENCES

- [1] Bonifer, I.b. & Froning, Glenn Chicken skin composition as affected by aqueous washing. Journal of Food Science ,2006, 895 - 898.
- [2] D.C*, y. k, Lin and M.T. Chen, The optimum condition of extracting collagen from chicken feet and its characterization, Department of animal science, 2001,13-68.
- [3] Ethiopian ATA & USAID Investment Support Program, Study on Opportunity to invest in an integrated chicken processing plant in Ethiopia, 2006
- [4] FAS/Addis Ababa, Ethiopia's demand for chicken meat is expected to grow Reports on poultry and products, 2017.
- [5] F. Hassan and P. M. Sherief, Role and application of fish collagen, Seafood Export Journal, 1994,25, 19–24.
- [6] George G. Heinz, Greenville, Exotic Leather method of processing the same, and method of processing domestic fowl, 27,1978
- [7] J. H. Muyonga, C. G. B. Cole, and K. G. Duodu, Characterization of acid-soluble collagen from skins of young and adult Nile perch (*Latesniloticus*). Food Chemistry, (2004). 85(1), 81–89.
- [8] Jaya Prakash Alla, Giriprasath Raman than, Nishter Nishad Fathima, Tirichurapalli Sivagnanam Umab and Jonnalagadda Raghava Rao, Fish Skin and Exotic Leathers. JALCA, 2017,112.
- [9] Kumudini A. Munasinghe, Jurgen G. Schwarz, and Anthony K., Chicken Collagen from Law Market By-Products as an Alternate Source. Journal of Food Processing, 2014.
- [10] K. Arunmozhivarman Robinson J. J. Abraham, V. Apparao, and M. Parthiban, Extraction and Molecular Characterization of Collagen from Poultry Meat Processing By-Product (Chicken Skin), Int. J. Pure App. Biosci, 2017, 5 (5): 1085-1091.
- [11] L. L. Hood, Collagen in sausage casings,” in Advances in Meat Research, pp. 109–129, Pearson, Nostr and Reinhold, New York, USA, 1987.
- [12] Marco a. p. Orrico Júnior1, Ana c. a. Orrico2, Jorge de Lucas Júnior, anaerobic digestion of waste from poultry production: poultry litter and carcass, Eng. Agric., Jabot cabal, 2010, 30(3),546-554.
- [13] Omer F. Sari, SaimOzdemir, Ahmet Celebi, Utilization and Management of Poultry Slaughterhouse wastes with new methods. Sakarya University Environmental Engineering Department, 2016,54187.
- [14] P. Hashim, M. S. MohdRidzwan, J. Bakar, Isolation and Characterization of Collagen from Chicken Feet. International Journal of Bioengineering and Life Sciences,2014, (3).
- [15] R. Karthikeyan and R.K. Chandra Babu, Investigation on chicken leg Skin for the Preparation of fashionable leather and leather products, Journal of the American Leather Chemists Association, 2017, 112, 190-197.
- [16] George Exotic leather, method of processing the same, and method of processing domestic fowl. USA,1980, 64.
- [17] R. Karthikeyan, R.K. Chandra Babu, N.K., Mandal, A.B., and Sehgal, P.K., Soft leathers from hematuria stingray skins. Journal- Society of Leather Technologists and Chemists, 2017.
- [18] Thirumalachari, Recent Trends in Leather Making: Processes, Problems, and Pathways, 2005 ,35.
- [19] Zouboulis, Anastasios, Samaras, Petros, Krestou, Athina, Tzoupanos, Nikos, Leather production modification methods towards minimization of tanning pollution: "Green tanning, 2012.



VIII. International Symposium-2024

SEDIMENT ANALYSIS OF MIOCENE DEPOSITS IN THE RED BAY FORMATION, FLORIDA: INSIGHTS INTO NEARSHORE MARINE FACIES AND LITHOLOGICAL DISCREPANCIES.

Belkasim KHAMEISS

Kansas Geological Survey, 1930 Constant Ave., Lawrence, KS, USA 66047-3724.

Corresponding email; belkasimkahemsis@outlook.com.

Abstract

*In a groundbreaking study, three kilograms of sediments sourced from the extinct Red Bay Formation in Florida have undergone meticulous examination. The chosen analytical approach holds significance as the geological outcrop responsible for these samples no longer exists. The scrutinized sediments reveal an abundance of marine invertebrate deposits, showcasing a diverse array of gastropods and bivalves. This research marks a significant milestone by presenting the inaugural comprehensive documentation of foraminifera populations within this geological section, a facet previously overlooked by scientific inquiry. The identified bivalve species, including *Astarte distans*, *Chesapecten covepointensis*, *Crassostrea* sp., *Glyptoactis nodifera*, *Isognomon* sp., *Lirphora latilirata*, and *Pycnodonte* sp., alongside gastropod species such as *Ecphora meganae*, *Turritella tampae*, and *Leptomaria* sp., contribute to the richness of the findings. The age of the sediment bed, inferred from the documented fauna, places it in the middle Late Miocene, suggesting a prevalence of shallow marine environments during that period. These findings substantiate the hypothesis that the sediments attributed to the Red Bay Formation likely originated from nearshore marine settings. However, challenges persist in definitively assigning these sediments to the Red Bay Formation, given the shared lithological similarities with adjacent geological units. This study opens avenues for further exploration and underscores the complexity of geological attribution in paleontological research.*

Keywords: Red Bay Formation, Miocene deposits, bivalve species, gastropod species.

INTRODUCTION

Walton County, located along Florida's Emerald Coast in the northwestern region, is bordered to the south by the Gulf of Mexico. In this geological context, the "Red Bay Formation" is proposed to encompass sands, clays, and associated deposits housing the YOLDIA and ARCA fauna zones. Notably, the typical locality, McDaniel's Farm at Red Bay, exhibits a Red Bay Formation thickness of approximately 31.5 feet. The Red Bay Formation overlies the Yellow River Formation and shares a relatively youthful age with the Jackson Bluff Formation. The Choctawhatchee Stage, as assigned by

Puri and Vernon in 1964, is associated with these formations. For this study, the Alum Bluff Group is referred to as undifferentiated. This departure from prior nomenclature is grounded in the recognition that earlier classifications were based on micro- and macrofossil faunal distinctions and assumed age rather than lithological characteristics. These classifications do not align with the criteria established by the Code.

Consequently, some classifications have identified the sediments within the Alum Bluff as Chipola, Shoal River, Oak Grove, Whites Creek, Choctawhatchee, Red Bay, and Yellow River. Matson and Clapp, 1909. Designated Outcrop 10 in Red Bay, Walton County, as the Choctawhatchee, situating it within the middle unit of the Alum Bluff. This undifferentiated Alum Bluff outcrop is also considered the type site for the "short-lived" Red Bay Formation of Choctawhatchee age, as documented by Johnson, 1989. Within the scope of this study, three distinct species of cheilostome Bryozoa originating from two Miocene strata in northeastern Florida are reported. Notably, the Red Bay Formation harbors the initial records of *Discoporella umbellata depressa* Conrad, 1841, and *Hippoporidra calcarea* Smitt, 1873. Furthermore, Canu, and Bassler, 1923 discovery of *D. umbellata depressa* and *Cupuladria biporosa* represents the first records of Bryozoa from the Yellow River Formation. Given the ecological significance of these identified species, it is postulated that both the Red Bay and Yellow River formations were deposited within muddy, mildly turbulent, and temperate habitats less conducive to the development of an extensive bryozoan community, as reported by Scolaro, 1970.

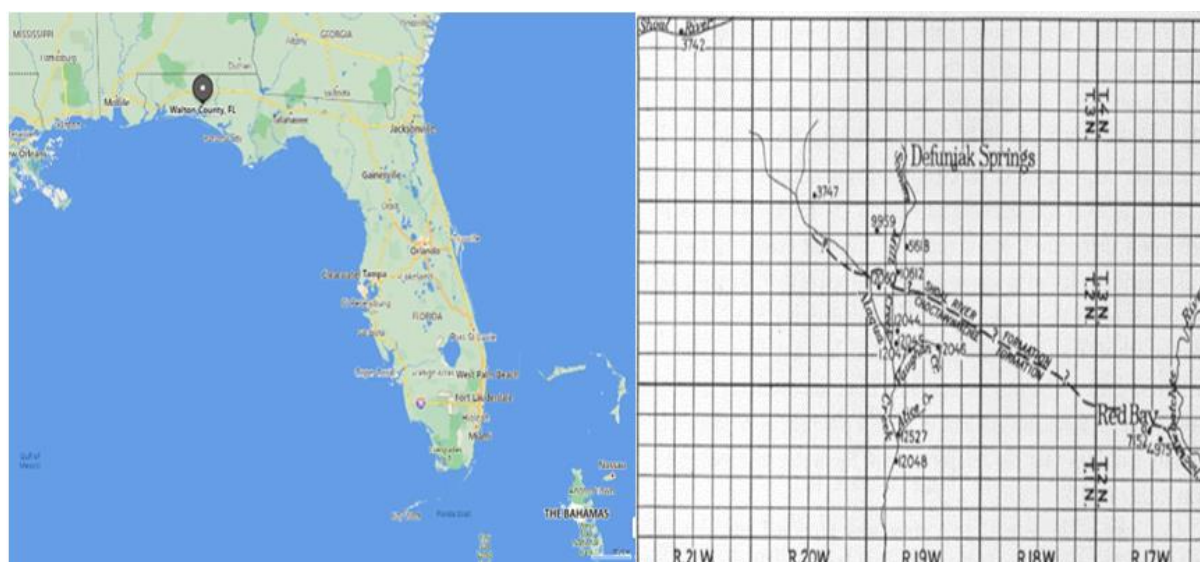


Figure 1: Shows the location of Walton County. Figure 2. This is the only Red Bay location map available. Wendell C. Mansfield and Gerald M., Ponton, 1932.

MATERIAL AND METHODS

The specimen has undergone collection, preservation, and categorization within the biostratigraphic laboratory of the Geology Department at Ball State University. A comprehensive sedimentological logging process was executed during the extraction of stratified mollusk samples from layers containing mollusk remains. The preservation quality of the mollusk shells is deemed moderate.

To establish a correlation, the positions of samples from previous campaigns were aligned with the aforementioned section. This alignment was based on the estimated stratigraphic position derived from field observations, further corroborated by considerations of lithology and fossil content. After this correlation, shell measurements were conducted using digital calipers on the right valve. Histological specimen measurements were performed using either the Leica Application Suite 4.6 or an ocular micrometer on a stereomicroscope. The determination of maximum shell height for both adult and embryonic shells involved measuring perpendicularly from the hinge line to the most distal point of the

ventral shell margin. Concurrently, maximum shell length measurements were taken parallel to the hinge line. Size representation is articulated in terms of shell length.

RESULTS

The thickness of this section is nearly one and a half meters, but this outcrop no longer exists due to construction. Figure 3, shows a lithological description of the section includes sandy shale beds with abundant benthic and planktonic foraminifera. the abundance of gastropods, bivalves, and other mollusks in the section.

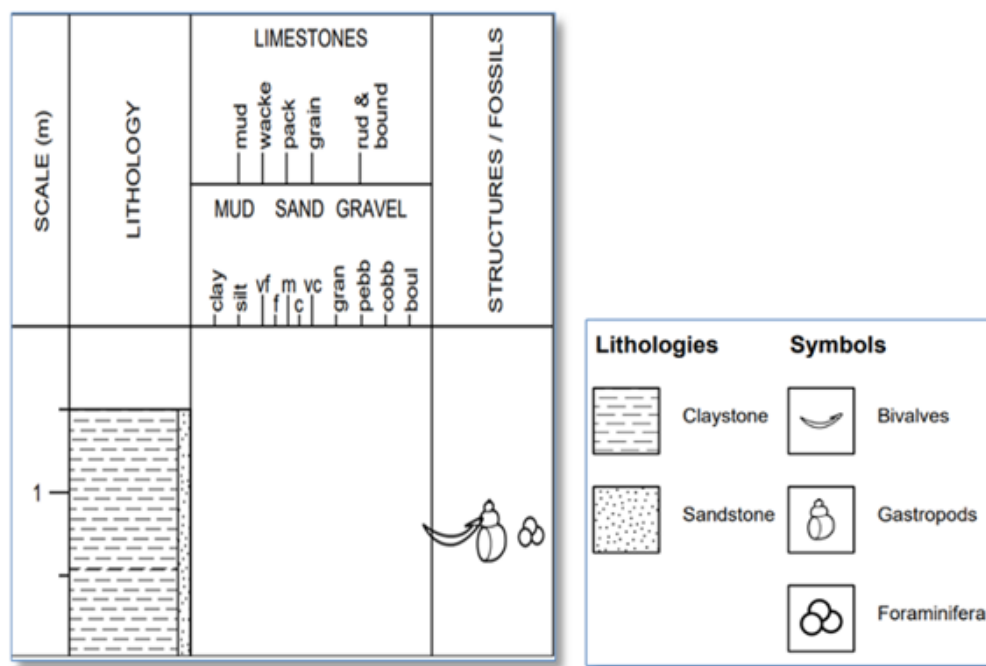


Figure 3 : Occurrence of biogenic components in Red Bay Formation.

Macroinvertebrate Fuana

The initial observation drawn from this dataset pertains to the macroinvertebrate fauna as documented within the sedimentary records. Analysis of the data classifies the observed mollusk species into two primary taxonomic classes: Bivalvia and Gastropoda. Notably, among these classes, Bivalvia exhibits the highest prevalence, as visually represented in Figure 4.

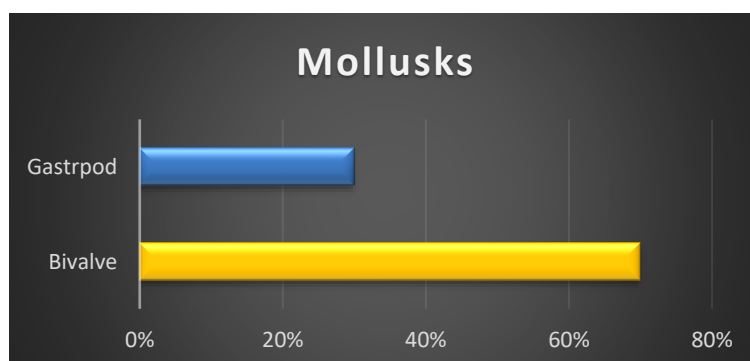


Figure 4: Shows the classes of the Mollusks.

a-Bivalvia:

Figure 5 provides a comprehensive depiction of the bivalve fauna within the Red Bay Formation region, encompassing a total of six taxonomic families: Astrartidae, Carditidae, Isognomnidae, Ostreidae, Pectindae, and Veneroidaeas. Furthermore, this diverse assemblage encompasses seven distinct species,

each belonging to one of these six families. These species are specifically identified as *Astarte distans*, *Chesapecten covepointensis*, *Crassostrea* sp., *Glyptoactis nodifera*, *Isognomon* sp., *Lirphora latilirata*, and *Pycnodonte* sp., all of which are visually represented in Figure 6.

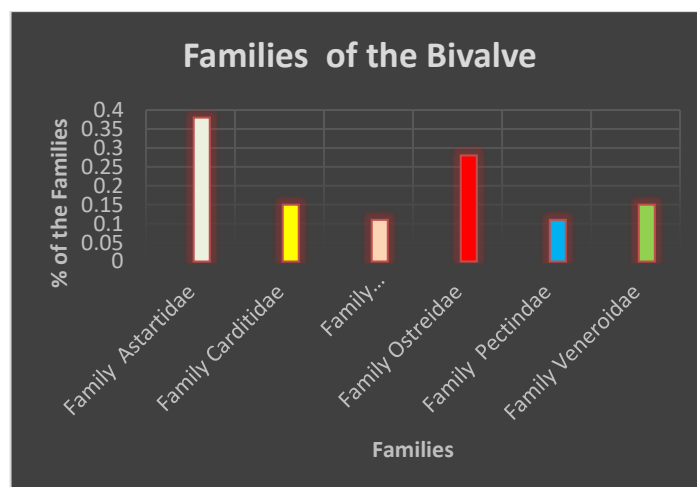


Figure 5:Shows the classes of the Bivalves- Mollusks.

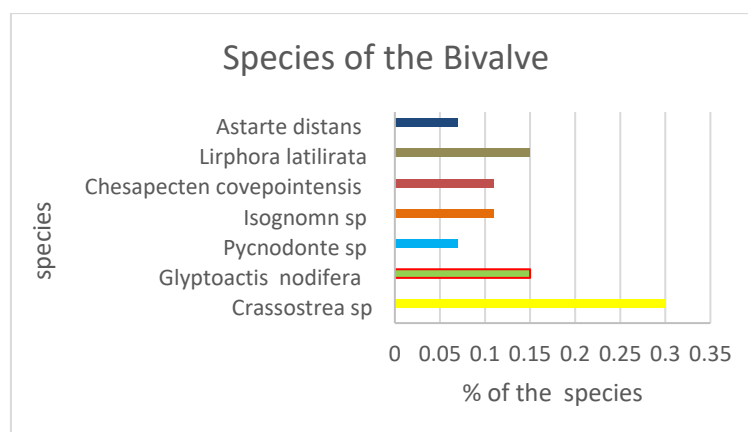


Figure 6: Shows the species of the Bivalves.

b-Gastropoda

This taxonomic class is characterized by the presence of only three families, namely Turritellidae, Muricidae, and Pleurotomariidae, as visually indicated in Figure 7. Within this class, a total of three distinct gastropod species have been identified, specifically *Ecphora meganae*, *Turritella tampae*, and *Leptomaria* sp., as evident in Figure 8. It is noteworthy that these three gastropod species collectively span the entire geological age range encapsulated by the Red Bay Formation, extending from the Cretaceous to the Miocene epoch.

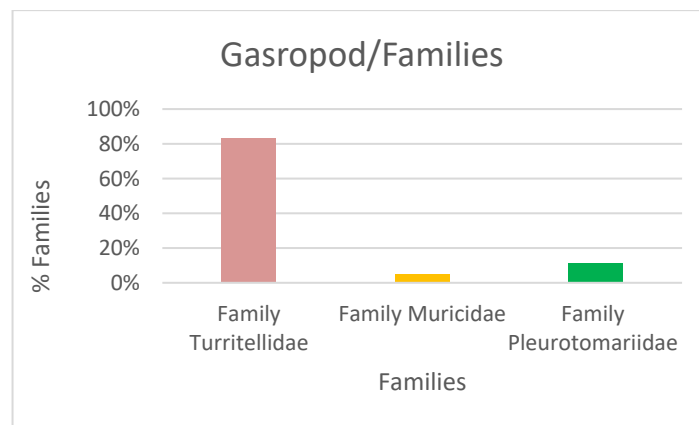


Figure 7: Shows the families of gastropods.

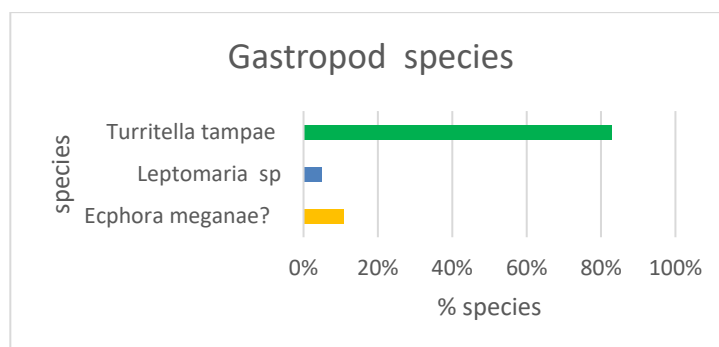


Figure 8: Shows the species of gastropods.

DISCUSSION

Paleocological and biostratigraphic implications

Based on the comprehensive data about the various bivalve species under consideration, the biostratigraphical age range collectively falls within the E-Middle Miocene epoch, as illustrated in Figure 9. *Crassostrea* sp., commonly known as oysters, have been documented thriving in estuarine and nearshore marine ecosystems. Their favored habitats are characterized by shallow, brackish water conditions, typically featuring a blend of freshwater and saltwater elements. This specific biostratigraphic range aligns with the E-Middle Miocene period, as corroborated by the research conducted by Ward and Blackwelder, 1987, as well as Kidwell, 2005; Beaman and Harris, 2007. *Pycnodonte* sp., representative of the Pycnodonte genus, showcases a versatile paleoenvironmental preference, which can vary based on both temporal and geographical factors. These bivalves are frequently encountered in marine settings such as coastal regions, shallow seas, and reef ecosystems. Pycnodonte fossils have been recovered from a range of sedimentary deposits, encompassing limestone, sandstone, and clay, as substantiated by research by Bitner, 2020.

Isognomn sp., another bivalve species, commonly inhabits shallow coastal areas, estuaries, reefs, and even deep-sea environments. Marine bivalves like *Isognomn* sp., are often associated with various sedimentary substrates, including sandy, muddy, or rocky formations. The findings of Coan and Valentich., 2012 underscore the adaptability and wide-ranging distribution of such bivalves. *Lirphora latilirata*, found within maritime habitats encompassing coastal areas, shallow seas, and reef systems, aligns its biostratigraphic range with the E-Middle Miocene, as documented by Conrad, 1841; Huber, 2010; Hendy et al., 2008.

Astarte distans predominantly populate shallow marine environments, including coastal areas, estuaries, and nearshore locations. This species demonstrates a remarkable tolerance for diverse sediment types, ranging from sandy to muddy substrates. Its wide geographic distribution is well-established, with

occurrences documented across various global regions. These observations are substantiated by the research contributions of Vokes ,1981; Bernard , 1979; Dall, 1903. *Chesapecten covepointensis*, characterized by a shallow marine habitat marked by warm, tropical to subtropical conditions, also aligns its biostratigraphic range with the E-Middle Miocene. This designation is affirmed by the findings presented by Sacco ,1897, Powell et al., 2001; Ward and Blackwelder 1987; Wood et al., 1973.

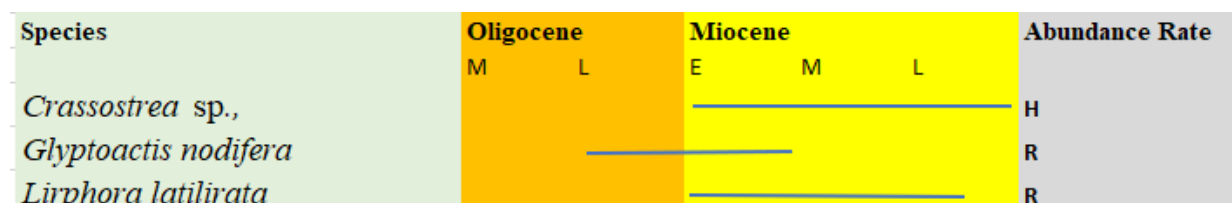


Figure 9 : Shows the biostratigraphical age range of Bivalve species.

Paleontology Taxonmonmy

Phylum Mollusca Linnaeus 1758

Bivalvia (Class) Linnaeus, 1758

Family Ostreidae Rafinesque, 1815

Crassostrea sp., Sacco,1897(Fig.10-1).

The valve, or shell, is noteworthy for its potential to reach lengths surpassing 8 inches, equivalent to 20 cm. As a bivalve mollusk, it comprises two distinct shells, referred to as "valves," conjoined at one end through a naturally occurring hinge structure. This union is facilitated by a robust and sizable muscular attachment.

Family Carditidae Fleming 1820 in 1828.

Glyptoactis nodifera Kellum 1926(Fig.10-2).

Family Ostreidae Rafinesque, 1815

Pycnodonte sp.,Ficher von Waldheim,1835(Fig.10-3).

The shell in question possesses a substantial thickness and diminutive size, featuring an inequivalve configuration that is notably oval to subtriangular in shape. Its overall contour is moderately to strongly convex, with a pronounced degree of convexity observed in the central region. The shell exhibits a robust build, characterized by a short umbonal region and an apex that inclines. The left valve of the shell is adorned with a distinctive sculptural pattern, comprising regular, nearly identical, and symmetric radial ribs that maintain uniform spacing in dorsal view. These radial ribs become broader as they extend toward the valve's periphery and exhibit a deep, narrow posterior curvature.

The number of radial ribs typically ranges between 22 and 28. Concentric growth lamellae are more conspicuous in proximity to the ventral border of the shell. In terms of proportions, the shell's height exceeds its length, featuring a small to moderately sized attachment area. The internal surface of the shell is smooth, distinguished by a large, crescentic, kidney-shaped muscle scar. Additionally, a triangular ligament area of the turkotreoid type, strongly curving posteriorly, is present, surpassing the dimensions in height compared to width. Narrow and diagonal bourelets are also discernible. Catachomata and shallow-short vermiculate-chomata are evident, while vesicular layers remain inconspicuous.

Family Isognomnidae Woodring, 1925

Isognomn sp., Lightfoot, 1786 (Fig.10-4).

These oysters, scientifically identified as belonging to a specific species, attain a maximum length of approximately 4.75 inches, equivalent to 12.1 cm. Their distinctive shell morphology is characterized by a markedly uneven exterior, typically presenting a blue-gray hue and often exhibiting extensive encrustation. Conversely, the inner surface of the shell is characterized by a smooth and iridescent pearly white appearance. These oysters employ their byssus, a proteinaceous secretion, to effectually affix themselves to substrates, which notably include the roots of mangrove trees, corals, and various other

anchoring surfaces. Due to their pronounced affinity for mangrove ecosystems, they are colloquially referred to as "tree oysters"

Family Pectinidae Rafinesque, 1815

Chesapecten covepointensis Ward 1992 (Fig.10-5).

Family Veneroidae Rafinesque, 1815

Lirphora latilirata Conrad,1841 (Fig.10-6).

This species is distinguished by its potential to reach a maximum size of approximately 4.5 cm, equivalent to 1.5 inches in length. The shell exhibits a distinctive morphology, characterized by its spherical and triangular shape, resulting in noticeable inflation. Of particular note are the conspicuous, robust concentric ridges prominently situated at the apex of the shell, often displaying pronounced shelving tendencies, which may render them brittle when subjected to desiccation. The hinge structure of the shell is a salient taxonomic feature, housing both cardinal and lateral teeth. This unique arrangement of dental structures plays a pivotal role in the accurate classification of this species. As for the shell's pigmentation, it predominantly assumes a tan coloration, intermittently accentuated by patches of purple and radial stripes. This intricate coloration scheme contributes significantly to the characteristic visual identity of the species.

Family Astartidae d'Orbigny, 1844

Astarte distans Conrad 1862,Dall, 1903 (Fig.10-7).

The shell color can vary but is often pale to medium brown, with occasional darker markings or patterns. The interior of the shell is usually glossy and white. Adult specimens of *Astarte distans* typically range from 2 to 5 centimeters in shell length, although variations can occur. The umbo (the highest point on the shell) is typically slightly anterior (towards the front) and may exhibit a faint radial ridge. *Astarte distans* have a well-developed hinge with cardinal teeth and lateral teeth, which are important for maintaining the alignment and closure of the two valves. A ligament, an elastic structure, is present along the hinge line and aids in shell opening. This species has a visible pallial line on the interior, indicating the attachment of the mantle to the shell.

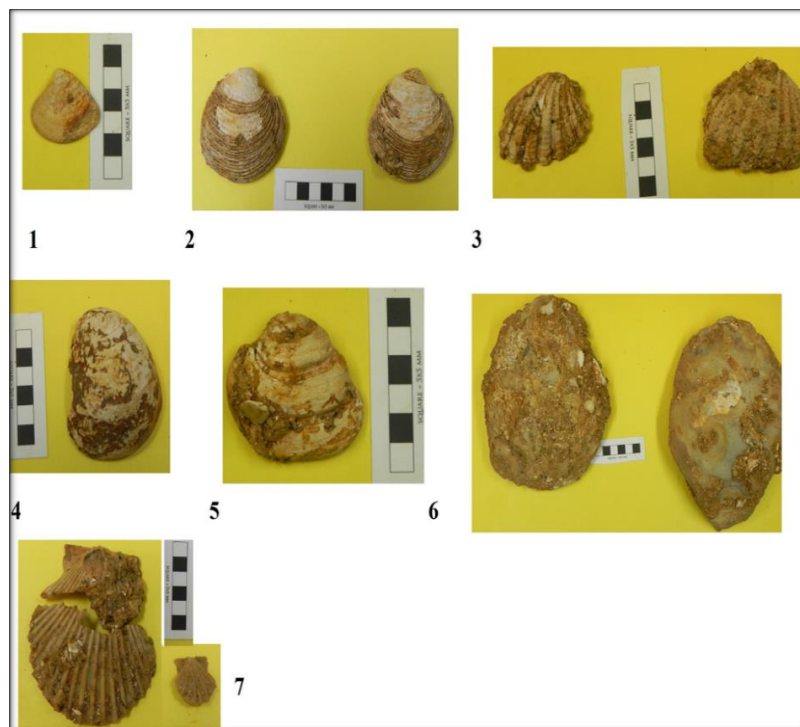


Figure 10: Shows the species of bivalves 1-*Crassostrea* sp.,
2- *Glyptoactis nodifera* 3- *Pycnodonte* sp.,4- *Isognomn* sp.,
5- *Chesapecten covepointensis* 6- *Lirphora latilirata* 7- *Astarte distans*.

Gastropoda

Paleocological and biostratigraphic implications

The Red Bay Formation area has yielded the presence of three distinct gastropod species, collectively spanning the entire temporal spectrum of this lithostratigraphic unit, from the Cretaceous to the Miocene epochs, as visually represented in Figures 11 and 12. *Turritella tampae*, belonging to the Turritellidae family of gastropods, inhabited exclusively marine environments. These organisms thrived in shallow marine habitats, encompassing coastal regions, estuaries, and continental shelves. *Turritella tampae* was predominantly distributed within warm, tropical to subtropical waters, establishing a biostratigraphic range that encompasses the Early Oligocene to the Middle Miocene, as documented by Heilprin in 1887. *Ecphora meganae*, also a marine gastropod species, found its habitat in regions characterized by a warm and subtropical climate during the Miocene epoch. These areas were typified by shallow seas teeming with a diverse array of marine life. The biostratigraphic range of *Ecphora meganae* is situated squarely within the Middle Miocene epoch, as established by research conducted by Portell et al., 2006, and Ward and Gilinsky in 1988. *Leptomaria* sp., representing another gastropod species, inhabited tropical to subtropical waters across different geological epochs. Their biostratigraphic range extends from the Early Cretaceous to the Paleocene epoch, as verified by the works of Eudes-Deslongchamps in 1864 and Kummel in 1964. Collectively, these gastropod species provide valuable insights into the paleoenvironmental conditions and ecological preferences of the Red Bay Formation area over significant geological timeframes.

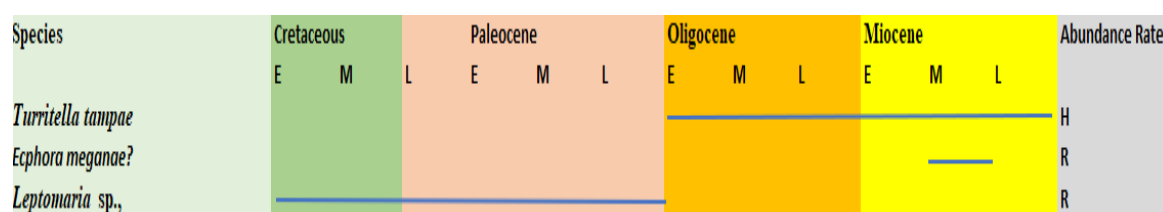


Figure 11. Shows the biostratigraphical age range of gastropod species.

Family Turritellidae Lovén, 1847

Turritella tampae Heilprin 1887 (Fig.12-1).

The elongated, conical shell exhibits a color spectrum spanning from brownish-yellow to white, with a striking height and pointed apex. It is composed of a significant number of whorls, typically ranging from 16 to 20, which expand progressively. The shell's surface is adorned with numerous spiral ridges, of which 3 to 6 are notably prominent and may assume a bead-like appearance. In terms of dimensions, the shell can attain a length of up to 3 cm and a width of approximately 1 cm. The aperture of the shell, despite its angular configuration, is relatively diminutive in size. The outer lip of the shell's aperture bears a crenulated texture. Notably, there is an absence of an umbilical cord, a distinctive feature of this species. The operculum, a concave structure that seals the aperture, assumes a circular form and is of minute proportions. Its margins are adorned with numerous pinnate bristles, adding to its intricate structure. When considering the soft anatomy of the snail, including its tentacles, siphon, and foot, discernible patterns in white are observable. The minute foot of this specimen showcases distinct black patches as well as a longitudinal streak, further contributing to its distinctive features.

Family Muricidae Rafinesque, 1815

Ecphora meganae? Ward and Gilinsky 1988(Fig.12-2).

The spire of the specimen is notably abbreviated, comprising only two distinct volutions, while the presence of additional volutions is concealed beneath the overlying whorls. One of these volutions exhibits four evenly spaced belts, which are markedly raised, featuring a wider configuration at their upper region in comparison to their point of intersection with the whorl. Furthermore, these belts are characterized by the presence of one or two deeply imprinted lines, demarcating creased regions that extend across the belts. The aperture of the shell is suboval in shape, and the canal is relatively short and slender. The labrum, or outer lip, exhibits a groove corresponding to each of the external ribs. The

umbilicus, a critical feature of the shell's structure, is notably expanded and substantial, although it remains concealed from view at the innermost upper region. The outer edge of the umbilicus is prominent and exhibits pronounced dentations.

3-Family: Pleurotomariidae Swainson, 1840

Leptomaria sp., Eudes-Deslangchamps 1864(Fig.10-3).

The specimen under examination belongs to the genus characterized by a substantial shell size, with maximum dimensions measuring 100.4 mm in diameter, a minimal diameter of 85.1 mm, and a height of 108.8 mm. The shell exhibits a tall, widely conical spire, comprising eight well-preserved teleoconch whorls. Notably, the shell's base displays a subtle yet consistent convexity, devoid of an umbilicus. The spire maintains a spire angle of 68 degrees, presenting an equally conical profile when viewed in profile. The suture, while slightly adpressed, forms a connection with the preceding whorl either at or slightly above a faint peripheral bulge. The protoconch, encompassing the initial two teleoconch whorls, is notably absent. Subsequent teleoconch whorls exhibit an exceptionally subtle gradation, displaying a mild convexity and lacking a clearly defined ramp angle. The shell's predominant ornamental feature is a spiral sculpture, characterized by the presence of six to seven low and narrow cords, spanning the same width as the intervening spaces between the suture and the selenizone. Additionally, between the selenizone and the peripheral bulge, there are approximately 12 to 15 such spiral cords. Similarly, the shell's base showcases comparable spiral cords, estimated to number between 19 and 22 on the final whorl.



Figure 12 : Shows 1-*Turritella tampae*
2- *Ecphora meganae*?3- *Leptomaria* sp.,

CONCLUSION

In summary, the examination of a three-kilogram sample comprising red clay and sediment sourced from the now-extinct Red Bay Formation in Florida has yielded valuable insights into the marine invertebrate composition and foraminifera diversity within this geological deposit. The conspicuous presence of abundant gastropods and bivalves within the sample is indicative of a thriving marine ecosystem. Moreover, this investigation represents the inaugural characterization of foraminifera within this specific outcrop, illuminating their previously overlooked existence. The identification of gastropod

species, such as *Ecphora meganae*, *Turritella tampae*, and *Leptomaria* sp., alongside bivalve species like *Astarte distans*, *Chesapecten covepointensis*, and *Crassostrea* sp., augments our comprehension of the biotic assemblage in this locality. The predominance of benthic foraminifera, including *Anonnamalinoide* sp., *Trilorculina quadrilateralis*, *Textularia articulata*, among others, in the sediment samples implies a shallow marine setting. The presence of planktonic foraminifera, belonging to the Globigerinids group, such as *Globigerinoids bisphericus*, *Globigerinoids kennetti*, and *Orbulina universa*, reinforces the interpretation of marine facies. However, the exact stratigraphic placement of these sediments within the Red Bay Formation remains uncertain due to lithological resemblances with adjacent strata. In essence, these findings contribute significantly to our comprehension of the paleoenvironment and paleoecology of the Red Bay Formation, offering valuable data for geological and paleontological investigations in the region.

The paleoecological and biostratigraphic implications of the aforementioned bivalve species suggest their widespread presence in E-Middle Miocene reef systems, shallow seas, and coastal environments. These species exhibit preferences ranging from sandy to muddy substrates, including *Crassostrea* sp., *Pycnodonte* sp., *Isognomn* sp., *Lirphora latilirata*, *Astarte distans*, and *Chesapecten covepointensis*. They frequently coexist in diverse habitats, encompassing deep-sea environments, nearshore marine locales, and estuaries. Their expansive geographic distribution underscores their adaptability and global presence within the designated biostratigraphic timeframe. The data presented in the chart and related publications enhance our comprehension of the paleoenvironments and ecological proclivities of these bivalve species during the E-Middle Miocene, offering crucial insights into ancient marine ecosystems and their evolutionary trajectories. The paleoecological and biostratigraphic inferences about *Turritella tampae*, *Ecphora meganae*, and *Leptomaria* sp., indicate that these were marine species that inhabited warm, tropical to subtropical waters during various epochs. *Turritella tampae*, a turritellid snail, thrived in shallow marine environments, including coastal regions, estuaries, and continental shelves, during the Early Oligocene to Middle Miocene. *Ecphora meganae* flourished in the Middle Miocene, characterized by a warm, subtropical environment teeming with marine life in shallow seas. *Leptomaria* sp., with its broad biostratigraphic range from the Early Cretaceous through the Paleocene, demonstrates its presence in tropical to subtropical waters across those time intervals. These revelations augment our comprehension of ancient marine ecosystems and cast light on the paleoenvironments and geographical distribution of these marine organisms throughout diverse geological epochs.

REFERENCES

- [1] Beaman, R.J., and Harris, P.T.,: Paleo-environments and deepwater habitats of the eastern Australian continental margin.,2007., 54, pp.1428-1451. Deep-Sea Research Part II: Topical Studies in Oceanography.
- [2] Bernard, F., :Bivalve Mollusks of the Western Beaufort Sea. Natural History Museum Los Angeles County, 1979. Contributions in Science 313, pp. 80.
- [3] Bitner, M. A.,: Evolution and palaeoecology of Late Cretaceous–Paleogene coralliferous deposits of the Omphalocyclus Dumortier, 2020 , pp. 185-213. 1884 (Bivalvia, Cardiida) in the Eastern Tethys. Historical Biology.32.
- [4] Canu, F., Bassler, R. S.,; Bryozoa des iles Hawaiï. 1927. 8, pp.1-67. Bulletin de la Société des Sciences de Seine-et-Oise.
- [5] Coan, E. V., and Valentich-Scott, P.,: Bivalve seashells of tropical West America. Marine bivalve mollusks from Baja California to northern. 2012, pp.1258. Peru. 2.
- [6] Conrad, T. A.,: Description of twenty-six new species of Fossil shells, discovered by him in the Medial Tertiary deposits of Calvert Cliffs, 1841., pp. 28-35. Maryland. Proceedings of the Academy of Natural Sciences of Philadelphia. 1.
- [7] Conrad, T.,: Descriptions of new genera, subgenera and species of Tertiary and recent shells.- Proc. 1862. v. 14, pp. 284. Acad. Nat. Sci. Phila.,
- [8] Dall, W.H.,: Synopsis of the family Astartidae, with a review of the American species. 1903. pp.933–951. Proceedings of the U.S. National Museum 26

- [9] Eudes-Deslongchamps, E.: Note sur la delimitation des genres *Trochotoma* et *Ditremaria*. Notes Paléontologiques, 1864, 1, pp.35-47.
- [10] Fleming, J.: A History of British Animals, Exhibiting the Descriptive Characters and Systematical Arrangement of the Genera and Species of Quadrupeds, Birds, Reptiles, Fishes, Mollusca, and Radiata of the United Kingdom; Including the Indigenous, Extirpated, and Extinct Kinds, Together with Periodical and Occasional Visitants 1828, pp .565. Bell & Bradfule, Edinburgh, and James Duncan, London. Xxiii
- [11] Hendy, A. J. W., Buick, D. P., Bulinski, K. V., Ferguson, C. A., Miller, A. I.: Unpublished census data from Atlantic coastal plain and circum-Caribbean Neogene assemblages and taxonomic opinions. 2008.
- [12] Heilprin, A.: Fossils of the silex- bearing marl (Miocene) of Ballast Point, Hills-boro Bay. 1887, vol. 1, pp. 105-123. Wagner Free Inst. Sci. Trans.
- [13] Huber, M.: Compendium of bivalves. A full-color guide to 3,300 of the world's marine bivalves. A status on Bivalvia after 250 years of research. 2010. 901. Hockenheim: Conch Books
- [14] Johnson, R.A.: Geologic descriptions of selected exposures in Florida, 1989. pp.174. Florida Geological Survey special publication. 30.
- [15] Kellum, L.B., : Paleontology and stratigraphy of the Castle Hayne and Trent Marls in North Carolina. 1926, pp.44. U.S. Geological Society Professional Paper, v. 143.
- [16] Kidwell, S.M.: Shell composition has no net impact on large-scale shell bed dynamics in Chesapeake Bay oysters (*Crassostrea virginica*), 2005. pp.673-676. A geochemical test. Geology. 338.
- [17] Kummel, B.: Nautiloidea—Orthocerida. 1964, pp. 82-115. In R. C. Moore (Ed.), Treatise on Invertebrate Paleontology, Geological Society of America, and University of Kansas Press. Mollusca 3. 1
- [18] Linnaeus, C.: Systema Naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. 1758. pp, 824. Editio decima, reformata 10th revised edition, vol. 1.
- [19] Lightfoot, J.: A Catalogue of the Portland Museum, lately the property of the Dutchess Dowager of Portland, deceased., 1786. pp. 194. which will be sold by auction by Mr. Skinner & Co book. London. Viii.
- [20] Lovén, S.: Malacozoologi. Öfversigt af Kongliga Vetenskaps Akademiens Förhandlingar. 1847. Volume 4, pp.175-199.
- [21] Matson, G.C., and Clapp, F.G.: A preliminary report on the geology of Florida with special reference to the stratigraphy. 1909. pp.13-173. Florida Geological Survey Annual Report. 2.
- [22] Orbigny A.D. d'.,: Paléontologie française. Description zoologique et géologique de tous les animaux Mollusques et Rayonnés fossiles de France. 1844-1848. pp. 1-807. Terrains crétacés. Volume 3.
- [23] Portell, R. W., Kowalewski, M., and Carraway, K. L., : Environmental control on gastropod morphological evolution. 2006., pp. 253-277. A stratocladistic analysis of *Ecphora*. Paleobiology. 32.
- [24] Powell, E.N., Allmon, W.D., and Peterson, C.H.: Chesapecten: The remarkable scallops of Chesapeake Bay. 2001. University of Oklahoma Press.
- [25] Puri, H.S., and Vwenon, R.O., : Summary of the geology Florida and guidebook to the classic exposures. 1964, pp.312. Florida Geological Survey Publication. 5.
- [26] Rafinesque, C. S.: Analyse de la nature ou Tableau de l'univers et des corps organisés. Book. 1-224, (self-published). 1815, pp.144. Palermo.
- [27] Sacco F.: I Molluschi dei terreni terziarii del Piemonte e della Liguria, Parte 23 (Ostreidae, Anomiidae, Dimyidae). 1897., pp. 99-100. Bollettino dei Musei di Zoologia ed Anatomia Comparata della R. Università di Torino. 12(298).
- [28] Scolaro, R.: Notes on Miocene Bryozoa from Northwestern Florida. 8, 1970. pp.93-98.
- [29] Smitt, F. A.: Floridan Bryozoa, Part 2. K. svenska VetenskAkad //anrf/, Stockholm, 1873. 9 (4), pp.3-83.

- [30] Swainson, W.,: A treatise on malacology or shells and shell-fish. 1840. pp.1-419. London: Longman,
- [31] Vokes, H. E.,: Notes on the fauna of the Chipola Formation. The genus *Astarte* (Mollusca: Bivalvia). 1981. 16, pp.165-167. Tulane Studies in Geology and Paleontology.
- [32] Ward, P.D., and Blackwelder, B.W., : Shallow-marine and nonmarine depositional environments and habitats. 1987. pp. 357-381. In: Davis, R.A., & Dalrymple, R.W. (Eds.), Principles of Tidal Sedimentology. Springer.
- [33] Ward, L.W., Gilinsky, N.L.,: *Ecphora* (Gastropoda: Muricidae) from the Chesapeake Group of Maryland and Virginia *Notulae Naturae* 469.1988, pp. 1-21.
- [34] Waldheim, G.,: Lettre à M. le Baron de Férussac sur quelques genres de coquilles du Muséum-Demidoff et en particulier sur quelques coquilles fossiles de la Crimée. Bulletin de la Société Impériale des Naturalistes de Moscou. 8, 1835. pp.99-123.
- [35] Ward, L. W.,: Molluscan biostratigraphy of the Miocene, middle Atlantic coastal plain of North America. 1992. pp.1-147. Virginia Museum of Natural History Memoir. 2
- [36] Wendell, C., and Gerald M.,: Faunal zones in the Miocene Choctawhatchee Formation of Florida.1932. 22. 4, pp. 84-88. Journal of the Washington Academy of Sciences.
- [37] Wood, C.L., Ward, L.W.,: and Johnson, J.G., Biostratigraphic, paleoecologic, and paleoenvironmental implications of Chesapeake Group (Miocene) mollusks from Virginia and Maryland., 1973. pp. 854. United States Geological Survey Professional.
- [38] Woodring, W.P. ,: Miocene Mollusca from Bowden Jamaica, pelecypods, and scaphopods. 1925. 366, pp. 1–564. Carnegie Institution of Washington.



VIII. International Symposium-2024

ROLE OF MARINE ALGAE IN PLANT GROWTH AND PROTECTION FOR SUSTAINABLE AGRICULTURE

Eetizez KAROUI¹, Karim ENNOURI², Mohammed Ali TRIKI¹, Monia ENNOURI^{1,3}

¹Olive tree institute LR 16 IO 01, university of Sfax, Tunisia. eetizez.karoui.etud@fss.usf.tn

²Digital Research Centre of Sfax, Technopark of Sfax, University of Sfax, Tunisia.

³Higher Institute of applied science and technology of Mahdia, University of Monastir, Tunisia

Abstract:

*Climate change, population growth, and the overuse of chemical pesticides and fertilizers are placing unsustainable pressure on existing agricultural and food production techniques. Finding strategies that reduce the adverse impacts in agriculture industry is crucial to supporting sustainable food production systems and preserving the health of the environment for future generations. Macroalgae (seaweed like *Ascophyllum nodosum*, *Sargassum vulgare*, *Gracilaria gracilis*, *Padina gymnospora*...) or microalgae (unicellular like *Chlorella* spp, *Spirulina* ...) provide a variety of biological solutions for sustainable agriculture. Indeed, there are several ways in which algae can contribute to sustainable and ecologically sound agriculture. Algae could be used as biological fertilizers rich in nutrients (nitrogen and phosphorous, potassium...) that can enhance soil fertility and promote plant growth. Algae-based soil conditioners increase the availability of nutrients, water retention, and soil structure. They also offer the ability to promote and stimulate soil microbial life and the absorption of nutrients by roots. Similarly, they contain many compounds that act as antioxidants, polysaccharides, phytohormones, vitamins and provide an effective shield against abiotic stresses in plants. Certain algae can function as biocontrol agents against plant diseases by producing chemicals with antibacterial and antifungal activities. Algal extracts may increase plant defenses against illness and inhibit the propagation of diseases, which reduces the need for chemical pesticides.*

Keywords: Agriculture, Algae, Fertilizer, Stimulation, Fertilization, Antimicrobial activity.

GENERAL INTRODUCTION

One of the main challenges facing the agricultural sector is increasing food production to feed the growing population. Indeed, the world population is expected to reach 9.15 billion in 2050 [1, 2]. Agricultural production need the use of fertilizer, stimulants to help plant growth and pesticides to fight pests. With the climate changes in the recent years, we are observing the increase in the resistance of pathogens which find environmental conditions allowing them to proliferate well and we observe the increased use of chemical pesticides in agriculture. Tudi et al. [3] reported that if pesticides weren't

used, the fruit production would decrease by 78%, vegetable production would decrease by 54%, and cereal production would decrease by 32%. Pesticides are used for a variety of purposes, including as boosting crop productivity, controlling the spread of illnesses, and eliminating or suppressing dangerous pests. However, pesticides have unavoidable negative effects, they are destroying the quality of the soil and water, which has a dangerous effect on people, animals, birds, and plants in addition to seriously affecting the environment. Additionally, pesticides disrupt biodiversity and cause ongoing exposure, either directly or indirectly [4]. Climate change may impact the use of pesticides as well as the amount of pesticides released into the environment. Currently, one of the most intellectually difficult problems confronting humanity as a whole is climate change [5]. Also the properties of soil are directly altered by climate change, which also affects how pesticides are applied [3, 6, 7]. In addition to having a direct effect on pesticide application, the effects of climate change on soil conditions also have an indirect effect on pesticide use by first affecting the growth and distribution of weeds, apparition of diseases, and insect pests in crops [3].

The prevalence of pathogens in natural and agricultural ecosystems can be significantly impacted by changes in global temperatures, which raises the danger of coming into contact with novel pests and diseases. Numerous fungal soil-borne plant diseases are expected to become more prevalent as a result of global warming, which will have a substantial impact on primary productivity [8, 9]. In recent years, research has turned towards biological solutions favoring the use of plant extracts or microorganisms for their application in agriculture as a fertilizer, stimulator or as a biopesticide.

Algae - whether macro (seaweed and kelp) or micro (unicellular) - have been farmed for food for thousands of years. They have evolved into highly efficient resource gatherers, and have consistently demonstrated that they can be a source of nutritious, high-biomass food that could address many of the issues we currently have with food production [10].

This review's main goal is to exhibit the important roles that marine algae play in the areas of crop protection, stimulation, and fertilization. Marine algae provide a viable substitute for traditional agricultural inputs because of their high nutritional content and bioactive components. They give natural resistance to pests and diseases, increase soil fertility, and encourage plant development. Farmers can increase crop yields and resilience by incorporating marine algae or their extracts into the agricultural practices, which will help to create a more resilient and environmentally friendly agricultural system. This paper emphasizes the potential of marine algae to revolutionize contemporary agriculture while highlighting their potential benefits.

INTRODUCTION TO MARINE ALGAE

Algae are photoautotrophic, prokaryotic (cyanobacteria) or eukaryotic organisms using light, carbon dioxide, and water to transform nitrogen and phosphorus from the environment into biomass. After that, the biomass can be separated using a suitable technique to produce different types of bioproducts [11, 12]. Algae are an autotrophic group that can generate their own food through anabolic processes. They also contain a wide variety of organisms differing by their size, shape, and the degree of complexity of their body structures. Owing to their extreme diversity, algae are typically classified as macroalgae, which are fully visible, and microalgae, which can only be seen with the use of magnification (with microscope) [13].

Because they make up phytoplankton, microalgae are found only in the euphotic zone, suspended in the water column, and in surface waters. The base of the marine food chain is made up of phytoplankton, which feeds on invertebrates like mussels, copepods, and other crustaceans, as well as mollusks and vertebrates like juvenile sardines and other species. Macroscopic marine algae known as macroalgae, or seaweeds, can grow to reach several meters long. If they are not subjected to severe herbivory, some of these algae's thalli can grow to attain 65 meters long [13].

Only 5.000 of the more than 800.000 kinds of algae found in nature have been thoroughly studied. Only a small subset of the 5.000 species of algae have been chosen in order to explore their possible uses in plant growth under specific growth circumstances [14].

USES OF ALGAE AS BIOFERTILIZER

Using algae as fertilizer is one of the oldest traditional uses. The use of biological agents as fertilizers to raise the nutrient content of the soil and hence boost productivity is called bio-fertilization, it is a sustainable agricultural method. In order to enhance soil fertility and boost biomass yield, soil microflora has been exposed. It has been determined that this is the appropriate, ecologically acceptable, bio-based fertilizer for pollution-free agricultural applications [15].

Algae can be used in agriculture not only as biofertilizers but also as soil conditioners to increase soil fertility and plant productivity [15]. Model biofertilizers are thus algal communities from wastewaters that have an ideal nitrogen, phosphorus, and potassium ratio (NPK) and secondary nutrients.

Because of their widespread use, increased metabolic flux, quick generation time, and innate ability to convert inert nitrogen into nitrogen able to be used by plants (a process known as N fixation), it can serve as an alternative to conventional chemical fertilizers [16]. Thus, soil's characteristics were developed including the improvement of texture, aeration, carbon content, and nitrogen fixation. The presence of algae among other living things that can be found in a variety of soil types and conditions may be a sign of a healthy range for the soil environment. Through control of water flow, the algal development also lessens soil erosion. In a similar vein, algae play also a role in soil fertility, it has been reported that soil microflora increases soil fertility and biomass productivity [15, 17]. Algal microflora, on the other hand, has also been discovered to be a true bio-based fertilizer for environmentally friendly and pollution-free farming practices.

Despite being photosynthetic, the algae have evolved to withstand harsh conditions and have been shown to flourish in conditions with intense light, minimal water requirements, and limited nutrient levels, such as C and N. Because they are superb N-fixing agents, they are very independent of alerts in terrestrial N pools that manufacture primary essential amino acids, growth promoters, and hormones required for successful crop growth in cropping systems. Since most farmers due to lack of financial means cannot afford synthetic agricultural fertilizer unless it is subsidized, nature and the kind of soil have a major role in determining agricultural production [15, 16].

Microalgae generate bioactive molecules including growth hormones, polysaccharides, and antimicrobials. These qualities make them potential choices for biofertilizers since they promote improvement of plant growth [18].

The potential chelating abilities of algal polysaccharides, primarily alginates, fucoidans, carrageenans, and laminarins, are another feature of these compounds. These molecules, which contain a lot of chemical groups, mostly carboxyl residues, have a high capacity to bind trace element cations. Algal extracts with micronutrients can be used as foliar fertilizers because to this feature. These hydrocolloids have also the ability to gel and bind water [19, 20].

To evaluate the impact of fertilizers, a variety of soil indicators are employed. Certain studies employ the physical and chemical features of soil, while others concentrate on its biochemical properties, which are directly related to the quantity and activity of soil microbial biomass [21]. The impacts of algae biofertilizers on the native soil microbial community, biochemical properties, and physico-chemical characteristics of the soil was resumed in Figure 1.

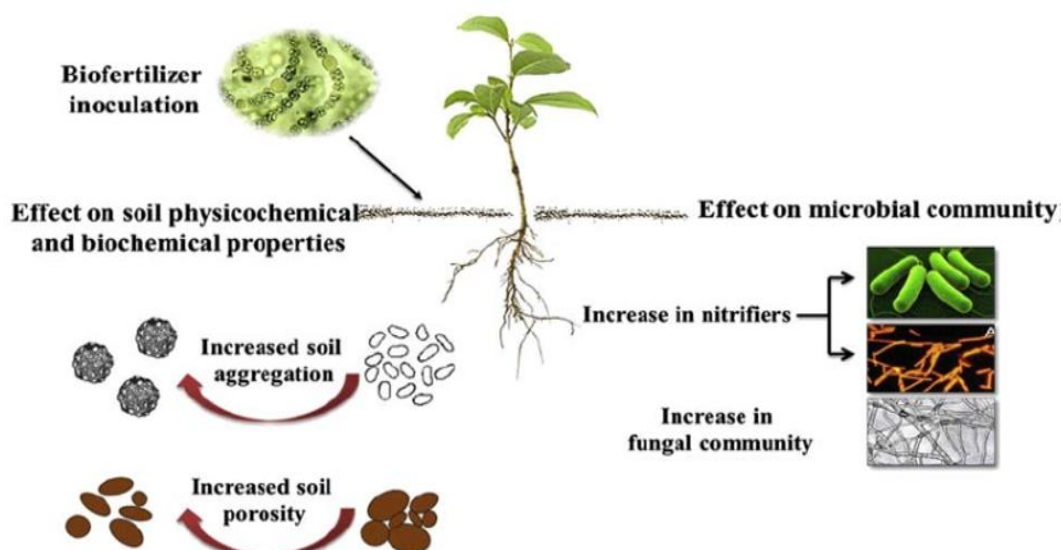


Figure 1: Effects of biofertilizers on physiological and biochemical properties of soil [21].

USES OF ALGAE AS BIOSTIMULANT

The term "biostimulants" refers to materials that can increase plant physiology, including root and shoot growth, boost the uptake of minerals and nutrients, and improves plant tolerance to biotic and abiotic stresses all of which can raise crop yields [22]. Macroalgae extracts contain a number of bioactive substances such as amino acids, polysaccharides, vitamins, fatty acids, mineral elements, phenolics, and small amounts of phytohormones that contribute to their biostimulant properties. This discovery has made macroalgae an essential part of the market of biostimulant plant-based products. Macroalgae have been used as biostimulants since the early 1980s, the macroalgal biostimulant market is well established. Nevertheless, the underlying mechanism of action of each bioactivity is often unknown, but efforts are underway to address these questions. Indeed, bioactives compounds are a complex mixture whose biostimulating activities are determined by their physico-chemical properties. It has now been reported that current biotechnological advances are helping to elucidate the mechanisms of the action of biostimulants, and in turn, will lead to product development for the plant and crop industry [23, 24].

Microalgal biostimulants have an immense scope and potential to make agriculture more sustainable and resilient. Macroalgae (seaweeds) and microalgae have been long considered a rich source of plant biostimulants with an attractive business opportunities in agronomy and agro-industries [24].

Phytohormones have a major impact on the growth and development of plants. Synthetic or natural exogenous plant hormone supplementation have been utilized in agriculture to boost yields and crop productivity while suppressing weeds. Algae produce auxins, cytokinin, jasmonate, and other growth hormones that are useful as biostimulants in agriculture [25, 26].

When talking about the use of algae as fertilizer, we must go back to the 19th century, when the coastal inhabitants collected the large brown algae carried by the tide, placed them on their land and observed their beneficial effect on plants and the agricultural soils [27, 28].

Since the 1950s, the extracts derived from several macroalgal species were used in many applications. As of right now, these extracts are recognized as "plant biostimulators".

Plants undergo physiological reactions that include enhanced plant growth, improved flowering and yield, stimulation of the edible product's quality and nutritional content, and extended shelf life. Additionally, the application of several extract kinds has increased plants' resistance to a variety of abiotic stresses [28, 29].

Furthermore, the most widely used technique in the world of agriculture is liquid algal biofertilizer. High levels of trace minerals and growth-regulating substances, especially cytokinins, are the main ingredients in liquid fertilizers, which have a favorable effect on plant development and growth [30].

Algal extracts improve nutritional status, vegetative development, yield, and fruit quality in a variety of orchards and vineyards. They contain several vital elements, such as Zn, K, Mg, Ca, P, S, K, Zn, Mo, Cu, Co, and Fe, as well as a number of growth regulators, vitamins, and polyamines. Microalgae and cyanobacteria produce a variety of phytohormones, phenolic compounds, polysaccharides, terpenoids, free fatty acids, and alpha and beta carotenoids. These compounds have biological activities (Figure 2) and are a source of vital nutrients, which greatly increases agricultural yields [16, 30].

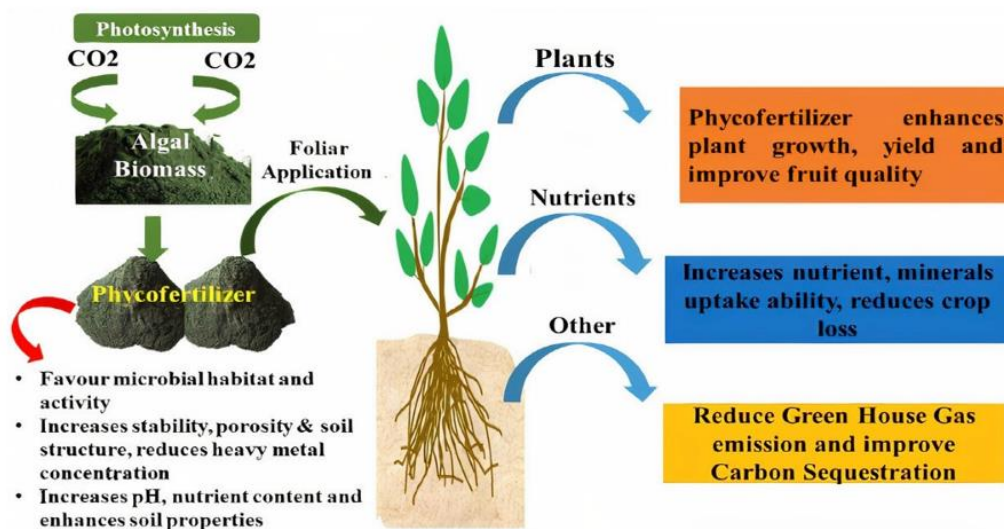


Figure 2. Applications of phycofertilizers in agriculture [30].

ALGAE AS BIOCONTROL AGENTS AGAINST PLANT DISEASES

Numerous phytopathogens, including nematodes, bacteria, viruses, fungi, and Oomycetes, are continuously present in plants. These pathogens have the potential to drastically lower the productivity of major crops grown around the world. The yearly agricultural yield losses due to several pathogenic illnesses ranging from 20% to 40% [31]. Algae extracts are rich sources of bioactive elicitors in addition to being an abundant supply of vitamins, saccharides, enzymes, amino acids, phytohormones, and elements such as molybdenum, boron, manganese, iron, iodine, and zinc [32, 33, 34].

The agricultural sector is also highly benefited from microalgae, as they are the good promoters of crop growth [35].

Some eukaryotic microalgae have been shown to exert antibacterial and antifungal activity. Microalgae produce biologically active extracellular compounds that mediate plant growth, like the Plant Growth Regulators (PGRs), which are effective at very low concentrations (phytohormones, amino acids, polypeptides, polysaccharides and vitamins [36, 37, 38].

For instance, polysaccharides found in marine macroalgae initiate signaling cascades that in turn activate plant defense mechanisms and resistance to pathogen invasion. The degree of sulfatation has a direct bearing on this characteristic. Fucans and laminarins (from brown algae), ulvans (from green algae), and carrageenans (from red algae), are naturally occurring elicitors of plant defense [20, 39].

Plant growth substances potential demonstrates that, because to their verified phytohormone concentration, seaweed and microalgae are both ideal options for plant biostimulation (Figure 3). As a result, their application may be considered at a different stage of the plant's life cycle [40].

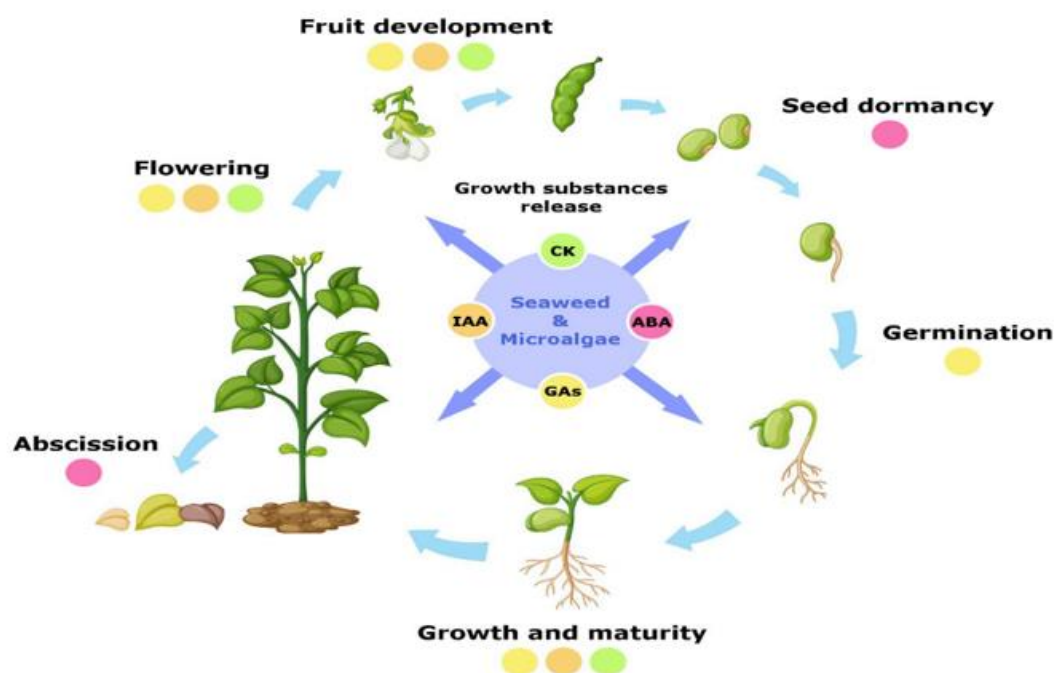


Figure 3: Colour online. Known phytohormones produced by seaweed and microalgae and their potential impact on the life cycle of a crop. IAA, Auxins; CK, Cytokinins; GAS, Gibberellins and ABA, Abscissic Acid [40].

UTILITIES OF THE DIFFERENT VARIETIES OF ALGAE IN AGRICULTURE

Agricultural land is constantly degrading as a result of intensive farming practices. The soil is the primary component of agricultural productivity; it serves as both a plant's substrate and a basic resource that has to have its nutrients replenished. Research is gradually shifting its attention, though, to create new natural products from aquatic ecosystems that are just as effective as certain synthetic ones but have less of an adverse effect on the environment and human health [18].

There are a number of ways in which algae can contribute to sustainable and ecologically sound agriculture. First, they are natural products that contain numerous bioactive compounds that are important to the general growth and development of crops. They also offer the ability to promote and stimulate soil microbial life and the absorption of nutrients by roots. Similarly, they contain many compounds that act as antioxidants and provide an effective shield against abiotic stresses in plants [28]. The Table 1 presents the different utilities of micro and macro algae and present some examples of the use of algae in agriculture for different purposes.

Table 1: Utilities of different varieties of algae in agriculture

Major Class of Algae	Variety of Algae	Utilities	References
Brown macro algae	Padina gymnospora	Algae extract preserved the quantitative effectiveness of PSII (FV/FM) in tomato plants, indicating a defense of the photosynthetic system against damage brought on by salinity stress. -An increase in the antioxidant enzyme activity (SOD, APX, and CAT) has been noted, which helps to mitigate the oxidative damage caused by selenium. The role of APX and SIAOX1 in reducing oxydative stress highlights their critical role in protecting against salin stress. -Proline, flavonoïdes, and other secondary metabolites have increased in content, acting as a protective factor by maintaining	[40]

		the redox balance of cells and stabilizing enzymes and cell structures.	
	Ascopphyllum nodosum	Algae can improve soil health by providing essential nutrients(N,P,K) -Increasing seed germination, plant development, and yield - Protecting plants from biotic and abiotic stresses by enhancing soil structure, microbial activity, and nutrient availability	[41]
		The presence of bioactive substances, which promotes improved plant development. Moreover, it encourages modifications to the chemical composition of soil and increases tomato crop nutrient uptake in subtropical climates.	[42]
	Sargassum vulgare	-the extracts' ability to promote plant growth and yield whilst: The application of Sargassum vulgare extracts has the potential to increase plant height, biomass, racially developed plants, and leaf surface area. These improvements are frequently attributed to increased photosynthetic activity and improved nutrient absorption. - Natural antifungal properties are present in Sargassum vulgare extracts by protecting the plants from pathogenic attack from destructive foliar pathogens (A. solani and Xcv). -Sargassum vulgare shows significant potential for environmentally friendly ZnO nanoparticle production: ZnO-NPs have demonstrated effective antifungal properties against a number of well-known fungi. They present themselves as an alternative for the management of fungal pathogens in both humans and plants, especially those resistant to antibiotics. The biologically synthesized zinc oxide nanoparticles (ZnO-NPs) derived from Sargassum vulgare exhibit promising properties for a range of industrial uses, such as biological fungal conflict, food preservation, and environmental cleaning.	[43]
			[44]
Brown macroalgae	Stoechospermum marginatum	-The several advantageous components found in S. marginatum liquid extracts are responsible for the improvements in the growth, biochemical composition, and yield metrics of brinjal plants. -The possibility of using liquid seaweed extracts in place of chemical fertilizers to support sustainable crop development and output. Furthermore, their use is consistent with organic farming's environmentally favourable methods. -The components found in the seaweed extract, including vitamins, cytokinins, auxins, macro and micro elements, amino acids, and compounds that resemble abscisic acid, are responsible for the observed growth improvement. These elements have an impact on cellular metabolism, which promotes improved crop output and growth. Furthermore, micronutrients support the health of the soil, while growth hormones particularly cytokinins play a critical role in stimulating cell size, division, shoot formation, and root development.	[45]
Green macroalgae	Ulva lactuca	-Algae extracts are useful in many fields, such as nanotechnology, healthcare, agriculture, and environmental sustainability. -used for the green synthesis of nanoparticles presents a viable substitute for conventional techniques, offering safe, efficient, and eco-friendly results.	[46]
	Codium taylorii	-the extracts' ability to promote plant growth and yield whilst the potential of seaweed extracts (SWEs) in tomato and sweet pepper plants as foliar treatments and biopriming agents, with an emphasis on the impacts on seed germination, seedling growth, resistance to disease, and total plant production.	[43]

	Caulerpa serrulate	- protecting the plants from pathogenic attack from destructive foliar pathogens (A. solani and Xcv). -The molecular evidence suggests the activation of defense mechanisms and hormonal responses in treated plants, contributing to their enhanced performance	
	Ulva intestinalis	-The application of the ulva intestinalis extract significantly enhanced the growth of the two plants, increasing their biomass and standing height. -Significant changes have been observed in the levels of several molecules, such as sugars and amino acids. This suggests that the metabolism of treated plants has improved. - Increasing stress tolerance or an important plant hormone levels have been balanced in a beneficial way, promoting better growth and stress resistance.	[47]
Red macro-algae	Asparagopsis taxiformis	-the possibility of creating biopesticides to manage the pest in agriculture	[48]
	Laurencia johnstonii		
	Acanthophora spicifera.	-the extracts' ability to promote plant growth and yield whilst SWEs, particularly from A. spicifera, showed promising results as biopriming agents and foliar treatments in tomato and sweet pepper plants.	[43]
	Gracilaria ornata		
Green micro-algae	Chlorella vulgaris	-Improve plant development and increase levels of secondary metabolites including glucosinolates and anthocyanins. - surnameant exempt de Chlorella (CFS), ont entraîné une augmentation significative des composés phytochimiques, tels que les glucosinolates aromatiques et les anthocyanines, dans le chou frites	[49]
	Scenedesmus obliquus	-The germination rate of the plant seeds was greatly increased by using Scenedesmus obliquus extract -Plants treated with algae extract developed their stems more robustly and stronger. -Scenedesmus obliquus's improved nitrogen intake encouraged the seedlings' broad root development. - the extract-treated leaves showed elevated photosynthetic activity and a deeper color of gree	[50]

CONCLUSIONS AND RECOMMENDATIONS

In summary marine algae are essential for raising agricultural sustainability and productivity. When used as biofertilizers, they greatly enhance the nutrients in the soil, encouraging stronger and better plant development. Marine algae's bioactive chemicals function as organic stimulants, boosting the vitality and resistance of plants to environmental challenges. Additionally, by protecting crops from pests and diseases, their protective qualities provide an environmentally friendly substitute for conventional pesticides. Using marine algae into agriculture promotes sustainable farming practices, which are essential to the maintain of the long-term health of the ecosystem, while also increasing crop yields. The potential of marine algae to transform agricultural methods was highlighted in this paper, providing a comprehensive strategy for attaining both ecological balance and food security

REFERENCES

- [1] [1]Calicioglu, O., Flammini, A., Bracco, S., Bellù, L., & Sims, R. (2019). The future challenges of food and agriculture: An integrated analysis of trends and solutions. *Sustainability*, 11(1), 222.
- [2] [2]Ajijah, N., Fiodor, A., Pandey, A. K., Rana, A., & Pranaw, K. (2023). Plant growth-promoting bacteria (PGPB) with biofilm-forming ability: a multifaceted agent for sustainable agriculture. *Diversity*, 15(1), 112.
- [3] [3]Tudi, M., Daniel Ruan, H., Wang, L., Lyu, J., Sadler, R., Connell, D., ... & Phung, D. T. (2021). Agriculture development, pesticide application and its impact on the environment. *International journal of environmental research and public health*, 18(3), 1112.
- [4] [4]Rani, L., Thapa, K., Kanojia, N., Sharma, N., Singh, S., Grewal, A. S., ... & Kaushal, J. (2021). An extensive review on the consequences of chemical pesticides on human health and environment. *Journal of cleaner production*, 283, 124657.
- [5] [5]Ukhurebor, K. E., Aigbe, U. O., Olayinka, A. S., Nwankwo, W., & Emegha, J. O. (2020). Climatic change and pesticides usage: a brief review of their implicative relationship. *eJournal of Interdisciplinary Research* (ISSN: 2408-1906), 5(1).
- [6] [6]Bernardes, M. F. F., Pazin, M., Pereira, L. C., & Dorta, D. J. (2015). Impact of pesticides on environmental and human health. *Toxicology studies-cells, drugs and environment*, 195-233
- [7] [7]Poveda, J., & Díez-Méndez, A. (2023). Use of elicitors from macroalgae and microalgae in the management of pests and diseases in agriculture. *Phytoparasitica*, 51(4), 667-701.
- [8] [8]Delgado-Baquerizo, M., Guerra, C. A., Cano-Díaz, C., Egidi, E., Wang, J. T., Eisenhauer, N., ... & Maestre, F. T. (2020). The proportion of soil-borne pathogens increases with warming at the global scale. *Nature Climate Change*, 10(6), 550-554.
- [9] [9]Singh, B. K., Delgado-Baquerizo, M., Egidi, E., Guirado, E., Leach, J. E., Liu, H., & Trivedi, P. (2023). Climate change impacts on plant pathogens, food security and paths forward. *Nature Reviews Microbiology*, 21(10), 640-656.
- [10] [10]Diaz, C. J., Douglas, K. J., Kang, K., Kolarik, A. L., Malinovski, R., Torres-Tiji, Y., ... & Mayfield, S. P. (2023). Developing algae as a sustainable food source. *Frontiers in Nutrition*, 9, 1029841.
- [11] [11]Ometto, F., Quiroga, G., Pšenička, P., Whitton, R., Jefferson, B., & Villa, R. (2014). Impacts of microalgae pre-treatments for improved anaerobic digestion: thermal treatment, thermal hydrolysis, ultrasound and enzymatic hydrolysis. *Water research*, 65, 350-361.
- [12] [12]Babich, O., Sukhikh, S., Larina, V., Kalashnikova, O., Kashirskikh, E., Prosekov, A., ... & Dolganyuk, V. (2022). Algae: Study of edible and biologically active fractions, their properties and applications. *Plants*, 11(6), 780.
- [13] [13]Pereira, L. (2021). Macroalgae. *Encyclopedia*, 1(1), 177-188.
- [14] [14]Elster, J. (2002). Ecological Classification of Terrestrial Algal Communities in Polar Environments: Dedicated to Professor Josef Svoboda on his 70th birthday. *Geoecology of Antarctic ice-free coastal landscapes*, 303-326.
- [15] [15]Ammar, E. E., Aioub, A. A., Elesawy, A. E., Karkour, A. M., Mouhamed, M. S., Amer, A. A., & El-Shershaby, N. A. (2022). Algae as Bio-fertilizers: Between current situation and future prospective. *Saudi Journal of Biological Sciences*, 29(5), 3083-3096.
- [16] [16]Mahapatra, D. M., Chanakya, H. N., Joshi, N. V., Ramachandra, T. V., & Murthy, G. S. (2018). Algae-based biofertilizers: a biorefinery approach. *Microorganisms for Green Revolution: Volume 2: Microbes for Sustainable Agro-ecosystem*, 177-196.
- [17] [17]Abdel-Raouf, N., Al-Homaidan, A. A., & Ibraheem, I. B. M. (2012). Agricultural importance of algae. *African Journal of Biotechnology*, 11(54), 11648-11658.
- [18] [18]Dineshkumar, R., Kumaravel, R., Gopalsamy, J., Sikder, M. N. A., & Sampathkumar, P. (2018). Microalgae as bio-fertilizers for rice growth and seed yield productivity. *Waste and biomass valorization*, 9, 793-800.
- [19] [19]Tuhy, L., Chojnacka, K., Michalak, I., & Witek-Krowiak, A. (2015). Algal extracts as a carrier of micronutrients-utilitarian properties of new formulations. *Marine algae extracts: processes, products, and applications*, 465-488.
- [20] [20]Michalak, I., Chojnacka, K., & Saeid, A. (2017). Plant growth biostimulants, dietary feed supplements and cosmetics formulated with supercritical CO₂ algal extracts. *Molecules*, 22(1), 66.
- [21] [21]Chatterjee, A., Singh, S., Agrawal, C., Yadav, S., Rai, R., & Rai, L. C. (2017). Role of algae as a biofertilizer. In *Algal green chemistry* (pp. 189-200). Elsevier.)
- [22] [22]Mazepa, E., Malburg, B. V., Mógor, G., de Oliveira, A. C., Amatussi, J. O., Corrêa, D. O., ... & Nosedá, M. D. (2021). Plant growth biostimulant activity of the green microalga *Desmodesmus subspicatus*. *Algal Research*, 59, 102434.
- [23] [23]Bulgari, R., Franzoni, G., & Ferrante, A. (2019). Biostimulants application in horticultural crops under abiotic stress conditions. *Agronomy*, 9(6), 306.

- [24] [24]Kapoor, R. V., Wood, E. E., & Llewellyn, C. A. (2021). Algae biostimulants: A critical look at microalgal biostimulants for sustainable agricultural practices. *Biotechnology Advances*, 49, 107754
- [25] [25]Aliyu, O. M., Adeigbe, O. O., & Awopetu, J. A. (2011). Foliar application of the exogenous plant hormones at pre-blooming stage improves flowering and fruiting in cashew (*Anacardium occidentale* L.). *Journal of crop science and biotechnology*, 14, 143-150.
- [26] [26]Choudhary, N., Tripathi, A., Singh, P. K., Parikh, H. S., & Tiwari, A. (2024). Application of algae for enhanced plant growth and food productivity. *Systems Microbiology and Biomanufacturing*, 1-11.
- [27] [27]Lembi CA, Waaland JR. *Algae and Human Affairs*. Cambridge,UK: Cambridge University Press; 1988. 375–70 p
- [28] [28]Lopez-Padron, I., Martinez-Gonzalez, L., Perez-Dominguez, G., Reyes-Guerrero, Y., Nunez-Vazquez, M., & Cabrera-Rodriguez, J. A. (2020). Algae and their uses in agriculture. An update. *Cultivos Tropicales*, 41(2), NA-NA.
- [29] [29]Battacharyya D, Babgohari MZ, Rathor P, Prithiviraj B. Seaweed extracts as biostimulants in horticulture. *Scientia Horticulturae*. 2015; 30(196):39–48. doi:10.1016/j.scienta.2015.09.012
- [30] [30]Abideen, Z., Waqif, H., Munir, N., El-Keblawy, A., Hasnain, M., Radicetti, E., ... & Haider, G. (2022). Algal-mediated nanoparticles, phycochar, and biofertilizers for mitigating abiotic stresses in plants: A review. *Agronomy*, 12(8), 1788..
- [31] [31]Ayaz, M., Li, C. H., Ali, Q., Zhao, W., Chi, Y. K., Shafiq, M., ... & Huang, W. K. (2023). Bacterial and fungal biocontrol agents for plant disease protection: Journey from lab to field, current status, challenges, and global perspectives. *Molecules*, 28(18), 6735.
- [32] [32]Jiménez, E., Dorta, F., Medina, C., Ramírez, A., Ramírez, I., & Peña-Cortés, H. (2011). Anti-phytopathogenic activities of macro-algae extracts. *Marine drugs*, 9(5), 739-756.
- [33] [33]Sultana, V., Baloch, G. N., Ara, J., Ehteshamul-Haque, S., Tariq, R. M., & Athar, M. (2012). Seaweeds as an alternative to chemical pesticides for the management of root diseases of sunflower and tomato. *Journal of Applied Botany and Food Quality*, 84(2), 162.
- [34] [34]Pandit, M. A., Kumar, J., Gulati, S., Bhandari, N., Mehta, P., Katyal, R., ... & Kaur, J. (2022). Major biological control strategies for plant pathogens. *Pathogens*, 11(2), 273.
- [35] [35]Roy, A., Gogoi, N., Yasmin, F., & Farooq, M. (2022). The use of algae for environmental sustainability: trends and future prospects. *Environmental Science and Pollution Research*, 29(27), 40373-40383.
- [36] [36]Chiaiese P., Corrado G., Colla G., Kyriacou M. C., Roupheal Y. (2018). Renewable sources of plant biostimulation: microalgae as a sustainable means to improve crop performance. *Front. Plant Sci*. 871. doi: 10.3389/fpls.2018.01782
- [37] [37]Chanda M., Merghoub N., EL Arroussi H. (2019). Microalgae polysaccharides: the new sustainable bioactive products for the development of plant bio-stimulants? *World Journal of Microbiology and Biotechnology*, 35, 1–10. doi: 10.1007/s11274-019-2745-3
- [38] [38]Ferreira, A., Bastos, C. R., Marques-dos-Santos, C., Acién-Fernandez, F. G., & Gouveia, L. (2023). Algaeculture for agriculture: from past to future. *Frontiers in Agronomy*, 5, 1064041
- [39] [39]Burketova, L., Trda, L., Ott, P. G., & Valentova, O. (2015). Bio-based resistance inducers for sustainable plant protection against pathogens. *Biotechnology advances*, 33(6), 994-1004.
- [40] [40]Berthon, J. Y., Michel, T., Wauquier, A., Joly, P., Gerbore, J., & Filaire, E. (2021). Seaweed and microalgae as major actors of blue biotechnology to achieve plant stimulation and pest and pathogen biocontrol—a review of the latest advances and future prospects. *The Journal of Agricultural Science*, 159(7-8), 523-534.
- [41] [40]Hernández-Herrera, R. M., Gómez-Leyva, J. F., Sánchez-Hernández, C. V., Ocampo-Álvarez, H., Ramírez-Romero, R., & Palmeros-Suárez, P. A. (2024). Seaweed extract ameliorates salt stress in tomato plants by enhancing the antioxidant system and expression of stress-responsive genes. *Journal of Applied Phycology*, 1-14.
- [42] [41]Kumari, S., Sehrawat, K. D., Phogat, D., Sehrawat, A. R., Chaudhary, R., Sushkova, S. N., ... & Shende, S. S. (2023). *Ascophyllum nodosum* (L.) Le Jolis, a pivotal biostimulant toward sustainable agriculture: A comprehensive review. *Agriculture*, 13(6), 1179.
- [43] [42]Villa e Vila, V., Rezende, R., Marques, P. A. A., Wenneck, G. S., Nocchi, R. C. D. F., Terassi, D. D. S., ... & Matumoto-Pintro, P. T. (2023). Seaweed extract of *Ascophyllum nodosum* applied in tomato crop as a biostimulant for improving growth, yield and soil fertility in subtropical condition. *Journal of Applied Phycology*, 35(5), 2531-2541.
- [44] [43]Ali, O., Ramsubhag, A., & Jayaraman, J. (2023). Application of extracts from Caribbean seaweeds improves plant growth and yields and increases disease resistance in tomato and sweet pepper plants. *Phytoparasitica*, 51(4), 727-745

- [45] [44]Karkhane, M., Lashgarian, H. E., Mirzaei, S. Z., Ghaffarizadeh, A., Sepahvand, A., & Marzban, A. (2020). Antifungal, antioxidant and photocatalytic activities of zinc nanoparticles synthesized by *Sargassum vulgare* extract. *Biocatalysis and Agricultural Biotechnology*, 29, 101791
- [46] [45] Ramya, S. S., Vijayanand, N., & Rathinavel, S. (2015). Foliar application of liquid biofertilizer of brown alga *Stoechospermum marginatum* on growth, biochemical and yield of *Solanum melongena*. *International Journal of Recycling of Organic Waste in Agriculture*, 4, 167-173.
- [47] [46]Amin, H. H. (2020). Biosynthesized silver nanoparticles using *Ulva lactuca* as a safe synthetic pesticide (in vitro). *Open Agriculture*, 5(1), 291-299.
- [48] [47] Paulert, R., Ascrizzi, R., Malatesta, S., Berni, P., Nosedà, M. D., Mazetto de Carvalho, M., ... & Pistelli, L. (2021). *Ulva intestinalis* extract acts as biostimulant and modulates metabolites and hormone balance in basil (*Ocimum basilicum* L.) and parsley (*Petroselinum crispum* L.). *Plants*, 10(7), 1391.
- [49] [48]González-Castro, A. L., Rojas-Contreras, M., Romero-Bastidas, M., Águila-Ramírez, R. N., Rangel-Dávalos, C., & Arce-Amezquita, P. M. (2024). Evaluation of Baja Peninsula seaweeds against plant pathogens.
- [50] [49]Park, Y. J., Park, J. E., Truong, T. Q., Koo, S. Y., Choi, J. H., & Kim, S. M. (2022). Effect of *Chlorella vulgaris* on the growth and phytochemical contents of “Red Russian” kale (*Brassica napus* var. *Pabularia*). *Agronomy*, 12(9), 2138.
- [51] [50]Navarro-López, E., Ruíz-Nieto, A., Ferreira, A., Acién, F. G., & Gouveia, L. (2020). Biostimulant potential of *Scenedesmus obliquus* grown in brewery wastewater. *Molecules*, 25(3), 664.



VIII. International Symposium-2024

THE EMISSION OF NITRIC OXIDE AND CARBON DIOXIDE FROM CULTIVATED SOIL

Abdousalam AHMED. ALGAIDI¹, Hosam E.A.F. BAYOUMI HAMODA²,
Ibrahim ISSA³, Yosof SALEH HAMID⁴

¹Department of Microbiology, Faculty of Science, Sabha University, Sabha, Libya,
algaidiaa@yahoo.com

²Óbuda University, Rejtő Sándor Faculty of Light industry and Environmental Protection Engineering,
Institute of Environmental Engineering and Natural Sciences, Budapest, Hungary
bayoumi.hosam@uni-obuda.hu

³Department of Soil Science, Faculty of Agriculture, Sirte University, Sirte Libya,
ibrahim.issaa@su.edu.ly

⁴Department of Soil Science, Faculty of Agriculture, Tripoli University, Tripoli, Libya,
Jandoba2002@yahoo.com

Abstract

A microcosm experiment was carried out using slightly arable soil samples with a low humus content to identify NO and CO₂ emissions under the stressors of varying concentrations of two heavy metals, lead, and cadmium, in the cultivated soil. At a temperature of 15°C the experiment was conducted in glass vessels using homogenized soil samples. Four subsamples were prepared with maize plant residue, KNO₃, or both. Pb (CH₃COO)₂·3H₂O and CdCl₂ concentrations were added to soil samples, contaminating them with 2.5H₂O at 6, 12, and 24 mg Cd kg⁻¹ soil. CO₂ concentrations were found using a Thermal Conductivity Detector and Electron Capture Detector. Gas content was analysed daily, and one-point linear calibration and an external standard were used for the measurements. It has been demonstrated that carbon dioxide concentrations fluctuate more with time than nitrogen oxide concentrations. Gas emissions were inhibited by heavy metals, and soil microcosms revealed that lead (Pb) inhibits NO emission more than (Cd). A greater accumulation of NO and CO₂ was seen when comparing the outcomes of the microcosm assessment with the production of NO and CO₂ resulting from inorganic N fertilizers applied at similar doses in the field and greenhouse experiment. Based on this study, the concentration of NO and CO₂ in gas samples significantly depends on the proportion of nitrogen and carbon in the soil. The mini-experiment method that was conducted is appropriate for achieving the stated objective of this paper.

Keywords: NO and CO₂ emission; cultivated soil; heavy metal; temperature; microcosm experiment.

INTRODUCTION

Agricultural activities are one of the major sources of nitric gases and carbon dioxide emitted from soil, as a result of the excessive use or misuse of nitrogen fertilizers, as well as agricultural practices that lead to an increase in the percentage of carbon or NO_3 , and an increase in the rate of photosynthesis in plants resulting from increased levels of atmospheric carbon dioxide.

The observed emissions of nitrous oxide (N_2O), nitric oxide (NO), and carbon dioxide (CO_2) are the result of two counteracting phenomena: production and consumption by soil (Duxbury et al., 1993). Firestone and Davidson, 1989, stated that N_2O and NO are produced predominantly by microbial processes, as by-products of nitrification and products of denitrification.

The balance between these processes varies with climate, soil conditions, and soil management (Skiba and Smith, 2000). Nitric Oxide (NO) is a highly reactive trace gas that affects atmospheric chemistry and air quality, although forest soils are recognized as an important source of atmospheric NO , there are significant uncertainties in global inventories of NO emissions in forest soils (Kai Huang et al, 2022), also nitrification, a vital process driving NO production in agricultural soils, is generally considered a two-step process that consists of ammonia oxidation catalysed by ammonia-oxidizing archaea or bacteria, and subsequent nitrite oxidation catalysed by nitrite-oxidizing bacteria recently, it was also discovered that the process can be performed in a one-step procedure by *Nitrospira* (Beeckman et al., 2018) highly reactive gas, nitric oxide (NO) affects atmospheric chemistry and air quality it can also interact with stratospheric ozone and indirectly promote global warming and soil is one of the main sources to tropospheric NO emission ranged (IPCC, 2021), fossil fuel combustion by power plants, industrial activities, transportation and residential energy use sectors leads to the emission of nitrogen oxides ($\text{NO}_x = \text{NO} + \text{NO}_2$) as well as carbon dioxide (CO_2), traditional bottom-up NO_x and CO_2 emission estimates have a time lag of several years because it takes time to access and compile accurate information on energy consumption and emission factors (F. Liu et al., 2020), carbon mineralization is used to determine the effect of various organic and inorganic materials on soil functions. Chemical, physical, and biological changes cause mineralization of soil organic matter, and increased carbon dioxide emissions cause mineralization of soil organic matter (Van Gestel et al. 1991), which represents about 60% of the total greenhouse effect (Rastogi et al. 2002). Although vegetation and soil act as a sink and storage for carbon dioxide in the air (Franzluebbers and Doraiswamy 2007), CO_2 production is a natural last step in the mineralization of organic matter, which returns carbon originally fixed by photosynthesis to the atmosphere aerial. Production of nitric oxide can be during through nitrogen conversion processes in the soil, but in most cases, it is considered denitrification and nitrification are the main sources in the soil, several processes are considered to be responsible for Nitric Oxide production, including autotrophic, and heterotrophic nitrification, dissimilatory reduction of NO_2^- to NH_4^+ , denitrification, other reducing biological processes by common bacteria not typically defined as denitrifies and non-biological reactions, these processes cover a wide range of metabolisms, from autotrophic to heterotrophic, from oxidative to reductive, thus different forms of nitrogen can have several different effects on nitrogen transformations in the soil and nitric oxide emissions as they kinds of soil microorganisms, denitrification of nitrate and nitrite is generally considered as the dominant source of NO in heavy textured soils.

The microbial reduction of NO_3^- to NO_2^- and then to gaseous NO and N_2 called enzymatic denitrification because each step of the process is governed by specific reductase enzymes, most denitrification is accomplished by heterotrophic bacteria which require complex organic compounds of nitrogen and carbon for metabolic synthesis, besides carbon availability pH, temperature, soil water content, characteristics, fertilization, crop species etc. influence denitrification Huang et al (2004) experienced a correlation between the NO and CO_2 emissions and the dissolved organic C concentration of soil, and C:N ratio of different plant residues. The residue type is thought to be an important factor affecting NO emissions as well (Shelp et al. 2000). Denitrifying bacteria are a diverse group of bacteria that include many different phyla. This group of bacteria can perform denitrification as part of the nitrogen cycle. Denitrification is performed by a variety of denitrifying bacteria that are widely distributed in soil metabolize nitrogenous compounds using various enzymes, and convert NO_x to nitrogen gas turning nitrogen oxides back to nitrogen gas (N_2) or nitrous oxide (N_2O). This study aimed to detect the NO and

CO₂ emission under the stresses of different concentrations of cadmium and lead of the cultivated soil at low incubation temperature (15°C) and low soil moisture regime (30% WFPS).

MATERIALS AND METHODS

The soil samples were collected from the cultivated soil, the most important physical and chemical properties of the soil are pH (KCl) 7, total salt content 0.054%, humus 1.48%, total organic C 1.08 %, total N 0.08 %, NH₄⁺-N 0.53 mg 100g⁻¹, NO₃⁻-N 0.18 mg 100g⁻¹, the soil was dried after collecting the samples under room temperature and before the initial soil analysis, the specific properties of the soil that were used in the experiment are presented, which was the use of a slightly arable soil sample of low humus content in the experiment, the microcosm experiment was conducted in glass vessels of 1200 cm³ containing 200 g of homogenized (<2 mm) soil and covered by silicon-septa, the soil samples at 30% of water holding capacity were contaminated by the addition of different, doses of Pb (CH₃COO)₂.3H₂O at 40, 80 and 160 mg Pb kg⁻¹ soil and Cd Cl₂.2.5H₂O at 6, 12 and 24 mg Cd kg⁻¹ soil, the vessels incubated in a laboratory thermostat at 15°C for 32 days. Electron Capture Detector (ECD) and Thermal Conductivity Detector (TCD) detected CO₂ concentrations, respectively. The separated gas content was analyzed three times per day whenever measurements were carried out using external standards and one-point linear calibration. The NO gas emission was detected by the chemiluminescent detector (Model 7050 analyzer of ANTEK Instruments L.P., USA) which is specifically designed for the analysis of NO in samples. The most important characteristics of GC and NO measurements can be shown in Tables 1 and 2, respectively.

Table 1. The most important characteristics of GC

GC analysis of gas samples	HP 5980 Series II type gas chromatograph	
Analysed gases	CO ₂	
Carrier gases and flow rates	He: 27ml/min	
Temperature of Injector	70°C	
Columns (temperature of oven is 50 °C)	Porapak Q (80/100 mesh, 6ft)	
Detectors (temperature)	TCD (150°C)	
Calibration	External standard	
Calibration gas mixture contains	9.7 v/v% CO ₂	
Evaluation of chromatograms	HP 3390 Ser. II integrator, HP CHEM	

Table 2. The most important characteristics of NO analyser

NO-analysis of gas samples	Antek 7050 Nitric oxide analyser	
Analysed gas	NO	
Carrier gas	He	
Gas for ozone generation	O ₂	
Temperature of photomultiplier	5°C	
Detector	chemiluminescent	
Calibration gas mixture contains	1ppm NO	
Evaluation of peak areas	HP 3390 Ser. II integrator, HP CHEM	

RESULTS AND DISCUSSION

As shown in Figure 1. The amount of emissions rate of NO, when soil samples were contaminated with 6, 12, and 24 mg Cd kg⁻¹ soil, illustrates that the amount (emission rate) of NO in heavy metal-free (control) soil microcosms was increased up to the 6th day of incubation, and then gradually significantly decreased by increasing the incubation time. Also, it was observed that the rate of NO emissions was inversely proportional to the Cd concentration applied to the soil samples. The maximum emission of the NO was on the 4th day and then significantly decreased by increasing the incubation time up to the 32nd day. The emission of gas at the lowest Cd concentration was significantly different from the

emission of the gas at the other two concentrations. On the 32nd day of incubation, the amount of gas emissions was reduced by 73, 82, 88, and 95%, respectively with the soil-contaminated doses (6, 12, and 24 mg Cd kg⁻¹).

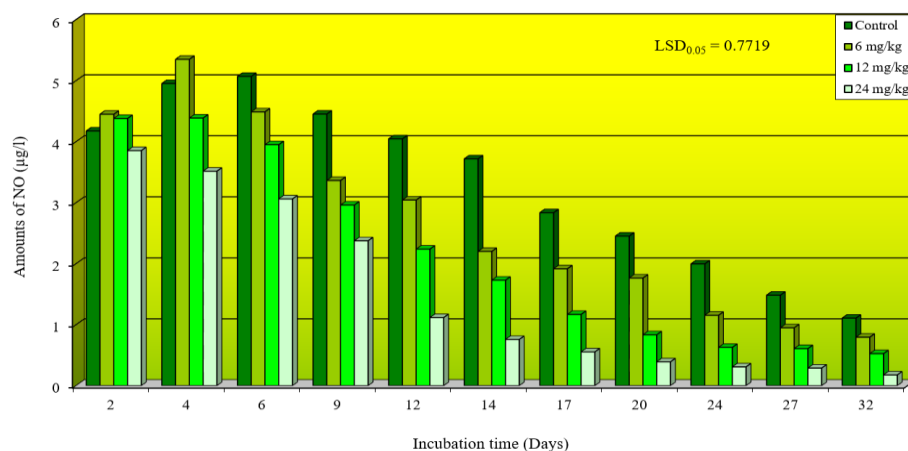


Fig. 1. Nitric oxide amounts detected in microcosm containing cultivated soil of 30% WFPS treated with different concentrations of Cd and incubated at 15°C

The treatment of Pb at different concentrations (figure 2) showed the amount emissions rate of NO when soil samples contaminated with 40, 80 and 160 mg Pb kg⁻¹ soil, and after two days of incubation, the detection NO amounts in the microcosms of control soil samples while the detected amounts demonstrate that the amount of detected NO in control microcosms was increased by increasing the incubation time up to the 14th day and it started to decrease gradually to at the 32nd day of incubation. The results showed that the amount of NO in the soil contaminated with 40 mg Pb kg⁻¹ soil was on the 2nd day of incubation and followed by a gradual reduction in the emissions to be at a minimum on the 32nd day of incubation. Also, the amounts of gas detected in the microcosms contaminated by 80 mg Pb kg⁻¹ soil were higher than those detected in microcosms of soil contaminated by 160 mg Pb kg⁻¹ soil and lesser than those contaminated by 40 mg Pb kg⁻¹ soil.

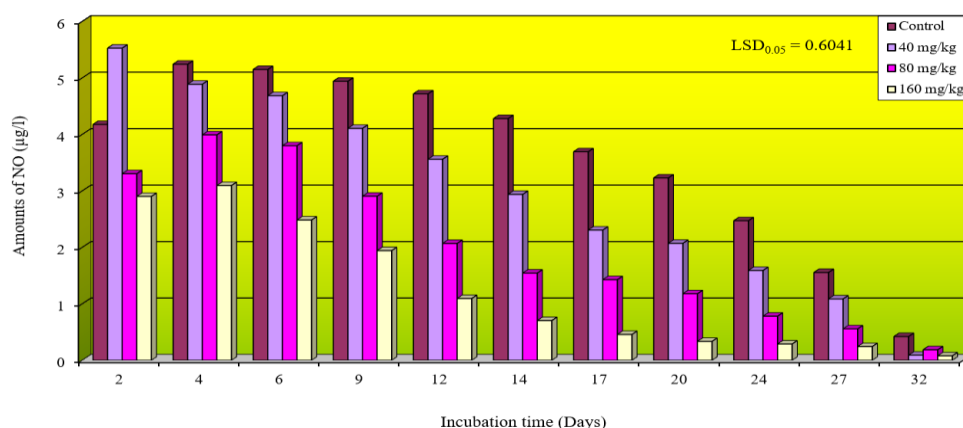


Fig. 2 Nitric oxide amounts detected in microcosm containing cultivated soil of 30% WFPS treated with different concentrations of Pb and incubated at 15°C

CO₂ emission treated with different concentrations of Cd is shown in Figure 3. In the case of Cd contamination, the amount of CO₂ emitted from the microcosms of soil samples contaminated by 6, 12,

and 24 mg Cd kg⁻¹ soil. It was found that the maximum emission rate of the gas was detected at 20th day of incubation from heavy metal-free soil (control soil). There are gradual increases in the emission rates up to the 20th day of incubation and then started to decrease to the end of the detection time at 32nd day of the incubation. Also, it was found that the emission rates of the gas were increased by increasing the contamination doses up to 12 mg Cd and decreased in microcosms of contaminated soil samples with 24 mg Cd kg⁻¹

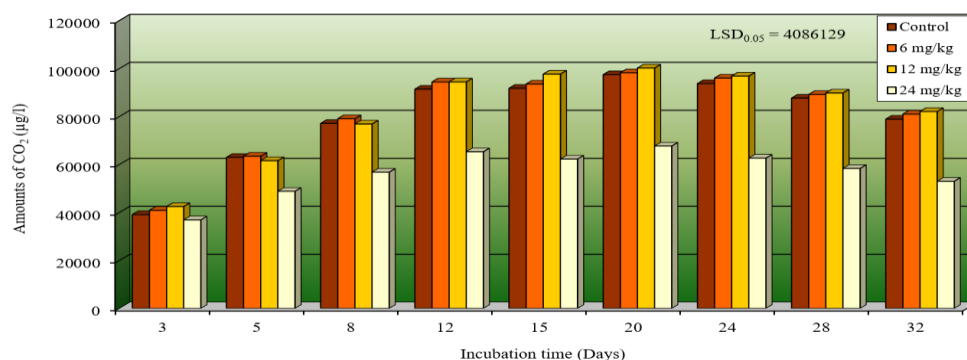


Fig. 3 Carbon dioxide amounts detected in microcosm containing cultivated soil of 30% WFPS treated with different concentrations of Cd and incubated at 15°C

The results shown in Figure 4. Illustrates CO₂ emission and the Pb contamination was found where the gas emission increased with incubation time and gave maximum emission rates of CO₂ at 12 days incubation and then decreased. However, the results of the microcosms of soil samples demonstrate the detected amounts of CO₂ detected during 32 days of incubation. It was found that maximum emission rates were at the 20th day of incubation in Pb-free control microcosms and the 12th day of incubation under the effects of 40, 80, and 160 mg Pb kg⁻¹ soil.

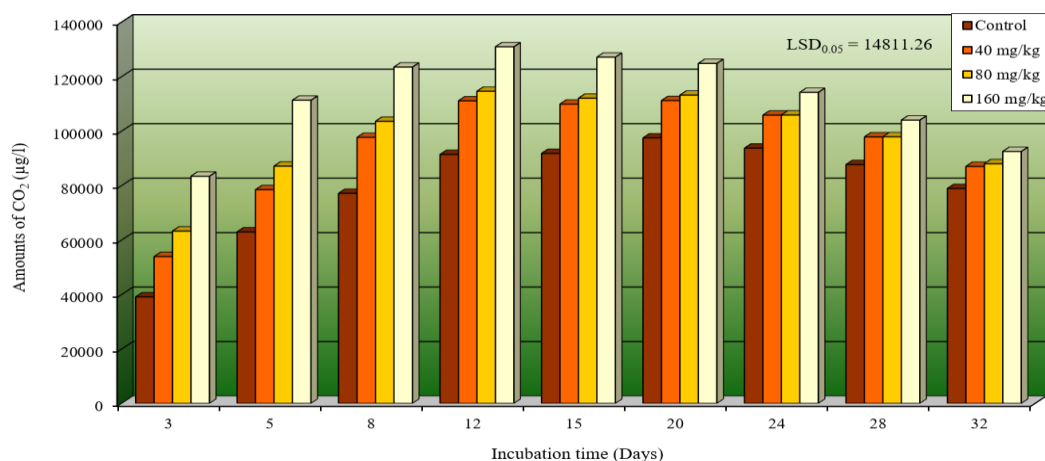


Fig. 4. Carbon dioxide amounts detected in microcosm containing cultivated soil of 30% WFPS treated with different concentrations of Pb and incubated at 15°C

CONCLUSION

The study results showed that soil atmospheric CO₂ concentrations are more variable over time than NO concentrations. Lead and cadmium acted as inhibitors of gas emission, Pb is more inhibited NO emission than Cd. Comparing the results of the microcosm experiments with the production of NO and CO₂ arising from inorganic N fertilizers applied at similar doses in the field and greenhouse experiments, a higher accumulation of NO and CO₂ was recorded. The soil characteristics (e.g., soil pH, organic and inorganic contents, etc.) could be the main component for gas emissions under the investigated ecological factors. The experiment method proved to be suitable for estimating the emission of NO and CO₂ from cultivated soil.

REFERENCES

- [1] Chang C., Cho C.M., Janzen H.H.: Nitrous oxide emission from long-term manured soils. *Soil Sci. Soc. Am. J.* (1998); 62: 677-682.
- [2] Clemens J., Schillinger M.P., Goldbach H., Huwe B.: Spatial variability of N₂O emissions and soil parameters of an arable silt loam a field study. *Biol. Fert. Soils.* (1999); 28: 403-406.
- [3] Groffman P.M., Tiedje J.M.: Relationships between denitrification, CO₂ production and air-filled porosity in soils of different texture and drainage. *Soil Biol. Biochem.* (1991); 23: 299-302.
- [4] Beeckman F., Motte H., and Beeckman T.: Nitrification in agricultural soils: impact, actors and mitigation. *Curr. Opin. Biotechnol.* (2018); 50: 166–173.
- [5] Huang K, Chenxia S, Dongwei L, Yihang D, Ronghua K, Haoming Y, Yuqi L, Xue L, Geshe A.G, Zhi Q, Jesper R.C, Weixing Z, Yunting F: A strong temperature dependence of soil nitric oxide emissions from a temperate forest in Northeast China. *Agricultural and Forest Metrology.* (2022); V 323, Article 109035.
- [6] Huang Y., Zou J., Zheng X., Wang Y., Xu X.: Nitrous oxide emissions as influenced by amendment of plant residues with different C:N ratios. *Soil Biol. Biochem.* (2004); 36: 973-981.
- [7] Jackson L.E., Stivers L.J., Warden B.T., Tanji K.K.: Crop nitrogen utilization and soil nitrate loss in a lettuce field. *Fert. Res.* (1994); 37: 93-105.
- [8] de Klein C.A.M., van Logtestijn R.S.P.: Denitrification in grassland soils in the Netherlands in relation to irrigation, N-application rate, soil water content and soil temperature. *Soil Biol. Biochem.* (1996); 28: 231-237.
- [9] Linzmeier W., Gutser R., Schmidhalter U.: Nitrous oxide emission from soil and from a nitrogen-15-labelled fertilizer with new nitrification inhibitor 3,4-dimethylpyrazole phosphate (DMPP). *Biol. Fertil. Soils.* (2001); 34: 103-108.
- [10] Liu, F., Duncan, B. N., Krotkov, N. A., Lamsal, L. N., Beirle, S., Griffin, D., McLinden, C. A., Goldberg, D. L., and Lu, Z.: A methodology to constrain carbon dioxide emissions from coal-fired power plants using satellite observations of co-emitted nitrogen dioxide, *Atmos. Chem Phys.* (2020); 20: 99-116.
- [11] IPCC, 2001: Climate Change: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the governmental Panel on Climate Change [Houghton, J.T., et al. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. (2001); 881 pp.
- [12] MacKenzie A.F., Fan M.X., Cadrin F.: Nitrous oxide emission in three years as affected by tillage, corn, soybean, alfalfa rotations, and nitrogen fertilization. *J. Environ. Qual.* (1998); 27: 698-703.
- [13] Németh T., Abd-El-Galil A., Radimsky L., Baczó Gy.: Effect of plant residues on ammonium and nitrate content of soils during incubation. In: Van Cleemput O., Hofman G., Vermoesen A. (Eds.), *Progress in Nitrogen Cycling Studies*, Kluwer, London. (1996); pp. 109-118.
- [14] Shelp M.L., Beauchamp E.G., Thurell G.W.: Nitrous oxide emissions from soil amended with glucose, alfalfa, or corn residues. *Commun. Soil Sci. Plant An.* (2000); 31: 877-892.

- [15] Simek M., Elhottová D., Klimec F., Hopkins D.W.: Emissions of N₂O and CO₂, denitrification measurements and soil properties in red clover and ryegrass stands. *Soil Biol. Biochem.* (2006); 36: 9-21.
- [16] Weier K.L., Doran J.W., Power J.F., Walters D.T.: Denitrification and dinitrogen/nitrous oxide ratio as affected by soil water, available carbon, and nitrate. *Soil Sci. Soc. Am. J.* (1993); 57: 66-72.
- [17] Duxbury, J. M., L. A. Harper, and A. R. Mosier, Contribution of agroecosystems to global climate change, in *Agricultural Ecosystems Effects on Trace Gases and Global Climate Change*, Spec. Publ. (1993); 55, pp. 1-18, Am. Soc. of Agron., Madison, Wis.,
- [18] Firestone, M. K., and Davidson, E. A. Microbiological basis of NO and N₂O production and consumption in soil. (1989); 7–21.
- [19] Skiba, U, Smith, K.A. The control of nitrous oxide emissions from agricultural and natural soils. *Chemosphere.* (2000); 2: 379-386.



VIII. International Symposium-2024

FAUNISTICS AND TAXONOMIC STUDY OF SPIDER (ARACHNIDA: ARANEAE) FAUNA IN DISTRICT BATTAGRAM KP, PAKISTAN

Izhar ULLAH^{*}, Shabir AHMAD, Sardar Azhar MAHMOOD, Said Nawaz KHAN, Asifa KHAN, Mohammad YOUSAF

Department of Zoology, Hazara University Mansehra, Pakistan

Abstract

*The current study investigated spiders (Arachnida: Araneae) Fauna in the Battagram District from March to November of 2022. All around up to 900 spider specimens were collected by using a variety of methods, such as the use of bark pitfall traps, ground pitfall traps, cryptic searching, aerial hand collection, ground hand collection, vegetation beating, and white beating sheets from 31 locations throughout the research area, and then were kept in 70% ethanol, and were then classified into 15 families, 41 genera, and 53 species using taxonomic keys of (Tikader, 1987;) and online keys on <http://araneae.nmbc.ch/>; Ali, 2017. The families that have been confirmed are Agelenidae, Araneidae, Corinnidae, Gnaphosidae, Idiopidae, Lycosidae, Pisauridae, Salticidae, Sparassidae, Palpimanidae, Pholcidae, Tetragnathidae, Theridiidae, Thomisidae, Oxyopidae. From the research area, all species have been discovered for the first time; however, *Aculepeira carbonaria*, *Agelena orientalis*, *Allagelena gracilis*, *Araniella inconspicua*, *Agalenatea redii*, *Araniella proxima*, *Araneus angulatus*, *Araniella opisthographa*, *Bassaniodes bufo*, *Cambalida flavipes*, *Drassyllus lutetianus*, , *Gnaphosa leporina*, *Histoipona torpida*, *Heriaeus simoni*, *Langona aperta*, *Palpimanus gibbulus*, *Parasyrisca schenkeli*, *Pardosa bifasciata*, *Pisaura mirabilis*, *Tegenaria lapicidinarum*, *Tegenaria silvestris*, *Thyene calebi*, *Xysticus bifasciatus* and *Xysticus ferrugineus*, for the first time from Pakistan. The Araneidae family was the most prevalent family with 13 species classified under 9 genera; the least number of species reported belonged to the Palpimanidae, Pisauridae, and Theridiidae families. Further investigation into the spider fauna of Battagram could potentially commence from the current study.*

Keywords: Arachnida, Araneae, Taxonomy, Fauna, Spider, Battagram.

INTRODUCTION

Pakistan is mostly an agricultural country with a diverse range of fauna. A large portion of the land is utilized for the cultivation of different crops, which provide as home for different kinds of invertebrates. The spider is one of the more prominent members of the community among them, although historically it has received less attention from scientists who view it as a minor organism (Abida Butt & Beg, 2001); (Perveen et al., 2012). Members of the Araneae order of arachnids are referred to as "spiders" (Arthropoda: Chelicerata: Arachnida) (R. Singh, 2022). Spiders are found all over the world and are

very competent at adjusting to any kind of natural setting, with the exception of the open sea and the air (Subedi et al., 2022). After one order of arachnids (Acari) and the five major orders of insects (Coleoptera, Diptera, Hymenoptera, Hemiptera, and Lepidoptera), Araneae ranks seventh in terms of species diversity (Sharma et al., 2020) containing 4,265 genera, 132 families, and 50,220 species (R. Singh, 2022). Approximately forty spider species are poisonous and can fatal to humans (Platnick, 2006). Spiders also differ widely in form; some have extended, cylindrical rear ends, while others have very rounded, ball-like abdomens (Borowiec, 2022). Theridiosomatidae (Araneae: Araneoidea) is a family of tiny spiders (body length, 0.5–3 mm) (Suzuki et al., 2022). They undergo ecdysis (molting) to complete their metamorphosis (Sajid et al., 2021a). Researchers are looking at the chemical makeup of silk and spider venom (Oldrati et al., 2017). These findings could have implications for biomaterials, (Vollrath and Knight, 2001), pharmaceuticals (Herzig et al., 2020) and technologies (Hajian et al., 2024); (Moradmand and Yousefi, 2022). Spider lifespans range from two years to twenty years. Male spiders have a shorter lifespan than female spiders. Male spiders mature between a year and two after birth, and they face death after mating (Ghar et al., 2022). A female's egg sac can hold from several hundred to a thousand eggs, each of which contains a hatchling that is protected from temperature fluctuations, parasitoids, predators, and parasitic parasites (Ewunkem & Agee, 2022). Spiders have a significant economic worth. Being primarily entomophagous predators, they not only serve as efficient bio-indicators of various environments but also manage insect populations in agroecosystems and the wild (Tiwari & Singh, 2021) ; (Tikader, 1987) ; (Raju et al., 2021). In the food chain, spiders are an essential link (Dubey et al., 2021). The silk, venom, and hemolymph of spiders are useful materials for pharmaceutical research, biological engineering, and medical treatment (Lia et al., 2022). Communities of species-rich spiders can control the density of prey (Palaspagar, 2022). In spite of these proclaimed values, very little attention has been paid to spider conservation (Molur, Siliwal, & Daniel, 2008) (G. Singh & Singh, 2021). In addition, by describing new species, changing their status, and making other nomenclatural choices, researchers are advancing our understanding of spider taxonomy.

MATERIALS AND METHODS

Study Area

The current investigation was carried out in Battagram District. Battagram, which has a total surface area of 1,301 Km², is situated in the western region of Khyber Pakhtunkhwa, Pakistan, between 34° 33' and 34° 47' N and 72° 54' and 73° 15' E. (Haq, 2012). Battagram is home to lush forest peaks with elevations ranging from 525 meters at Thakot to more than 4690 meters at Sukaisar (HAQ¹, AHMAD, & ALAM, 2011). It is bounded to the east by the Mansehra district, to the south by the Torghar district, to the west by the Shangla district, and to the north by the Kohistan district (Ahmad et al., 2020). Climates ranging from subtropical to "alpine" are covered by the intricate ecology. Battagram is a place of flourishing agriculture, wilderness, woodlands, and grasslands (Bibi et al., 2021). The well-known Western Himalayan Moist Temperate Ecology states that District Battagram's vegetation zones fall under the moist temperate category (Haq, Ahmad, & Alam, 2011).

Collection of Spiders

Spider specimens were collected from March to November from 31 different locations in the District of Battagram, which included hills, marshy areas, fields, land, subsurface, structures, vegetation, dry timber, valleys, and flat areas and methods include:

- ❖ Ground Pitfall trap
- ❖ Bark Pitfall Trap
- ❖ Cryptic searching
- ❖ Ground hand collection
- ❖ Aerial hand collection
- ❖ White Beating Sheet



Figure 1: White Beating Sheet



Figure 2: Bark Pitfall Trap

Specimens Preservation

The collected spiders were stored in separate vials with 70% ethanol. Each specimen's specific information was written on its corresponding tube. These could contain the time, date, and location of the collection. Additionally, several significant specimens were kept in 100% ethanol for use in molecular research.

Identification of Spiders

Under a stereo microscope, spiders belonging to 15 families, 41 genera, and 53 species were identified using taxonomic keys of Tikder (1987) and online Keys at (<http://araneae.nmbc.ch>; Ali, 2017).

Results and Discussion

The purpose of the current study was to determine the diversity of spiders in different habitats in District Battagram, KP, Pakistan. The investigation identified 53 species, 41 genera, and 15 families within the Araneae order. All the species are documented for the first time from research area while *Gnaphosa leporina*, *Tegenaria lapicidinarum*, *Allagelena gracilens*, *Thyene calebi*, *Pisaura mirabilis*, *Pardosa bifasciata*, *Aculepeira carbonaria*, *Tegenaria silvestris*, *Araniella proxima*, *Drassyllus lutetianus*, *Araniella opisthographa*, *Xysticus ferrugineus*, *Histopona torpida*, *Langona aperta*, *Cambalida flavipes*, *Araniella inconspicua*, *Palpimanus gibbulus*, *Cambalida flavipes*, *Agalenatea redii*, *Parasyrisca schenkeli*, *Xysticus bifasciatus*, *Agelena orientalis*, *Heriaeus simoni*, *Pisaura mirabilis*, *Bassaniodes bufo* and *Araneus angulatus*, for the first time from Pakistan.

Taxonomy

Family: Agelenidae (Funnel web- or Cobweb spiders) (C. L. Koch, 1837)

***Tegenaria lapicidarum* (Spassky, 1934)**

Material examined: Gangwal 6♂ and 2♀, 34.821102N, 73.156448E, 1849m a.s.l. Gallai Medan 2♂ and 2♀, 34.861039N, 73.194125E, 2806m a.s.l. 18-vii-22.

Global Distribution: Russia (Europe), Ukraine (WSC, 2024).

Comments/Remarks: There are no prior records of this species from Pakistan. Current research has verified its presence in the country's northernmost region.

***Tegenaria silvestris* (L. Koch, 1872)**

Material Examined: Parra 4♂ and 1♀, 34.925595N, 73.06408E, 2200m a.s.l. Baba Zangal 3♂ and 1♀, 34.925308N, 73.06867E, 2420m a.s.l. 13-vi-22. Meeran Hills 1♂, 34.584339N, 72.994E, 1711m a.s.l. 03-ix-22.

Global Distribution: Europe (WSC, 2024) and new to Pakistan.

Comments/Remarks: There have never been any reports of *Tegenaria silvestris* from Pakistan. The study area and Pakistan were the first places where this particular species was discovered.

***Histopona torpida* (C. L. Koch, 1837)**

Material Examined: Baba Zangal 3♂, 34.925308N, 73.06867E, 2420m a.s.l. 13-vi-22.

Global Distribution: Caucasus, Europe (WSC, 2024) and new to Pakistan.

Comments/Remarks: Prior records of *Histopona torpida* from Pakistan are nonexistent. Pakistan and the research area were the first places where the species was discovered.

***Allagelena gracilens* (C. L. Koch, 1841)**

Material Examined: Gangwal 3♂ and 2♀, 34.821102N, 73.156448E, 1849m a.s.l. 18-vii-22. Nogram 2♀, 34.821579N, 73.097748E. 21-vii-22. Ajpora 3♂ and 1♀, 34.589055N, 73.038963E, 1449m a.s.l. 13-viii-22. Meeran Hills 1♂ and 1♀. 34.584339N, 72.994E, 1711m a.s.l. 03-ix-22.

Global Distribution: Central Asia to Europe (WSC, 2024) and new to Pakistan.

Comments/Remarks: There was no data about the targeted species in Pakistan.

***Agelena orientalis* (C. L. Koch, 1837)**

Material Examined: Biland Kot 2♂, 34.58658N, 72.956903E, 1909m a.s.l. 12-iv-22. Manser 1♂ and 4♀. 34.653088N, 72.963237E, 1475m a.s.l. 07-v-22.

Global Distribution: Iran, Iraq and Italy to Central Asia (WSC, 2024), and new to Pakistan.

Comments/Remarks: On the Pakistani *Agelena orientalis*, no information was discovered.

Family: Araneidae (Orbweb spiders) (Clerck, 1757)

***Araniella nympha* (Simon, 1889)**

Material Examined: Kuzabanda 3♂ and 2♀, 34.63301N, 73.008243E, 1169m a.s.l. 07-iii-22. Matta Torkhail, 1♂, 34.622718N, 73.002446E, 1220m a.s.l. 17-iii-22. Gijbori 1♂ and 3♀, 34.654325N, 72.976635E, 1277m a.s.l. 09-v-22. Pashto 9♂ and 3♀, 34.910452N, 73.043002E, 1792m a.s.l. 09-vi-22. Kandao Paiza 3♂ and 4♀, 34.834987N, 73.04479 E, 1463m a.s.l. 10-vi-22. Jab Khwar 1♂ and 1♀, 34.904715N, 73.047527E, 1667m a.s.l. 12-vi-22. Dheri Mashakhail 1♂ and 1♀, 34.677767N, 72.968732E, 1552m a.s.l. 02-x-22. Izhar Ullah and Akhtar Ali.

Global Distribution: China, Pakistan, India (WSC, 2024).

Comments/Remarks: (Dyal, 1935) reported this species from Lahore and (Qadir, 1997) recorded it from Sialkot and (Mukhtar, 2004) reported it from different localities i.e. Gujranwala, Lahore and Kasur.

***Araniella opisthographa* (Kulczyński, 1905)**

Material Examined: Peerhari 4♂ and 2♀, 34.614692N, 72.963449E, 1585m a.s.l. 16-iv-22. Battagram 1♂, 34.67809N, 73.02416E, 1036m a.s.l. 26-iv-22. Bartonay 3♂ and 1♀, 34.682625N, 72.948424E. 17-v-22.

Global Distribution: Turkey, Caucasus, Europe, Russia (Europe) to Central Asia, Iran, (WSC, 2024) and new to Pakistan.

Comments/Remarks: This species has never been reported from Pakistan before.

***Araniella proxima* (Kulczyński, 1885)**

Material Examined: Shabora 4♂, 34.640558N, 73.02433E, 1711m a.s.l. 12-iii-22. Paimal 1♂, 34.742278N, 72.998298E. 18-v-22.

Global Distribution: Turkey, Europe, North America, Kazakhstan, Russia, (Europe to Far East), (WSC, 2024) and new to Pakistan.

Comments/Remarks: There were no records of the concerned species in Pakistan.

Araniella inconspicua (Simon, 1874)

Material Examined: Manser 5♂ and 1♀, 34.653088N, 72.963237E, 1475m a.s.l. 07-v-22. Pokal 1♂ and 1♀, 34.814791N, 73.071696E. 15-vii-22. Shikrah 2♂, 34.671448N, 72.956061E, 1851m a.s.l. 03-x-22.

Global Distribution: Central Asia, Turkey, China, Iran, Europe and Russia (from Europe to the Far East) (WSC, 2024) and new to Pakistan.

Comments/Remarks: No past record was found of the subjected species from Pakistan.

Araniella cucurbitina (Clerck, 1757)

Material Examined: Kuzabanda 3♂ and 1♀, 34.63301N, 73.008243E, 1169m a.s.l. 07-iii-22. Paimal 1♂ and 1♀, 34.742278N, 72.998298E. 18-v-22. Batangai 7♂ and 4♀, 34.912014N, 73.046762E, 1928m a.s.l. 12-vi-22.

Global Distribution: Korea, Europe, Russia (Europe) to Central Asia, Turkey, China, (WSC, 2024).

Comments/Remarks: An earlier report of *Araniella cucurbitina* from the District of Faisalabad, Punjab, Pakistan was made by (Rana et al., 2019). Additionally, District Battagram revealed its presence for the first time in this survey.

Cyclosa confragra (Thorell, 1892)

Material Examined: Manser 5♂ and 7♀, 34.653088N, 72.963237E, 1475m a.s.l. 07-v-22. Ajpora 15♂ and 8♀, 34.589055N, 73.038963E, 1449m a.s.l. 13-viii-22. Shamlai Thor 10♂ and 12♀, 34.67667N, 73.133215E, 1844m a.s.l. 15-viii-22. Dheri Mashakhail 2♂ and 2♀, 34.677767N, 72.968732E, 1552m a.s.l. 02-x-22. Shikrah 1♂ and 1♀, 34.671448N, 72.956061E, 1851m a.s.l. 03-x-22.

Global Distribution: Bangladesh to Malaysia, India, Pakistan, (WSC, 2024).

Comments/Remarks: Dyal, S. (1935) described it from Lahore, (Mukhtar, 2004) stated it from Attock, Chakwal, and Jehlum. (Khatoon, 1986) identified it from Islamabad, and (Qadir, 1997) reported it from Sialkot. (Ghazanfar et al., 2016) recorded it from Punjab. This species is documented for the first time from District Battagram.

Neoscona mukerjei (Tikader, 1980)

Material Examined: Gantar 7♂ and 10♀, 34.853465N, 73.149881E. 22-vii-22. Izhar Ullah.

Global Distribution: Pakistan, India, Bangladesh (WSC, 2024).

Comments/Remarks: (Sameem, 2012) reported it from Malakwal, Upper Punjab. (Ghazanfar et al., 2016) also reported it from Punjab. (Mukhtar et al., 2012) reported from different sites in Punjab. (Tahir et al., 2011) reported from Pakistan.

Aculepeira carbonaria (L. Koch, 1869)

Material Examined: Batila 4♂, 5♀, 34.841184N, 73.096092E, 1556m a.s.l. 11-vi-22. Pokal 2♂ and 4♀, 34.814791N, 73.071696E. 15-vii-22.

Global Distribution: Southern Europe, Kazakhstan, Alps, Turkey, China, Russia (Europe and Central Asia), (WSC, 2024) and fresh to Pakistan.

Comments/Remarks: As far as we know, Pakistan has no records of this species. Evidence supporting its presence was gathered for the current study from District Battagram in Khyber Pakhtunkhwa, Pakistan.

Agalenatea redii (Scopoli, 1763)

Material Examined: Battagram 3♂ and 2♀, 34.67809N, 73.02416E, 1036m a.s.l. 26-iv-22. Kandao Paiza 4♂ and 3♀, 34.834987N, 73.04479E, 1463m a.s.l. 10-vi-22. Izhar Ullah.

Global Distribution: Russia (Europe to South Siberia), Azores, China, Caucasus, Europe, Central Asia, Iran, Turkey (WSC, 2024) and new to Pakistan.

Comments/Remarks: There are no known records of *Agalenatea redii* from Pakistan. Initially documented by a examine materials from district Battagram.

Araneus angulatus (Clerck, 1757)

Material Examined: Rashang 1♀, 34.819251N, 73.115735E. 20-vii-22. Nogram 2♂ and 1♀, 34.821579N, 73.097748E. 21-vii-22.

Global Distribution: Iran, Europe, Russia, Turkey, (Europe to Far East), Korea, Central Asia (WSC, 2024) and now reported from Pakistan.

Comments/Remarks: This species has not been documented in Pakistan, as far as we know. The current study from district Battagram in Khyber Pakhtunkhwa, Pakistan, proved its existence.

***Bijoaraneus mitificus* (Simon, 1886)**

Material Examined: Ajpora 7♂ and 5♀, 34.589055N, 73.038963E, 1449m a.s.l. 13-viii-22. Meeran Hills 6♂ and 7♀, 34.584339N, 72.994E, 1711m a.s.l. 03-ix-22.

Global Distribution: Philippines, Bangladesh, Pakistan, Cambodia, China, Taiwan, India, Thailand, Singapore, New Guinea (WSC, 2024).

Comments/Remarks: (Ullah and Zahid, 2022) recounted *Bijoaraneus mitificus* from District Swat Khyber Pakhtunkhwa, Pakistan.

***Eriovixia excelsa* (Simon, 1889)**

Material Examined: Kuzabanda 2♂ and 4♀, 34.63301N, 73.008243E, 1169m a.s.l. 07-iii-22. Jab Khwar 4♂ and 8♀, 34.904715N, 73.047527E, 1667m a.s.l. 12-vi-22. Parra 6♂ and 9♀, 34.925595N, 73.06408E, 2200m a.s.l. 13-vi-22. Baba Zangal 3♂ and 11♀, 34.925308N, 73.06867E, 2420m a.s.l. 13-vi-22. Banna 5♂ and 12♀, 34.830039N, 73.063751E. 23-vii-22. **Global Distribution:** South Africa, India, Indonesia, Thailand, Taiwan, Philippines, Pakistan. Introduced to Eswatini, China, (WSC, 2024).

Comments/Remarks: (Dyal, 1935) earlier documented it from the eastern part of Pakistan (Lahore). (Luqman et al., 2021) described it from Buner valley with a taxonomic study from February 2018 to January 2019. (Sajid et al., 2021) also logged it from District Dir Lower Pakistan. (Vetter et al., 2013) recounted it from Faisalabad Pakistan and (Ghazanfar et al., 2016) re-counted it from Sindh.

***Hypsosinga heri* (Hahn, 1831)**

Material Examined: Shabora 4♂ and 2♀, 34.640558, N, 73.02433E, 1711m a.s.l. 12-iii-22. Matta Torkhail 2♂ and 1♀, 34.622718N, 73.002446E, 1220m a.s.l. 17-iii-22. Biland kot 5♂ and 3♀, 34.58658N, 72.956903E, 1909m a.s.l. 12-iv-22. Bartonay 4♂ and 6♀, 34.682625N, 72.948424E. 17-v-22. Kandao Paiza 4♂ and 1♀, 34.834987N, 73.04479E, 1463m a.s.l. 10-vi-22. Parra 5♂ and 3♀, 34.925595N, 73.06408E, 2200m a.s.l. 13-vi-22. Baba Zangal 4♂ and 6♀, 34.925308N, 73.06867E, 2420m a.s.l. 13-vi-22. Pokal 7♂ and 9♀, 34.814791N, 73.071696E. 15-vii-22. Gallai Medan 3♂ and 5♀, 34.861039N, 73.194125E, 2806m a.s.l. 18-vii-22. Nogram 2♂ and 6♀, 34.821579N, 73.097748E. 21-vii-22. Dheri Mashakhail 2♂ and 3♀, 34.677767N, 72.968732E, 1552m a.s.l. 02-x-22.

Global Distribution: Russia (Europe to Central Asia, West Siberia), Caucasus, Europe, Central Asia, China, Iran, Israel (WSC, 2024).

Comments/Remarks: (Vetter et al., 2013) recorded the *Hypsosinga* Species from Faisalabad Pakistan.

Family: Corinnidae (Karsch, 1880)

***Cambalida flavipes* (Gravely, 1931)**

Material Examined: Shabora 1♂ and 1♀, 34.640558N, 73.02433E, 1711m a.s.l. 12-iii-22. Peerhari 1♂ and 2♀, 34.614692N, 72.963449E, 1585m a.s.l. 16-iv-22. Paimal 1♂ and 2♀, 34.742278N, 72.998298E. 18-v-22. Pagora 1♀, 34.646473N, 72.067454E. 05-xi-22.

Global Distribution: India (WSC, 2024) and new to Pakistan.

Comments/Remarks: No record was found from Pakistan. *Cambalida flavipes* was new to Pakistan.

***Castianeira zetes* (Simon, 1897)**

Material Examined: Rashang 4♂ and 7♀, 34.819251N, 73.115735E. 20-vii-22.

Global Distribution: India, Pakistan, Bangladesh (WSC, 2024).

Comments/Remarks: (Mukhtar, 2004) identified the subjected species from Punjab, Pakistan.

Family: Gnaphosidae (Ground spiders) (Banks, 1892)

***Parasyrisca schenkeli* (Ovtsharenko & Marusik, 1988)**

Material Examined: Parra 2♂ and 1♀, 34.925595N, 73.06408E, 2200m a.s.l. 13-vi-22. Banna 1♂, 34.830039N, 73.063751E. 23-vii-22.

Global Distribution: Mongolia, China, Kazakhstan, (WSC, 2024) and new to Pakistan.

Comments/Remarks: This species has never before been documented from Pakistan. The present investigation validated its distribution and presence within Pakistan..

***Drassyllus lutetianus* (L. Koch, 1866)**

Material Examined: Dheri Mashakhail 3♀, 34.677767N, 72.968732E, 1552m a.s.l. 02-x-22. **Global Distribution:** Europe to Kazakhstan (WSC, 2024) and new to Pakistan.

Comments/Remarks: No records of this species have been discovered in Pakistan. It was reported from District Battagram in Khyber Pakhtunkhwa, Pakistan, in the current study. **Gnaphosa lucifuga (Walckenaer, 1802)**

Material Examined: Shabora 5♂ and 2♀, 34.640558N, 73.02433E, 1711m a.s.l. 12-iii-22. Parra 2♂ and 1♀, 34.925595N, 73.06408E, 2200m a.s.l. 13-vi-22. Baba Zangal 3♂ and 1♀, 34.925308N, 73.06867E, 2420m a.s.l. 13-vi-22.

Global Distribution: China, Iran, Turkey, Russia (Europe to South Siberia), Kazakhstan, Europe, Pakistan, Caucasus (WSC, 2024).

Comments/Remarks: (Ovtchinnikov et al., 2008) reported it from Pakistan (Punjab: Lahore). Additionally, this investigation verified its presence in Pakistan's District Battagram.

Gnaphosa leporina (L. Koch, 1866)

Material Examined: Baba Zangal 1♂ and 1♀, 34.925308N, 73.06867E, 2420m a.s.l. 13-vi-22. Jangrai 1♂, 34.82091N, 73.156457E, 1810m a.s.l. 15-vii-22. Gantar 1♂, 34.853465N, 73.149881E. 22-vii-22.

Global Distribution: China, Iran, Europe, Central Asia, Turkey, Caucasus, Russia (Europe to South Siberia), (WSC, 2024) and new to Pakistan.

Comments/Remarks: Regarding the subject species from Pakistan, no prior records could be located (WSC, 2024). In the current study, Pakistan provided the initial report on it.

Family: Idiopidae (Simon, 1889)

Material Examined: Matta Torkhail, Immature idiopes, 34.622718N, 73.002446E, 1220m a.s.l. 17-iii-22.

Global Distribution: Venezuela, Pakistan, Suriname, West Africa, (WSC, 2024).

Comments/Remarks: (Nazeer, 2008) recorded it from Pakistan. The present study confirmed its distribution by examining materials from District Battagram.

Family: Lycosidae (Wolf spiders) (Sundevall, 1833)

Lycosa bistriata (Gravely, 1924)

Material Examined: Kuzabanda 3♂ and 1♀, 34.63301N, 73.008243E, 1169m a.s.l. 07-iii-22. Peerhari 1♂ and 1♀, 34.614692N, 72.963449E, 1585m a.s.l. 16-iv-22. Manser 18♂ and 11♀, 34.653088N, 72.963237E, 1475m a.s.l. 07-v-22. Kandao Paiza 1♂ and 3♀, 34.834987N, 73.04479E, 1463m a.s.l. 10-vi-22. Parra 2♂ and 6♀, 34.925595N, 73.06408E, 2200m a.s.l. 13-vi-22. Nogram 3♀, 34.821579N, 73.097748E. 21-vii-22.

Global Distribution: India, Bhutan, Pakistan (WSC, 2024).

Comments/Remarks: (Mukhtar et al., 2012) recognized it from Shorkot, district Jhang, Punjab, Pakistan and (Ghazanfar et al., 2016) also stated it from Punjab, Pakistan.

Lycosa chaperi (Simon, 1885)

Material Examined: Peerhari 3♂ and 3♀, 34.614692N, 72.963449E, 1585m a.s.l. 16-iv-22. Shamlai Thor 1♂ and 4♀, 34.67667 N, 73.133215E, 1844m a.s.l. 15-viii-22.

Global Distribution: India, Pakistan, (WSC, 2024).

Comments/Remarks: (Ghazanfar et al., 2016) described it from Sindh and (Kazim et al., 2013) described it from the surroundings of Karachi University and also stated in the current study.

Lycosa kempfi (Gravely, 1924)

Material Examined: Ajpora 13♂ and 8♀, 34.589055N, 73.038963E, 1449m a.s.l. 13-viii-22. Dheri Mashakhail 1♂, 34.677767N, 72.968732E, 1552m a.s.l. 02-x-22. Shikrah 2♂ and 2♀, 34.671448N, 72.956061E, 1851m a.s.l. 03-x-22.

Global Distribution: India, Pakistan, Nepal, China, Bhutan (WSC, 2024).

Comments/Remarks: (Ghafoor, 2002) described it from Faisalabad, Pakistan and (A Ghafoor & Mahmood, 2011) recorded from District Gujranwala, Pakistan and (Bukhari et al.,) reported it from Faisalabad, Pakistan and (Ghazanfar et al., 2016b) described it from Punjab, Pakistan.

Pardosa pullata (Clerck, 1757)

Material Examined: Pokal 3♂ and 2♀, 34.814791N, 73.071696E. 15-vii-22. Shamlai Thor 4♂ and 7♀, 34.67667N, 73.133215E, 1844m a.s.l. 15-viii-22.

Global Distribution: Turkey, Caucasus, Europe, Russia (Europe to South Siberia), Central Asia, Kazakhstan, (WSC, 2024).

Comments/Remarks: (Kanwal and Rana, 2020) recorded it from Faisalabad, Punjab, Pakistan.

***Pardosa bifasciata* (C. L. Koch, 1834)**

Material Examined: Ajpora 2♂, 34.589055N, 73.038963E, 1449m a.s.l. 13-viii-22. Meeran Hills 3♂ and 1♀, 34.584339N, 72.994E, 1711m a.s.l. 03-ix-22.

Global Distribution: Russia (Europe to South Siberia), China, Europe, Nepal, Turkey, Kazakhstan, Caucasus, (WSC, 2024) and new to Pakistan.

Comments/Remarks: There have never been any publications about this species from any part of the nation (Pakistan). Through the examination of samples from District Battagram, the current inquiry confirmed its existence in Pakistan.

***Pardosa pseudoannulata* (Bösenberg & Strand, 1906)**

Material Examined: Shabora 5♂ and 1♀, 34.640558N, 73.02433E, 1711m a.s.l. 12-iii-22. Battagram 4♂ and 7♀, 34.67809N, 73.02416E, 1036m a.s.l. 26-iv-22. Batila 3♂ and 2♀, 34.841184N, 73.096092E, 1556m a.s.l. 11-vi-22.

Global Distribution: Indonesia (Java), Bhutan, Nepal, Pakistan, India, China, Japan, Korea, Philippines Laos, Taiwan (WSC, 2024).

Comments/Remarks: (Mukhtar, Khan, et al., 2012a) recorded it from Sahiwal and Sargodha. (Ghazanfar et al., 2016b) examined it from Punjab, Pakistan, and the present study also established their existence by examining materials from District Battagram.

***Pardosa pusiola* (Thorell, 1891)**

Material Examined: Pashto 4♂ and 3♀, 34.910452N, 73.043002E, 1792m a.s.l. 09-vi-22. Jab Khwar 2♂ and 2♀, 34.904715N, 73.047527E, 1667m a.s.l. 12-vi-22. Jangrai 1♂ and 1♀, 34.82091N, 73.156457E, 1810m a.s.l. 15-vii-22.

Global Distribution: Myanmar, Bhutan, China, Bangladesh, Indonesia (Java), Malaysia, Sri Lanka, Nepal, Laos, India (WSC, 2024).

Comments/Remarks: (Mukhtar et al., 2012) described it from, Punjab, Pakistan and (Ghazanfar et al., 2016b) verified it from Punjab, Pakistan. This species is noted for the first time from District Battagram.

***Hippasa holmerae* (Thorell, 1895)**

Material Examined: Gijbora 3♂ and 2♀, 34.654325N, 72.976635E, 1277m a.s.l. 09-v-22. Batangai 1♂ and 2♀, 34.912014N, 73.046762E, 1928m a.s.l. 12-vi-22. Parra 3♂ and 2♀, 34.925595N, 73.06408E, 2200m a.s.l. 13-vi-22.

Global Distribution: Taiwan, India to Philippines, China (WSC, 2024).

Comments/Remarks: (Ghafoor, 2002) reported it from Faisalabad, Pakistan and current research recognized its existence.

***Evippa praelongipes* (O. Pickard-Cambridge, 1871)**

Material Examined: Gallai Medan 3♂ and 4♀, 34.861039N, 73.194125E, 2806m a.s.l. 18-vii-22.

Global Distribution: Kazakhstan, Libya to Saudi Arabia, Pakistan, Turkmenistan?, Israel, India? (WSC, 2024).

Comments/Remarks: (Mukhtar et al., 2012) and (Ghazanfar et al., 2016) testified this species from Punjab, Pakistan.

Family: Pisauridae (Simon, 1890)

***Pisaura mirabilis* (Clerck, 1757)**

Material Examined: Pashto 2♂ and 1♀, 34.910452N, 73.043002E, 1792m a.s.l. 09-vi-22. Rashang 2♂, 34.819251N, 73.115735E. 20-vii-22. Banna 1♂, 34.830039N, 73.063751E. 23-vii-22.

Global Distribution: Caucasus, Central Asia, Europe, Turkey, Russia (Europe to Middle Siberia), Middle East, China (WSC, 2024) and now reported from Pakistan.

Comments/Remarks: *P. mirabilis* is listed for the first time from Pakistan with no previous record according the WSC, 2024.

Family: Salticidae (Jumping spiders) (Blackwall, 1841)

***Hasarius adansoni* (Audouin, 1826)**

Material Examined: Paimal 6♂ and 8♀, 34.742278N, 72.998298E. 18-v-22. Dheri Mashakhail 3♂ and 4♀, 34.677767N, 72.968732E, 1552m a.s.l. 02-x-22.

Global Distribution: Vietnam, Middle East, Africa. Hosted to both Americas, India, Europe China, Taiwan, Laos, Japan, Australia, Pacific Island (WSC, 2024).

Comments/Remarks: Previously recorded from Lahore, Pakistan by (Tahir et al., 2011) and (Kazim et al., 2014) recounted the subjected species from the campus of the University of Karachi, Sindh, Pakistan.

Langona aperta (Denis, 1958)

Material Examined: Batangai 2♂ and 3♀, 34.912014N, 73.046762E, 1928m a.s.l. 12-vi-22.

Global Distribution: India, Iran, Afghanistan (WSC, 2024) and novel to Pakistan.

Comments/Remarks: The present study reported this species for the first time from Pakistan. Prior to now, the nation had no records of the species were found but in current study reported it survival from Pakistan.

Plexippus paykulli (Audouin, 1825)

Material Examined: Biland kot 3♂ and 4♀, 34.58658N, 72.956903E, 1909m a.s.l. 12-iv-22. Kandao Paiza 4♂ and 1♀, 34.834987N, 73.04479E, 1463m a.s.l. 10-vi-22. Jab Khwar 2♂ and 3♀, 34.904715N, 73.047527E, 1667m a.s.l. 12-vi-22. Pagora 4♂ and 7♀, 34.646473N, 72.067454E. 05-xi-22.

Global Distribution: Africa. Introduced to both Americas, Europe, Nepal, Australia, Middle East, Southern Asia, Pacific Island (WSC, 2024).

Comments/Remarks: (Tahir et al., 2011) reported *Plexippus paykulli* from Lahore, Pakistan. (Tahir et al., 2014) described it from the University of Sargodha. (Shakila et al., 2000) stated the subjected species from Pakistan. (Hafiz et al., 2012) reported this species from the University of Sargodha. (Perveen et al., 2012) identified it from Frontier Region (FR) Peshawar, in the Federally Administered Tribal Areas (FATA) of Pakistan.

Plexippus clemens (O. Pickard-Cambridge, 1872)

Material Examined: Bartonay 3♂ and 3♀, 34.682625N, 72.948424E. 17-v-22. Batangai 1♂ and 2♀, 34.912014N, 73.046762E, 1928m a.s.l. 12-vi-22. Gangwal 9♂ and 4♀, 34.821102N, 73.156448E, 1849m a.s.l. 18-vii-22. Ajpora 2♂ and 1♀, 34.589055N, 73.038963E, 1449m a.s.l. 13-viii-22.

Global Distribution: Algeria, Pakistan, Yemen, Iran, India, Egypt, Libya, Turkey, China (WSC, 2024).

Comments/Remarks: (Саджид et al., 2020); (Sajid et al., 2020) documented the subjected species from Pakistan for the first time.

Menemerus marginatus (Kroneberg, 1875)

Material Examined: Peerhari 2♂ and 6♀, 34.614692N, 72.963449E, 1585m a.s.l. 16-iv-22. Pokal 2♂ and 1♀, 34.814791N, 73.071696E. 15-vii-22. Gantar 3♂ and 13♀, 34.853465N, 73.149881E. 22-vii-22.

Global Distribution: Afghanistan, Central Asia, Caucasus (Russia, Azerbaijan), Iran, Pakistan, India, Kazakhstan, United Arab Emirates (WSC, 2024).

Comments/Remarks: (Kazim et al., 2014) recorded the subjected species from Karachi, Sindh, Pakistan and (Bauer et al., 2015) reported it in their study from Pakistan and in current research it is reported from District Battagram.

Thyene calebi (Kanesharatnam & Benjamin, 2018)

Material Examined: Parra 1♂ and 2♀, 34.925595N, 73.06408E, 2200m a.s.l. 13-vi-22. Meeran Hills 1♂, 34.584339N, 72.994E, 1711m a.s.l. 03-ix-22.

Global Distribution: Sri Lanka, India, (WSC, 2024) and fresh to Pakistan.

Comments/Remarks: *Thyene calebi* was not logged previously from Pakistan. In Pakistan and the study area, this species has never been concealed before.

Phlegra bresnieri (Lucas, 1846)

Material Examined: Shabora 2♂ and 3♀, 34.640558N, 73.02433E, 1711m a.s.l. 12-iii-22.

Global Distribution: Southern Europe, Azerbaijan, Ivory Coast, Iran, Yemen, South Africa, Northern Africa, Tanzania, Turkey, (WSC, 2024).

Comments/Remarks: Documented by (Ali, P. A 2023) from Pakistan. In the present study, its existence was confirmed by examined materials from District Battagram.

Family: Sparassidae (Bertkau, 1872)

Heteropoda afghana (Roewer, 1962)

Material Examined: Pashto 1♂ and 1♀, 34.910452N, 73.043002E, 1792m a.s.l. 09-vi-22. Meeran Hills 1♀, 34.584339N, 72.994E, 1711m a.s.l. 03-ix-22.

Global Distribution: Afghanistan, India, Pakistan (WSC, 2024).

Comments/Remarks: (Jager, 2005) described the subjected species from N-Pakistan. No complete literature found on this species.

Family: Palpimanidae (Thorell, 1869)

Palpimanus gibbulus (Dufour, 1820)

Material Examined: Baba Zangal, 1♂ and 2♀, 34.925308N, 73.06867E, 2420m a.s.l. 13-vi-22.

Global Distribution: Central Asia, Mediterranean, (WSC, 2024) and novel to Pakistan.

Comments/Remarks: Palpimanus gibbulus is earlier not documented from any region of the country. In the current inquiry, their life is confirmed by examined materials from District Battagram.

Family: Pholcidae (Cellar Spiders) (C. L. Koch, 1850)

Pholcus phalangioides (Fuesslin, 1775)

Material Examined: Jangrai 2♂ and 2♀, 34.82091N, 73.156457E, 1810m a.s.l. 15-vii-22. Rashang 1♂ and 1♀, 34.819251N, 73.115735E. 20-vii-22. Nogram 1♂ and 3♀, 34.821579N, 73.097748E. 21-vii-22.

Global Distribution: Europe, New Zealand, Western Asia. Introduced to the Asia, Africa, Americas, Australia and numerous islands (WSC, 2024).

Comments/Remarks: (Mukhtar, 2004) stated it from Punjab and also described by (Khan and Zaman, 2015) from District Buner. (Lan et al., 2020) reported it from Gilgit Baltistan, Pakistan.

Family: Tetragnathidae (Long-jawed orb-web spiders) (Menge, 1866)

Leucauge decorata (Blackwall, 1864)

Material Examined: Battagram 3♂ and 1♀, 34.67809N, 73.02416E, 1036m a.s.l. 26-iv-22. Batila 1♂ and 1♀, 34.841184N, 73.096092E, 1556m a.s.l. 11-vi-22. Jab Khwar 2♂ and 1♀, 34.904715N, 73.047527E, 1667m a.s.l. 12-vi-22. Banna 4♂ and 5♀, 34.830039N, 73.063751E. 23-vii-22. Shamlai Thor 3♂ and 2♀, 34.67667N, 73.133215E, 1844m a.s.l. 15-viii-22.

Global Distribution: Bangladesh, China, Australia, India, Philippines, Thailand, Pakistan, Indonesia, Tanzania, Nepal, Japan, Papua New Guinea, Mozambique, South Africa (WSC, 2024).

Comments/Remarks: (Mukhtar et al., 2012) described by Sargodha and (Mukhtar et al., 2012) and (Ghazanfar et al., 2016) also known it from Punjab, Pakistan. (Butt and Siraj, 2006) recorded it from the area of Punjab and (Tahir et al., 2010) in the village Kirka found in the Lahore district. The subjected species were noted for the first time from the research area.

Family: Theridiidae (Comb-Footed Spiders) (Sundevall, 1833)

Theridion confusum (O. Pickard-Cambridge, 1885)

Material Examined: Gijbori 3♂ and 4♀, 34.654325N, 72.976635E, 1277m a.s.l. 09-v-22. Batangai 3♂ and 3♀, 34.912014N, 73.046762E, 1928m a.s.l. 12-vi-22.

Global Distribution: Pakistan (WSC, 2024).

Comments/Remarks: (Simmons & Marusik, 2022) documented it in his research work From Pakistan. No detailed literature is available on subjected species but the present study confirmed its distribution from Pakistan.

Family: Thomisidae (Crab spiders) (Sundevall, 1833)

Runcinia grammica (C. L. Koch, 1837)

Material Examined: Nogram 5♂ and 3♀, 34.821579N, 73.097748E. 21-vii-22. Pagora 4♂ and 2♀, 34.646473N, 72.067454E. 05-xi-22.

Global Distribution: Middle East to Iran, Russia (Europe to West Siberia), China, Central Asia, Europa. Introduced to St. Helena, South Africa, Japan (WSC, 2024).

Comments/Remarks: (Mukhtar, 2004) stated the subjected species from Punjab, Pakistan. (Sameem, 2012) known it from Malakwal Mandi Bahaudin, District Upper Punjab Province, Pakistan.

Xysticus bifasciatus (C. L. Koch, 1837)

Material Examined: Rashang 1♂, 34.819251N, 73.115735E. 20-vii-22. Ajpora 1♂ and 2♀, 34.589055N, 73.038963E, 1449m a.s.l. 13-viii-22.

Global Distribution: Caucasus, China, Europe, Central Asia, Russia (Europe to South Siberia), Kazakhstan, Turkey, (WSC, 2024) and new to Pakistan.

Comments/Remarks: No prior records pertaining to the *Xysticus bifasciatus* species were discovered in any region of the entire country (WSC, 2024).

***Xysticus ferrugineus* (Menge, 1876)**

Material Examined: Paimal 1♂ and 4♀, 34.742278N, 72.998298E. 18-v-22.

Global Distribution: Europe, China, Turkey, (WSC, 2023) and fresh to Pakistan.

Comments/Remarks: There was no prior documentation of the targeted species discovered in any region of the nation. By analyzing samples from District Battagram, Pakistan, the current research effort revealed it for the first time from Pakistan.

***Synema globosum* (Fabricius, 1775)**

Material Examined: Matta Torkhail 3♂ and 1♀, 34.622718N, 73.002446E, 1220m a.s.l. 17-iii-22. Gijbori 1♂ and 2♀, 34.654325N, 72.976635E, 1277m a.s.l. Banna 1♂ and 1♀, 34.830039N, 73.063751E. 23-vii-22.

Global Distribution: Turkey, Caucasus, Iran, Asia, Central China, Russia (Europe to Far East), Europe, Korea, Japan (WSC, 2024).

Comments/Remarks: (Cole, 2017) recognized the *Synema globosum* in their XI book from Pakistan.

***Bassaniodes bufo* (Dufour, 1820)**

Material Examined: Ajpora 1♂ and 3♀, 34.589055N, 73.038963E, 1449m a.s.l. 13-viii-22.

Global Distribution: Mediterranean (WSC, 2024) and novel to Pakistan.

Comments/Remarks: In Pakistan, *Bassaniodes bufo* is revealed for the first time; there are no prior records from the (WSC, 2024).

***Heriaeus simoni* (Kulczyński, 1903)**

Material Examined: Manser 3♂ and 1♀, 34.653088N, 72.963237E, 1475m a.s.l. 07-v-22. Meeran Hills 2♂ and 1♀, 34.584339N, 72.994E, 1711m a.s.l. 03-ix-22.

Global Distribution: Albania, Bulgaria, Greece, Croatia, Turkey, Cyprus, (WSC, 2024).

Comments/Remarks: The current research endeavor is the first to be described from Pakistan, and no prior WSC record of the subject species was discovered.

Family: Oxyopidae (Thorell, 1869)

***Oxyopes hindostanicus* (Pocock, 1901)**

Material Examined: Manser 2♂ and 4♀, 34.653088N, 72.963237E, 1475m a.s.l. 07-v-22. Rashang 1♂, 34.819251N, 73.115735E. 20-vii-22. Ajpora 1♂ and 3♀, 34.589055N, 73.038963E, 1449m a.s.l. 13-viii-22.

Global Distribution: India, Sri Lanka, Pakistan, Bangladesh, Maldives, (WSC, 2024).

Comments/Remarks: Already documented by (Ursani & Soomro, 2010) and (Ghazanfar et al., 2016b) from Sindh, Pakistan.

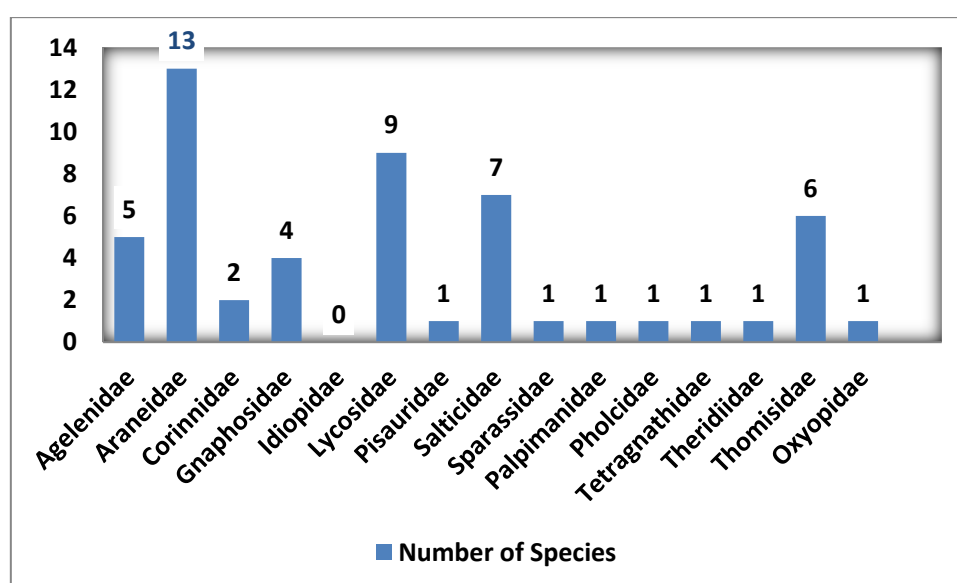


Figure 3: Number Species amongst the Spiders' families documented from District Battagram

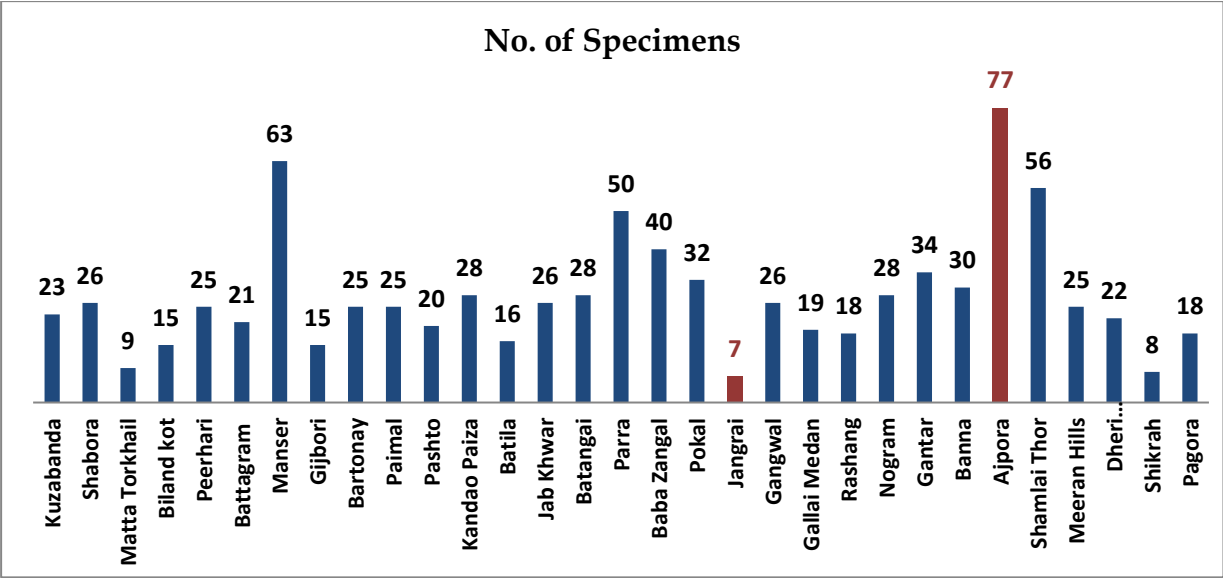


Figure 4: Locality wise richness of Spiders Samples Collected from District Battagram

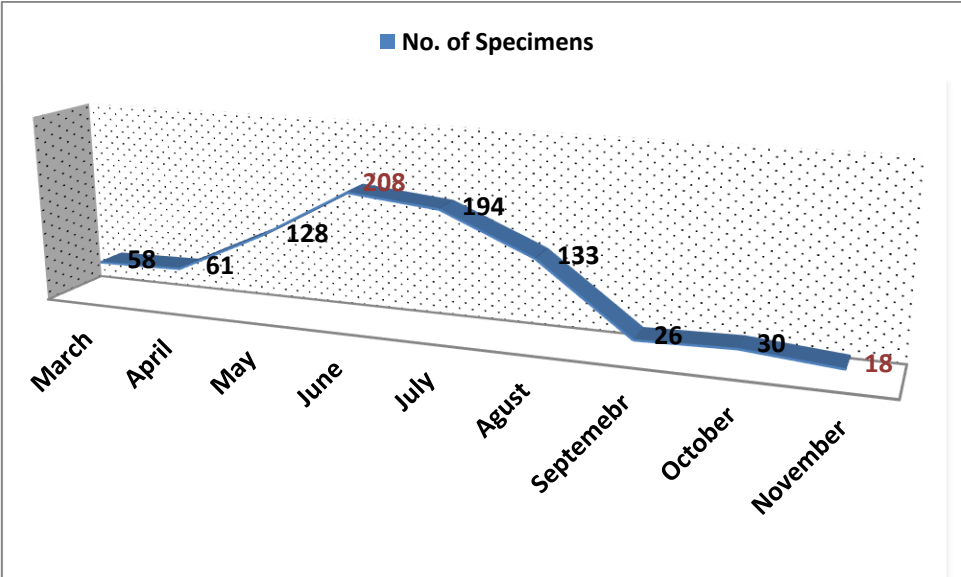


Figure 5: Monthly wise richness of Spiders Samples collected from District Battagram



*Tegenaria
lapicidarum*



*Tegenaria
silvestris*



*Histopona
torpida*



*Allagelena
gracilens*



*Agelena
orientalis*



*Araniella
nympha*



*Araniella
opisthographa*



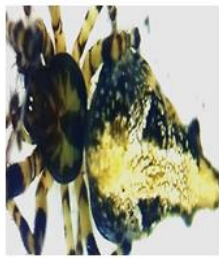
*Araniella
proxima*



*Araniella
inconspicua*



*Araniella
cucurbitina*



*Cyclosa
confragra*



*Neoscona
mukerjei*



*Aculepeira
carbonaria*



*Agalenatea
redii*



*Araneus
angulatus*



*Bijoaraneus
mitificus*



*Eriovixia
excelsa*



*Hypsosinga
heri*



*Cambalida
flavipes*



*Castianeira
zetes*



*Parasyrisca
schenkeli*



*Drassyllus
lutetianus*



*Gnaphosa
lucifuga*



*Gnaphosa
leporina*



*Idiops
Species*



*Lycosa
bistrata*



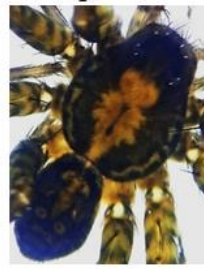
*Lycosa
chaperi*



*Lycosa
kempii*



*Pardosa
pullata*



*Pardosa
bifasciata*



*Pardosa
pseudoannulata*



*Pardosa
pusiola*



*Hippasa
holmerae*



*Evippa
praelongipes*



*Pisaura
mirabilis*



*Hasarius
adansoni*



*Langona
aperta*



*Plexippus
paykulli*



*Plexippus
clemens*



*Menemerus
marginatus*

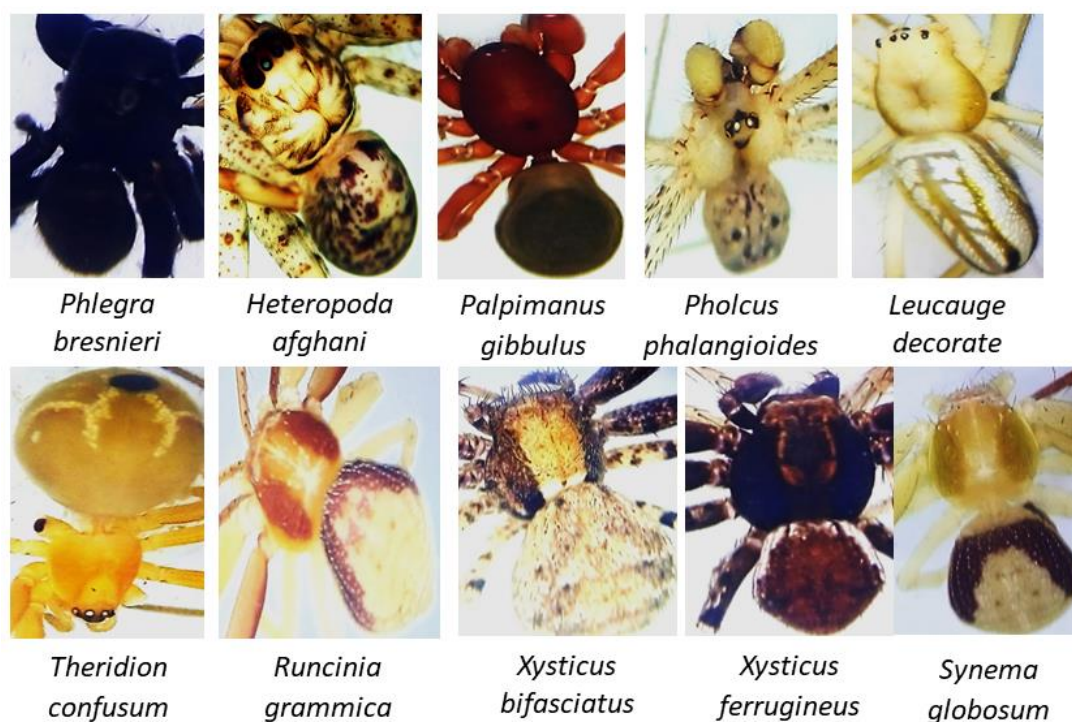


Figure: 6 Species diversity recorded from District Battagram

CONFLICT OF INTEREST

There is no conflict of interest stated by the authors.

ACKNOWLEDGMENTS

The study's participants' efforts and support were appreciated by the authors during the collection of research data/ collection phase.

REFERENCES

- [1] Abida Butt, A. B., & Beg, M. (2001). Description of two new species of spiders of the families Clubionidae and Oxyopidae from Pakistan.
- [2] Ahmad, S., Anwar, F., Ullah, I., Alam, M., Khan, J., Abid-ur-Rehman, F. A., & Ullah, R. (2020). Epidemiological and clinical manifestation of dengue virus infection: A Recent Report of 2018 from District Battagram Khyber Pakhtunkhwa. *International Journal of Mosquito Research*, 7(6 Part A), 5-8.
- [3] Ali, P. A. (2023). Online Catalogue of the Spiders (Arachnida: Araneae) of Pakistan: Online catalogue of the Spiders (Arachnida: Araneae) of Pakistan. In.
- [4] Bauer, T., Freudenschuss, M., Grabolle, A., Áàóãð, Ò., Ôðéääiùþñ, Ì., & Ñðääîëëå, À. (2015). *Plexippoides flavescens* (O. Pickard-Cambridge, 1872) and *Menemerus marginatus* (Kroneberg, 1875), new records for Pakistan (Aranei: Salticidae) *Plexippoides flavescens* (O. Pickard-Cambridge, 1872) è *Menemerus marginatus* (Kroneberg, 1875).
- [5] Bibi, M., Bibi, S., Akhtar, N., Ullah, Z., Khan, M. F., & Qureshi, I. Z. (2021). Butterfly (Order: Lepidoptera) species Richness, diversity and distribution in different localities of Battagram, Pakistan. *Saudi Journal of Biological Sciences*.

- [6] Borowiec, B. G. (2022). Long spider bodies under the sun. *Journal of Experimental Biology*, 225(3), JEB243441.
- [7] Bukhari, S. M., Maqsood, I., LiJie, T., Andleeb, S., UR, K., & Rehman, A. B. Assessment of Variance Indices of Araneid Fauna Grasped from Sugarcane Field by different trapping Methods at Faisalabad, Pakistan.
- [8] Butt, A., & Beg, M. (2001). Description of two new species of spiders of the families Clubionidae and Oxyopidae from Pakistan. *Pakistan Journal of Zoology*, 33(1), 35-38.
- [9] Butt, A., & Siraj, A. (2006). Some orb weaver spiders from Punjab, Pakistan. *J Pakistan Journal of Zoology*, 38(3), 215.
- [10] Cole, T. C., & Cole, T. C. (2017). XI. Arthropoda: Chelicerata–Spinnentiere–Spiders, Mites, Horseshoe Crabs. *J Wörterbuch der Wirbellosen/Dictionary of Invertebrates: Latein-Deutsch-Englisch*, 173-216.
- [11] Dubey, S., Malviya, S. J., & Pant, H. (2021). STUDY OF SPIDER DIVERSITY AT CENTRAL ORDNANCE DEPOT (COD) ESTATE, JABALPUR, MADHYA PRADESH. *Indian Journal of Scientific Research*, 12(1), 21-26.
- [12] Dyal, S. (1935). Fauna of Lahore: spiders of Lahore: Panjab Univ.
- [13] Ewunkem, A. J., & Agee, K. (2022). Spider Parental Care and Awe-Inspiring Egg Sac (Cocoon). *International Journal of Zoology*, 2022.
- [14] Ghafoor, A. (2002). Taxonomic and some ecological studies of the cursorial spiders of cotton fields at Faisalabad (Pakistan).
- [15] Ghafoor, A., & Mahmood, A. (2011). Population dynamics of the araneid fauna from district Gujranwala, Pakistan. *The Journal of Animal and Plant Sciences*, 21(4), 812-816.
- [16] Ghar, S. B., Das, Y. K., & Mulani, R. (2022). A study on morphometric and sexual dimorphism characteristics of giant huntsman spider in Kandi, sangareddy region of Telangana state, India. *International Journal of Entomology Research*, 7(8), 1-6.
- [17] Ghazanfar, M., Hussain, M., Hashim, M., & Fahid, A. (2016a). Checklist of spider (Araneae) fauna of Pakistan: A review. *J J Entomol Zool Studies*, 4, 245-256.
- [18] Ghazanfar, M., Hussain, M., Hashim, M., & Fahid, A. (2016b). Checklist of spider (Araneae) fauna of Pakistan: A review. *J Entomol Zool Studies*, 4, 245-256.
- [19] Hajian, M., Sadeghi, S., Barzoki, Z. E., Moradmand, M., Gholamhosseini, A., Ebrahimi, M. J. o. I. B., & Systematics. (2024). Ant diversity and species assemblages along an elevational gradient in the arid area of Central Iran. 10(1), 143–159-143–159.
- [20] HAQ¹, F. U., AHMAD, H., & ALAM, M. SPECIES DIVERSITY OF VASCULAR PLANTS OF NANDIAR VALLEY WESTERN HIMALAYA, PAKISTAN.
- [21] Haq, F. (2012). The critically endangered flora and fauna of district Battagram Pakistan. *Advances in Life sciences*, 2(4), 118-123.
- [22] Haq, F., Ahmad, H., & Alam, M. (2011). Traditional uses of medicinal plants of Nandiar Khuwarr catchment (District Battagram), Pakistan. *Journal of Medicinal Plants Research*, 5(1), 39-48.
- [23] Herzig, V., Cristofori-Armstrong, B., Israel, M. R., Nixon, S. A., Vetter, I., & King, G. F. J. B. p. (2020). Animal toxins—Nature’s evolutionary-refined toolkit for basic research and drug discovery. 181, 114096.
- [24] Jager, P. (2005). New large-sized cave-dwelling Heteropoda species from Asia, with notes on their relationships (Araneae: Sparassidae: Heteropodinae). *J Revue suisse de Zoologie*, 112(1), 87-114.
- [25] Kanwal, S., & Rana, N. (2020). Use of sewage wastewater in agriculture and its effects on soil macrofauna. *J Pakistan journal of agricultural sciences*, 57(3).
- [26] KAZIM, M., PERVEEN, R., & FATIMA, N. (2013). The spider diversity in and around University of Karachi Sindh Pakistan. *J THE ENTOMOLOGICAL SOCIETY OF KARACHI, PAKISTAN*, 28(2), 189-194.
- [27] Kazim, M., Perveen, R., Hussain, R., & Fatima, N. (2014). Biodiversity of spiders (Arachnida: Araneae) of Karachi (Urban) Sindh Province, Pakistan.

- [28] Kazim, M., Rukhsana, P., & Abid, R. (2014). Checklist of spiders (order Araneae: class Arachnida) from the campus of University of Karachi, Sindh, Pakistan. *International Journal of Biology and Biotechnology*, 11(1), 173-176.
- [29] Khan, J., & Zaman, A. (2015). Biodiversity of spider fauna in Pir Baba, district Buner, Khyber Pakhtunkhwa, Pakistan. *J Journal of Entomology Zoology Studies*, 3(1), 69-74.
- [30] Khatoon, S. (1986). A checklist of Arachnids of Pakistan. *J Bull. hydrobiol. Res*, 1, 645-650.
- [31] Lan, T., Yao, Z., Ali, A., Zheng, G., & Li, S. (2020). Two new species of the spider genus *Pholcus* Walckenaer, 1805 (Araneae: Pholcidae) from Pakistan. *J Zootaxa*, 4820(1), 177-185.
- [32] Lia, M., Rauf, A., & Hindayan, D. (2022). Comparisons of the composition of spider assemblages in three vegetation habitats in Bogor, West Java, Indonesia. *Biodiversitas Journal of Biological Diversity*, 23(1).
- [33] LIA, M., RAUF, A., & HINDAYANA, D. (2022). Comparisons of the composition of spider assemblages in three vegetation habitats in Bogor, West Java, Indonesia. *Biodiversitas Journal of Biological Diversity*, 23(1).
- [34] Luqman, L., Saeed, K., Muhammad, K., Ahmad, M., Akbar, F., Rasool, A., . . . Ahmed, S. (2021). Biodiversity of orb-web spiders (family: araneidae) of buner valley, Pakistan. *J Brazilian Journal of Biology* 82, e238339.
- [35] Molur, S., Siliwal, M., & Daniel, B. (2008). At last! Indian tarantulas on IUCN red list. *Zoos' Print*, 23(12), 1-3.
- [36] MUKHTAR, M. K. (2004). Taxonomic studies on the foliage spider fauna of Punjab. UNIVERSITY OF AGRICULTURE, FAISALABAD,
- [37] Mukhtar, M. K., Irfan, M., Tahir, H. M., Khan, S. Y., Ahmad, K. R., Qadir, A., & Arshad, M. (2012). Species composition and population dynamics of spider fauna of Trifolium and Brassica field. *Pakistan Journal of Zoology*, 44(5).
- [38] Mukhtar, M. K., Khan, S. Y., Jabeen, S., Tahir, H. M., Qadir, A., Ahmad, K. R., . . . Arshad, M. (2012a). A preliminary checklist of the spider fauna of Sargodha (Punjab), Pakistan. *Pakistan Journal of Zoology*, 44(5).
- [39] Mukhtar, M. K., Khan, S. Y., Jabeen, S., Tahir, H. M., Qadir, A., Ahmad, K. R., . . . Arshad, M. (2012b). A preliminary checklist of the spider fauna of Sargodha (Punjab), Pakistan. *J Pakistan Journal of Zoology*, 44(5).
- [40] Nazeer, K. (2008). *Send in the idiots: Stories from the other side of autism*: Bloomsbury Publishing USA.
- [41] Oldrati, V., Koua, D., Allard, P.-M., Hulo, N., Arrell, M., Nentwig, W., . . . Stöcklin, R. J. P. O. (2017). Peptidomic and transcriptomic profiling of four distinct spider venoms. 12(3), e0172966.
- [42] Ovtchinnikov, S., Ahmad, B., & Inayatullah, M. (2008). Description of a new spider species of the genus *Gnaphosa* (Araneae, Gnaphosidae) from Pakistan. *J Vestnik zoologii*, 42(1), e-13.
- [43] Palaspagar, R. S. (2022). CHAPTER ALUMINO-BORATE PHOSPHORS FOR LUMINESCENCE APPLICATION. *Recent Research at the Intersection of Science & Technology*, 39.
- [44] Perveen, F., Jamal, A., Yasmin, S., & Khatak, K. U. (2012). Biodiversity of spiders' fauna in the Frontier Region, Peshawar, Pakistan. *J J. Ent. Nematol*, 4, 22-33.
- [45] Platnick, N. I. (2006). The world spider catalog, version 7.0. American Museum of Natural History. <http://research.amnh.org/entomology/spiders/catalog/index.html>.
- [46] Qadir, A. (1997). Taxonomic studies of spider's families Araneidae, Oxyopidae, Clubionidae and Eresidae of Sialkot. MSc Thesis, Department of Zoology and Fisheries, Agriculture University ...,
- [47] Raju, A., Rahman, S., Rahman, S., Jagadeeshwar, R., & Reddy, S. (2021). Identification, documentation and relative abundance of predatory spider fauna in rice ecosystems of Telangana state. *The Pharma Innovation Journal*, 10(10S), 704-711.
- [48] Sajid, M., Zahid, M., Butt, A., Rasool, M., Shah, M., Ahmad, R., . . . Ullah, I. (2021a). 33. Faunal diversity of order Araneae species from District Dir Lower of Malakand division, Pakistan. *Pure and Applied Biology (PAB)*, 10(3), 902-912.

- [49] Sajid, M., Zahid, M., Butt, A., Rasool, M., Shah, M., Ahmad, R., . . . Ullah, I. (2021b). 33. Faunal diversity of order Araneae species from District Dir Lower of Malakand division, Pakistan. *J Pure Applied Biology*, 10(3), 902-912.
- [50] Sameem, M. A preliminary survey of spider fauna of Malakwal: Nawaz Hussain.
- [51] Sameem, M. (2012). A preliminary survey of spider fauna of Malakwal: Nawaz Hussain.
- [52] Shakila, M., Ghulam, S., & Muhammad, W. (2000). Revision of the genus *Plexippus* Koch (Araneae: Salticidae) from Pakistan. *J Pakistan Entomologist*, 22(1/2), 59-67.
- [53] Sharma, A., Singh, G., & Singh, R. (2020). Faunal Diversity of Linyphiidae (Araneomorphae: Araneae: Arachnida) in India. *Asian Journal of Conservation Biology*, 9(2), 304-314.
- [54] Simmons, Z. M., & Marusik, Y. M. (2022). On a confusion with the type localities of spiders described from the material collected during the Second Yarkand Mission. *Arachnology*, 19(sp1), 166-181.
- [55] Singh, G., & Singh, R. (2021). Faunal distribution of spiders of the families Titanoeidae, Trachelidae, Trochanteriidae, Uloboridae and Zodariidae (Arachnida: Araneae) in India. *Serket*, 17(4), 370-393.
- [56] Singh, R. (2022). An updated checklist of spiders (Arachnida: Araneae) of Rajasthan, India. India (June 30, 2022).
- [57] Subedi, S., Joshi, R., & Gurung, S. K. S. (2022). A checklist of spiders of Nepal (Arachnida; Araneae). *Heliyon*, e09927.
- [58] Suzuki, Y., Hiramatsu, T., & Tatsuta, H. (2022). Two new species and a new genus of ray spiders (Araneae, Theridiosomatidae) from the Ryukyu Islands, southwest Japan, with notes on their natural history. *ZooKeys*(1109).
- [59] Tahir, H. M., Abida Butt, A. B., Rakhshanda Naheed, R. N., Muhammad Bilal, M. B., & Imtiaz Alam, I. A. (2011a). Activity density of spiders inhabiting the citrus field in Lahore, Pakistan.
- [60] Tahir, H. M., Abida Butt, A. B., Rakhshanda Naheed, R. N., Muhammad Bilal, M. B., & Imtiaz Alam, I. A. (2011b). Activity density of spiders inhabiting the citrus field in Lahore, Pakistan. *Pakistan J. Zool.*, 683-688(43(4):).
- [61] Tahir, H. M., Butt, A., & Alam, I. (2010). Relationship of web characteristics and body measures of *Leucauge decorata* (Araneae: Tetragnathidae). *J Pakistan Journal of Zoology*, 42(3).
- [62] Tahir, H. M., Butt, A., Naheed, R., Bilal, M., & Alam, I. (2011). Activity density of spiders inhabiting the citrus field in Lahore, Pakistan. *Pakistan J. Zool.*, 43(4), 683-688.
- [63] Tikader, B. (1987). *Handbook, Indian Spiders: The Survey*.
- [64] Tiwari, A. K., & Singh, R. (2021). Diversity and distribution of pisauridae (Araneae: Araneomorphae: Arachnida) in India. *International Journal of Entomology Research*, 6(1), 119-125.
- [65] Ullah, I., & Zahid, M. J. B. J. o. B. (2022). New data on family Araneidae from district Swat with updated checklist of the family from Pakistan. *J Brazilian Journal of Biology*, 84.
- [66] Ursani, T. J., & Soomro, N. M. (2010). Check-list of spider fauna of Sindh Province, Pakistan. *Pakistan Entomologist*, 32(1), 18-23.
- [67] Vetter, R. S., Khan, S. Z., Arif, M. J., Hoddle, C., & Hoddle, M. S. (2013). Spiders (Araneae) surveyed from unsprayed citrus orchards in Faisalabad, Pakistan and their potential as biological control agents of *Diaphorina citri* (Hemiptera: Liviidae). *J Pak. Entomol*, 35, 61-69.
- [68] Vollrath, F., & Knight, D. P. J. N. (2001). Liquid crystalline spinning of spider silk. 410(6828), 541-548.
- [69] Саджид, М., Захид, М., Калёб, Д. Е., & Ахмад, III. (2020). New data on the jumping spider fauna of Pakistan (Araneae: Salticidae). *J Arthropoda Selecta. Русский артроподологический журнал*, 29(3), 330-333.
- [70] World Spider Catalog (2024). World Spider Catalog. Version 23.5. Natural History Museum Bern, online at <http://wsc.nmbe.ch>, accessed on {February 2-9}. doi: 10.24436/2.



VIII. International Symposium-2024

PEDOLOGICAL BACKGROUND FOR EARTHWORM RESEARCH IN THE GÖDÖLLŐ HILLSIDE

Zita Zsembery¹, Dorottya Pujsz²

¹*Herman Otto Institute, Budapest, Hungary, zita.zsembery@gmail.com

²Hungarian University of Agriculture and Life Sciences, Institute for Wildlife Management and Nature Conservation, Gödöllő, Hungary, pujsz.dorottya.timea@gmail.com

Abstract

Earthworms are considered ecosystem engineers because they produce macropores, enrich soils with nutrients, and help soil structure formation, etc. thus affecting soil properties tremendously. Earthworms play an important role in soil formation processes and provide many ecosystem services. The research aims to provide background information for earthworm research in the Gödöllő Hillside. We hypothesize that steep slopes affect earthworm abundance due to the loss of soil and nutrients at the upper third of the slopes and accumulation at the bottom of the slopes. Furthermore, soil moisture is expected to be higher at the bottom than at the top of the slopes. This means more possibilities for plant growth and thus organic plant materials that provide more food and better habitats for earthworms. Soil properties were measured by a Near Infrared Device. The majority of the measured properties did not prove our hypothesis. The phosphorous and soil moisture content is higher at the bottom of the slope but other properties are higher at the top. The next step is to examine the number of earthworms and the diversity of the earthworm species to find out if there are any differences due to the slope sections.

Keywords: invertebrates, protected natural area, soil properties,

INTRODUCTION

Evaluation of natural areas; natural and other landscapes [1], especially agricultural landscapes [2–3] are possible in many ways. Besides their well-known geographical description (e.g. topography, hydrology, climatic conditions, etc.), further in-depth investigations of natural state, e.g. phytolith analyses [4], invasive species analyses [5–6] and soil organic matter quality analyses [7–8] can help to evaluate other research results.

Soil characteristics are one of the most important inputs for the evaluation of the results of botanical [9] and zoological [10] investigations. However, wet chemical laboratory soil analyses [11] are expensive and time-consuming, and thus many land users and researchers are cautious when planning the related budget. Furthermore, there is an increasing number of analyses investigating the influencing the goodness of their outputs [11–13]. Alternative forms of soil analyses are getting increasing attention, e.g. spectroscopy-based measurements and handheld field devices.

There is limited information on earthworm populations in protected natural areas of Hungary, regardless of their highlighted role in soil formation processes, soil health and related ecosystem services. The purpose of the recent paper is to investigate the pedological background of a protected area where earthworms will be investigated shortly. The area is steep (above 12%) [14]. The steepness can be a tremendous influencing factor on earthworms so two slope sections were examined, one at the upper third of the slope and one at the lower third of the slope. The null hypothesis was that there are differences in soil properties (e.g. soil organic matter, phosphorous content and soil moisture are higher at the bottom of the slope) that will induce changes at least in the amount of the earthworm population.

MATERIALS AND METHODS

The Gödöllő Hillside is at the border of 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. This is a transitional zone between the Great Plain and the Northern Central Mountains. Due to its transitional nature, there is a special mesoclimate, which yielded unique vegetation. Hornbeam (*Carpinus betulus*) mixed with field maple-oak and small-leaved linden (*Tilia cordata*)-oak forests are growing here. These forests are the representatives of the cool continental forest-steppe vegetation of Hungary [15]. Areas above 200 m and in the northern region have a cool to moderately dry climate, while other areas have a moderately warm dry climate. There are appr. 1950 sunny hours per year. 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 [15].

Looking at the vegetation cover, the overall picture is characterized by a vivid mosaic of different forest associations [16]. 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 [17].

The hill stretches from the western border of Budapest to the Galga River. Its highest point is Margita (345 m). The more important lakes are Lake Naplás, Veresegyházi, Babatpuszta and Isaszeg.

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.

The examined area is in the middle of the Gödöllő Hillside, at the border of the city, south of Highway No. 3. (Fig. 1).

The Gödöllő Hillside is close to Budapest (the capital of Hungary) and undergone tremendous land use and land cover changes [18]. This fact must be taken into account during the evaluation of the results.

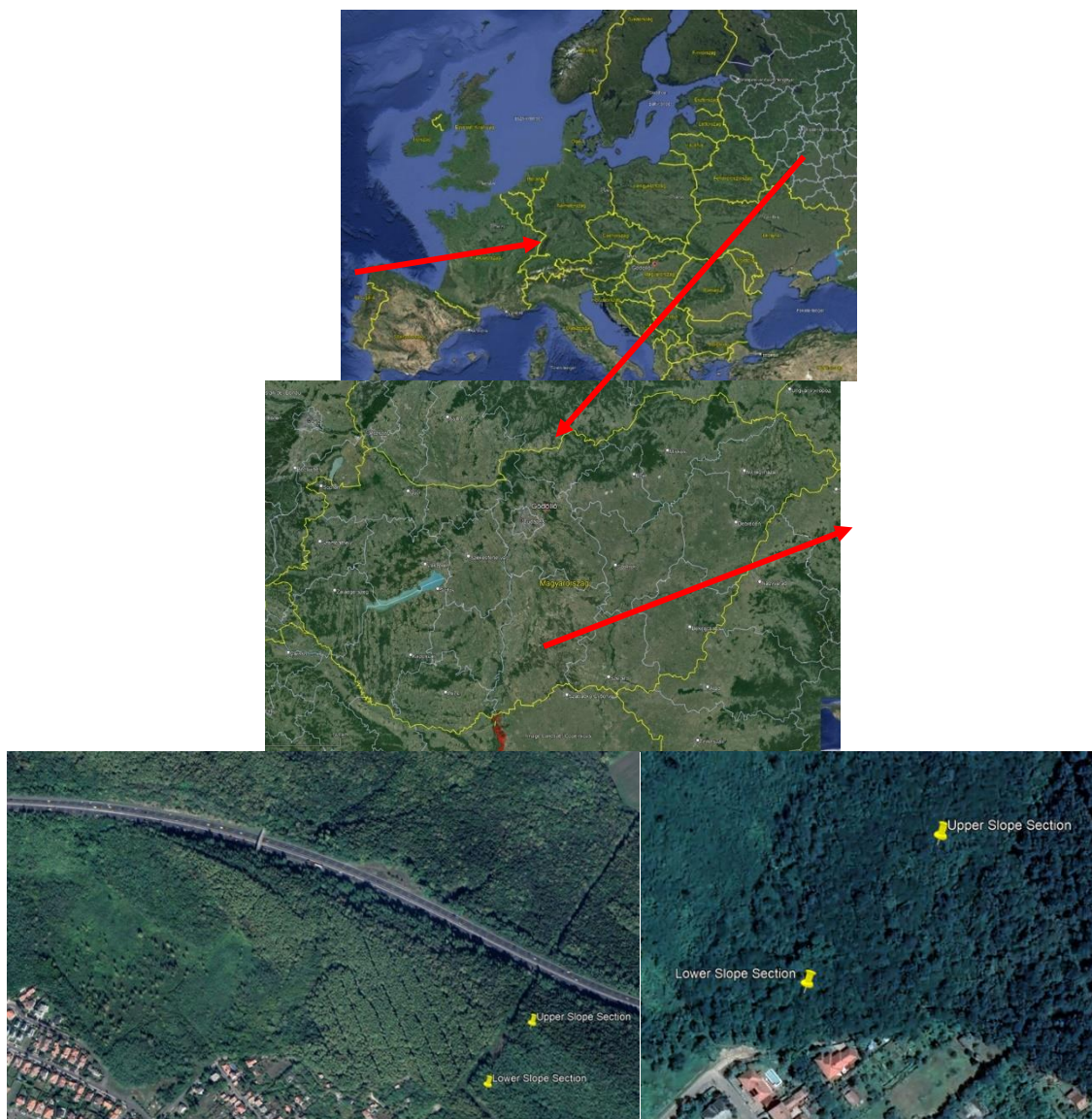


Figure 1: Situation of the investigated area at the border of Gödöllő city, Hungary
(Source: Google Earth)

Soil samples were taken from the upper 0–25 cm layer, following the collection of earthworms from a 25×25×25cm soil cube. Five samples were collected from the lower third of the slope and 5 samples from the upper third of the slope. Soil samples were cleaned from animal and plant residues and measured with the Near-Infrared Device (Fig. 2.).



Figure 2: The NIR soil scanner in a garden environment during in situ measurements

The NIR device measured pH (H₂O), soil organic matter, total organic carbon, total N and P, exchangeable K, Ca and Mg, CEC (Cation Exchange Capacity), total Al and Fe and soil moisture contents. 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.

STATISTICAL ANALYSIS

The test of normality was tested by Kolmogorov-Smirnov and Shapiro-Wilk test. According to the Shapiro-Wilk test the Ca, Fe and CEC has non-normal distribution so a Mann-Whitney U-test was used. All other data were examined with two-way T-probe.

In the case of pH, the variability of the two groups (upper third and lower third of the slope) differs (according to the Levene test) so the Welch test was used.

RESULTS AND DISCUSSION

Table 1. shows the results of the normality test of the data.

Table 1: Results of the normality of the data analysed

	1=lower, 2=upper	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
pH (H ₂ O)	1	.372	5	.022	.828	5	.135
	2	.312	5	.127	.881	5	.314
Soil Organic Matter (% m/m)	1	.323	5	.096	.856	5	.215
	2	.227	5	.200*	.960	5	.811
P (Mechlich 3 method) (mg/kg)	1	.200	5	.200*	.960	5	.805
	2	.204	5	.200*	.969	5	.870
Total N (g/kg)	1	.300	5	.161	.908	5	.453
	2	.237	5	.200*	.961	5	.814
Exchangeable K (mmol/kg)	1	.188	5	.200*	.968	5	.859
	2	.272	5	.200*	.942	5	.680

Exchangeable Ca (mmol/kg)	1	.414	5	.005	.630	5	.002
	2	.326	5	.089	.780	5	.055
Exchangeable Mg (mmol/kg)	1	.309	5	.134	.890	5	.355
	2	.271	5	.200*	.888	5	.349
Organic carbon (g/kg)	1	.277	5	.200*	.889	5	.350
	2	.205	5	.200*	.977	5	.916
Potentially Mineralizable N (g/kg)	1	.259	5	.200*	.920	5	.532
	2	.207	5	.200*	.939	5	.660
Total Al (g/kg)	1	.151	5	.200*	.995	5	.994
	2	.252	5	.200*	.888	5	.346
Total Fe (g/kg)	1	.293	5	.185	.751	5	.030
	2	.228	5	.200*	.901	5	.416
Clay content (%)	1	.348	5	.047	.779	5	.054
	2	.127	5	.200*	.999	5	1.000
Soil moisture (%)	1	.190	5	.200*	.935	5	.630
	2	.216	5	.200*	.908	5	.456
Cation Exchnage Capacity (mmol/kg)	1	.442	5	.002	.620	5	.001
	2	.152	5	.200*	.985	5	.960

The results of the basic statistics of the normal distribution data proved that the majority of the parameters have higher values (see green-colored cells) at the upper third of the slope (Table 2).

Table 2: Statistical data for the normal distribution parameters

Group Statistics					
	1=lower, 2=upper	N	Mean	Std. Deviation	Std. Error Mean
pH (H ₂ O)	1	5	7.6200	.10954	.04899
	2	5	8.1600	.25100	.11225
Soil Organic Matter (% m/m)	1	5	2.3200	.34928	.15620
	2	5	2.9000	.30822	.13784
P (Mechlich 3 method) (mg/kg)	1	5	41.8400	3.71255	1.66030
	2	5	26.1200	10.15318	4.54064
Total N (g/kg)	1	5	1.3000	.18708	.08367
	2	5	1.5400	.11402	.05099
Exchangeable K (mmol/kg)	1	5	3.1800	.42071	.18815
	2	5	3.7800	.28636	.12806
Exchangeable Mg (mmol/kg)	1	5	10.8400	1.80638	.80784
	2	5	9.8400	2.22104	.99328
Organic carbon (g/kg)	1	5	13.4800	2.09571	.93723
	2	5	16.9600	1.73003	.77369
Potentially Minera- lizable N (g/kg)	1	5	48.6800	8.02913	3.59074
	2	5	59.1400	4.56322	2.04074
Total Al (g/kg)	1	5	26.9600	.62690	.28036
	2	5	28.6800	3.02275	1.35181
Clay content (%)	1	5	11.2000	1.64317	.73485
	2	5	15.0000	2.23607	1.00000
Soil moisture (%)	1	5	17.4200	1.00598	.44989
	2	5	14.7400	1.61028	.72014

Only the phosphorous and soil moisture content is higher at the lower third of the slope, however, both were expected as phosphorous is connected to the soil particles so on a steep slope it is moving downwards. Also, the soil moisture was assumed to be higher as all water runoff is accumulating at the

bottom of the slope and even after a longer dry period it should be measurably higher at the lower part of the slope.

Table 3 shows the results of the T-test.

Table 3: Results of the T-test performed on the soil parameters at the lower and upper third of the slopes of the examined area in Gödöllő, Hungary

		Levene's Test for Equality of Variances				Significance	
		F	Sig.	t	df	One-Sided p	Two-Sided p
pH	Equal variances assumed	6.404	.035	-4.409	8	.001	.002
	Equal variances not assumed			-4.409	5.470	.003	.006
Soil Organic Matter (% m/m)	Equal variances assumed	.004	.950	-2.784	8	.012	.024
	Equal variances not assumed			-2.784	7.878	.012	.024
P (Mechlich 3 method) (mg/kg)	Equal variances assumed	2.851	.130	3.252	8	.006	.012
	Equal variances not assumed			3.252	5.051	.011	.022
Total N (g/kg)	Equal variances assumed	.252	.629	-2.449	8	.020	.040
	Equal variances not assumed			-2.449	6.611	.023	.046
Exchangeable K (mmol/kg)	Equal variances assumed	.712	.423	-2.636	8	.015	.030
	Equal variances not assumed			-2.636	7.051	.017	.033
Exchangeable Mg (mmol/kg)	Equal variances assumed	.168	.693	.781	8	.229	.457
	Equal variances not assumed			.781	7.681	.229	.458
Organic carbon (g/kg)	Equal variances assumed	.020	.891	-2.863	8	.011	.021
	Equal variances not assumed			-2.863	7.723	.011	.022
A_N_PMN (g/kg)	Equal variances assumed	.609	.458	-2.533	8	.018	.035
	Equal variances not assumed			-2.533	6.340	.021	.042
Potentially Mineralizable N (g/kg)	Equal variances assumed	17.580	.003	-1.246	8	.124	.248
	Equal variances not assumed			-1.246	4.343	.138	.276
Total Al (g/kg)	Equal variances assumed	.393	.548	-3.062	8	.008	.016
	Equal variances not assumed			-3.062	7.345	.009	.017
Clay content (%)	Equal variances assumed	.744	.413	3.156	8	.007	.013
	Equal variances not assumed			3.156	6.710	.008	.017

The Mg and Al content did not differ but all other parameters did.

According to the Mann-Whitney U-test, the soils of the upper third of the slope contains more Ca.

CONCLUSIONS AND RECOMMENDATIONS

Regardless of the considerable slope steepness (above 12%), the null hypothesis that soil parameters will be higher at the lower third of the slope was not fully, or we could rather state that less likely was proved. According to the hypothesis, more soil parameters was expected to prove our assumptions and fewer that did not. Still, a higher amount of phosphorous and soil moisture contents at the lower third of the slope and a higher Ca-content at the upper third of the slope are good indicators for proving the null hypothesis and are well known to behave similarly in other sloping areas [6–8]. We can state that these three parameters show significant differences between the upper and the lower third of the slopes so these can be used as explanatory factors in case there will be significant differences in the future research on earthworm quantities and/or abundance.

REFERENCES

- [1] Barczy, A., Csorba, P., Lóczy, D., Mezösi, G., Konkolyiné, Gyuró É., Bardóczyné, Székely E., Csima, P., Kollányi, L., Gergely, E., Farkas, Sz., Ángyán, J., Podmaniczky, L., Pirkó, B., Joó, K., Centeri, Cs., Grónás, V., Vona, M., Pető, Á.: Suggested Landscape and Agri-environmental Condition Assessment. *Tájökológiai Lapok*. 2008; 6(1–2): 77–94. <https://doi.org/10.56617/tl.4150>

- [2] Centeri, Cs.; Saláta, D.; Szilágyi, A.; Orosz, Gy.; Czóbel, Sz.; Grónás, V.; Gyulai, F.; Kovács, E.; Pető, Á.; Skutai, J (2021): Selected Good Practices in the Hungarian Agricultural Heritage. Sustainability. 2021; 13: 12 Paper: 6676, <http://dx.doi.org/10.3390/su13126676>
- [3] Kruse, A., Athanasiadou, E., Centeri, Cs., Michelin, Y., Slámová, M., Šmid Hribar, M., Ferrario, V.: Emerging Gaps in Research on Agricultural Landscapes. Journal of European Landscapes. 2024; 4(1): 1–35. <https://doi.org/10.5117/JEL2023.1.001.KRUS>
- [3] Pető, Á., Barczy, A., Joó, K., Grónás, V.: Phytolith Analysis of Modern Soil Profiles as a Tool to Demonstrate Land Use Changes and Anthropogenic Impacts (Case Study from the Bakony Mountains). Cereal Research Communications. 2008; 36: S5 pp. 955–958.
- [4] Rusvai, K., Saláta, D., Falvai, D., Czóbel, Sz.: Assessment of Weed Invasion at Bait Sites in a Central European Lower Montane Zone. Perspectives in Plant Ecology Evolution and Systematics. 2022a; 55 Paper: 125669 <https://doi.org/10.1016/j.ppees.2022.125669>
- [5] Rusvai, K., Wichmann, B., Saláta, D., Grónás, V., Skutai, J., Czóbel, Sz.: Changes in the Vegetation, Soil Seed Bank and Soil Properties at Bait Sites in a Protected Area of the Central European Lower Montane Zone. Sustainability. 2022b; 14: 20 Paper: 13134 <https://doi.org/10.3390/su142013134>
- [6] Jakab, G., Szabó, J., Szalai, Z., Mészáros, E., Madarász, B., Centeri, Cs., Szabó, B., Németh, T., Sipos, P.: Changes in Organic Carbon Concentration and Organic Matter Compound of Erosion-delivered Soil Aggregates. Environmental Earth Sciences. 2016; 75 (2): 144–154. <https://link.springer.com/article/10.1007/s12665-015-5052-9>
- [7] Masoudi, M., Centeri, Cs., Karlik, M., Jakab, G.: Extracted Samples and in situ Soil Investigations to Assess the Effects of Different Land Use and Tillage Management Practices on Soil Organic Matter Composition. Land Degradation & Development. 2023; 34(9): 2560–2572. <https://doi.org/10.1002/ldr.4629>
- [8] Centeri, Cs.: The Role of Vegetation Cover in the Control of Soil Erosion on the Tihany Peninsula. Acta Botanica Hungarica. 2002; 44 (3–4): 285–295. <https://doi.org/10.1556/abot.44.2002.3-4.7>
- [9] Benotmane, K.H., Boukheroufa, M., Sakraoui, R., Sakraoui, F., Centeri, C., Fehér, Á., Katona, K.: Comparative Effects of Wild Boar (*Sus scrofa*) Rooting on the Chemical Properties of Soils in Natural and Post-Fire Environments of the Edough Forest Massif (Northeastern Algeria). Land. 2024; 13(3), Paper 382. <https://doi.org/10.3390/land13030382>
- [10] Vona, V., Bakos, I. A., Giczi, Zs., Kalocsai, R., Vona, M., Kulmány, I. M., Centeri, Cs.: Múlt-jelen-jövő a Hazai Mezőgazdasági Talajvizsgálatokban. Agrokémia és Talajtan. 2020; 69 (1–2): 127–151. <https://doi.org/10.1556/0088.2020.00061>
- [11] Vona, V., Toth, E. A., Centeri, Cs., Giczi, Zs., Biro, Zs., Jakab, G., Milics, G., Kulmány, I. M., Kalocsai, R., Kovacs, A. J.: The Effect of Soil Physicochemical Characteristics on Zinc Analysis Methods. Soil and Water Research. 2021; 16(3): 180–190. <https://doi.org/10.17221/53/2020-SWR>
- [12] Kalocsai, R., Giczi, Z., Szakál, T., Centeri, C., Biró, Z., Vona, M., Kubina, L., Zsebő, S., Kulmány, I., Vona, V.: Effect of pH, Carbonate and Clay Content on Magnesium Measurement Methods on Hungarian Soils. Soil Syst. 2024; 8(49) <https://doi.org/10.3390/soilsystems8020049>
- [13] Dorka Vona, V., Kalocsai, R., Tóth, E., Giczi, Zs., Kovács, A.: Spektroszkópiai Módszerek Alkalmazása a Talaj Tápanyagtartalmának Meghatározására: Szakirodalmi Feldolgozás. Acta Agronomica Óváriensis. 2019; 60 (1): 140–164.
- [14] Pitta-Osses, N., Katona, K., Grósz, J., Centeri, Cs. Potential of wild boar (*Sus scrofa*) rooting for slowing down erosion processes. In: Pekárová, P., Miklánek, P., Halmová, D., Vitková, J. Water Dynamics Changes in the Soil–Plant–Atmosphere System. 2020. 11. 11., Bratislava, Slovakia, Ústav hydrológie SAV, Slovak Academy of Sciences, Institute of Hydrology, pp 188–195.
- [15] Dövényi, Z. (ed) Magyarország kistájainak katasztere. MTA Földrajztudományi Kutatóintézet, 2010. Budapest, pp. 876
- [16] Malatinszky, Á. Gödöllői-dombság környezet- és természetvédelme. In: Szabó L. (szerk.) (2011): Gödöllői-dombság természeti- és gazdaságföldrajzi viszonyai, kultúrtörténete. Agroinform Kiadó; 2011. pp. 135–156., Budapest, ISBN: 978-963-502-936-3
- [17] Demény, K. A Gödöllői-dombság általános bemutatása. Tájékológiai Lapok. 2007; 5(2): 213–233.
- [18] Centeri, Cs., Grónás, V., Demény, K., Idei, Sz., Penksza, K., Nagy, A.: Interrelation of Land Use Change, Nature Conservation and Urbanization in the Gödöllő Hillside, Hungary. In: E., Turunen; A., Koskinen (eds.) Urbanization and the Global Environment. Nova Science Publishers; 2012. pp. 1–50. New York, USA



VIII. International Symposium-2024

COMPARING SOIL PROPERTIES OF NATURAL AND ARABLE AREAS

Zita Zsembery*

Herman Otto Institute, Budapest, Hungary, zita.zsembery@gmail.com

Abstract

Arable farming starts with deforestation or tillage of grasslands. Soil properties suffer tremendous changes in these cases. Since soil is the major natural resource of food production and many ecosystem services, evaluation of its change is crucial for the survival of humans. The purpose of the research is to provide some insight into the changes through the comparison of soil properties of some arable fields and nearby semi-natural areas. Soil properties were measured by a Near Infrared Device. The results prove that some soil properties, e.g. soil organic matter, N- and P-content, pH, etc. can be significantly different between the two examined land use types. Based on the evaluation, we can conclude that besides significant differences there are also similarities, so the hypothesis regarding the changes does not occur to all the soil properties necessarily. The search for finding the reasons behind the causal linkage is exciting.

Keywords: intensive agriculture, nature conservation, soil change, soil quality, natural areas

INTRODUCTION

There is a continuous effort to prove the goodness of arable farming, regardless of the fact that as soon as natural or semi-natural areas undergone changes, their original vegetation is removed, they start their “journey” towards deterioration. There were several efforts to evaluate the assessment of the state of natural areas, several landscape types and agricultural areas [1–5].

Land use change [6-7] and anthropogenic effects [8–9] are wide spread in the examined areas and we can state that in all, human-affected areas all over the world.

Soils are very good indicators of land use change as their deterioration can be very fast, due to tillage operations, water and wind erosion, soil pollution and many other human-induced activities. The classic, wet chemical laboratory soil analyses [10] are still considered as the only scientifically sound methods for soil laboratory analyses. However, these are sometimes also considered expensive and time-consuming, along with the sampling that can also be expensive. Regardless of the wide-spread perception of the wet chemistry method to be the only acceptable way, there are certain comparative analyses between laboratories where the goodness of the protocol is checked [11–14]. There is an increasing number of companies who offer alternative, non-wet chemical forms of soil analyses, e.g. spectroscopy-based measurements.

The null hypothesis was that there are differences in soil properties between the arable and non-arable (in our case: tree covered) areas and there will be more nutrients on the arable field.

MATERIALS AND METHODS

In the northern area there were one site from Csomád (a pine forest and a nearby arable field was sampled), one site from Órbottyán (a black locust forest and a nearby arable field were sampled); to the east, two sites from Pánd (two black locust and the nearby arable fields were sampled) and one site from Szigetszentmárton (a black locust forest and the nearby arable field were sampled) (Fig. 1.). The climate of all areas are very similar as they are very close to the biggest city in Hungary. The Pánd area is slightly hilly with some smaller areas with higher slope steepness. Fig. 2. shows one of the area examined in Pánd, Hungary.

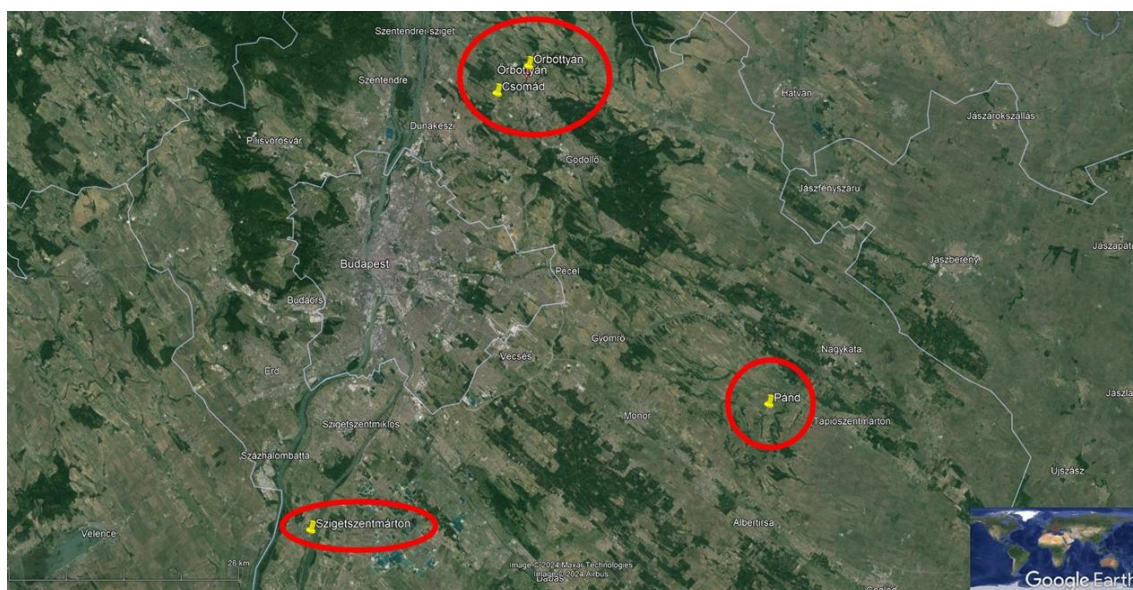


Figure 1: The investigated areas around Budapest (capitol of Hungary), the sites to the north and to the east are hilly while the southern one is flat, close to River Danube, one arable area and one forested area were compared, soil samples taken at the depth of 0–30 cm



Figure 2: The investigated area nearby Pánd, Hungary. On the photo the soil sampler can be seen with the sample taken in the young black locust forest, stored in a plastic bag.

Soil sampling and analyses

Five samples were collected from forests/tree lines and five samples from the nearby arable field (or vice versa). The sampling depth was 0–30 cm, following the sampling protocol used in Hungary on arable fields. Soil samples were stored in a plastic bag, until they were measured with Near-Infrared Device (Fig. 3.).



Figure 3: The NIR soil scanner in a garden environment during in situ measurements

The device is sending the data to the center of the Agrocared Ltd in the Netherlands through an application on a cell phone. The evaluation of the data is returning in a couple of minutes to the same cell phone that was used to send the data.

The raw data can also be downloaded from the web page of the same company. The NIR device measures the following parameters: pH (H₂O), soil organic matter (SOM), total organic carbon (TOC), total N and P, exchangeable K, Ca and Mg, CEC (Cation Exchange Capacity), total Al and Fe and soil moisture contents. 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.

STATISTICAL ANALYSIS

The following statistical analyses were used to evaluate the data: Kolmogorov-Smirnov test, Shapiro-Wilk test, Mann-Whitney U-test (for non-normal distribution) and 2-sided T-probe (for normal distribution).

RESULTS AND DISCUSSION

Table 1. shows the measured data of the parameters (Total Al, exchangeable K and potentially mineralizable N) that yielded significant differences during the comparison of forests and arable fields.

Table 1: Measured data of the Total Al, exchangeable K and potentially mineralizable N from the 0–30 cm layer of the soils of Csomád, Órbottyán, Pánd and Szigetszentmárton, Hungary

Field Name	Al (total) (g/kg)	K (exchangeable) (mmol/kg)	Potentially mineralizable N (mmol/kg)(g/kg)
Csomád – pine forest	26.4	2.4	32.3
Órbottyán – black locust	22.2	4.3	55.7
Pánd-1-6 – black locust	39.4	4.3	61.2
Pánd-1-5 – black locust	43.4	4.7	66.3
Szigetszentmárton – black locust	27.4	5.1	48.2
Average	31.76	4.16	52.74
Csomád – arable	26.4	1.8	22.2
Órbottyán – arable	27.5	2.6	39.3
Pánd-1-6 – arable	38.2	3.4	35
Pánd-1-5 – arable	39	3.2	37.3
Szigetszentmárton – arable	38.8	3.2	47.2
Average	33.98	2.84	36.2

As it is visible from Table 1., there were only three parameters where significant differences were found based on the statistical analyses. Some values are higher in the forest, some in the arable land but the values cover so wide range that the differences are not significant. There were significant differences in only 3 cases as follows:

1. Al-content is significantly different ($p=0.026$) – it has non-normal distribution so Mann-Whitney U-test was used. In all other cases 2-sided T-probe was used.
2. K-content is significantly different ($p=0.043$).
3. Potentially Mineralizable Nitrogen (N-PMN) is significantly different ($p=0.05$).

CONCLUSIONS AND RECOMMENDATIONS

Based on the results, we can conclude that some soil parameters proved our zero hypothesis, however, more parameters were expected to show the effects of arable farming. The possible reason for having a low number of proving parameters can be the lack of exact knowledge about the pre-historic data on the examined areas. In general, we can assume well that where there are trees, tree lines or forested patches now, this land use was there for many (30+) years so the effect of intensive agriculture should be measurable. But, as so many parameters are influencing the soil properties, we never know the exact causative relation between the states of the soils' parameters. The recommendation is that there should be more data about the history of the areas examined. Was it used intensively before? Were there tremendous effects, due to, e.g. former wars or former, even more intensive land uses? In the cooperative era, heavy loads of sewage, heavy metals and other forms of influencing factors ight have affected any of these areas.

REFERENCES

- [1] Barczy, A., Csorba, P., Lóczy, D., Mezösi, G., Konkolyiné, Gyuró É., Bardóczyné, Székely E., Csima, P., Kollányi, L., Gergely, E., Farkas, Sz., Ángyán, J., Podmaniczky, L., Pirkó, B., Joó, K., Centeri, Cs., Grónás, V., Vona, M., Pető, Á.: Suggested Landscape and Agri-environmental Condition Assessment. *Tájökológiai Lapok*. 2008; 6(1–2): 77–94. <https://doi.org/10.56617/tl.4150>
- [2] Scherr, S. J., McNeely, J. A.: Biodiversity Conservation and Agricultural Sustainability: Towards a New Paradigm of 'Ecoagriculture' Landscapes. *Phylosophical Transactions of the Royal Society B, Biological Sciences*. 2008; 363 (1491): 477–494. <https://doi.org/10.1098/rstb.2007.2165>
- [3] De Groot, R.: Function-analysis and Valuation as a Tool to Assess Land Use Conflicts in Planning for Sustainable, Multi-functional Landscapes. *Landscape and Urban Planning*. 2005, 75 (3-4): 175–186. <https://doi.org/10.1016/j.landurbplan.2005.02.016>

- [4] Centeri, Cs.; Saláta, D.; Szilágyi, A.; Orosz, Gy.; Czóbel, Sz.; Grónás, V.; Gyulai, F.; Kovács, E.; Pető, Á.; Skutai, J (2021): Selected Good Practices in the Hungarian Agricultural Heritage. Sustainability. 2021; 13: 12 Paper: 6676, <http://dx.doi.org/10.3390/su13126676>
- [5] Kruse, A., Athanasiadou, E., Centeri, Cs., Michelin, Y., Slámová, M., Šmid Hribar, M., Ferrario, V.: Emerging Gaps in Research on Agricultural Landscapes. Journal of European Landscapes. 2024; 4(1): 1–35. <https://doi.org/10.5117/JEL2023.1.001.KRUS>
- [6] Pető, Á., Barczy, A., Joó, K., Grónás, V.: Phytolith Analysis of Modern Soil Profiles as a Tool to Demonstrate Land Use Changes and Anthropogenic Impacts (Case Study from the Bakony Mountains). Cereal Research Communications. 2008; 36: S5 pp. 955–958.
- [7] Masoudi, M., Centeri, Cs., Karlik, M., Jakab, G.: Extracted Samples and in situ Soil Investigations to Assess the Effects of Different Land Use and Tillage Management Practices on Soil Organic Matter Composition. Land Degradation & Development. 2023; 34(9): 2560–2572. <https://doi.org/10.1002/ldr.4629>
- [8] Rusvai, K., Saláta, D., Falvai, D., Czóbel, Sz.: Assessment of Weed Invasion at Bait Sites in a Central European Lower Montane Zone. Perspectives in Plant Ecology Evolution and Systematics. 2022a; 55 Paper: 125669 <https://doi.org/10.1016/j.ppees.2022.125669>
- [9] Rusvai, K., Wichmann, B., Saláta, D., Grónás, V., Skutai, J., Czóbel, Sz.: Changes in the Vegetation, Soil Seed Bank and Soil Properties at Bait Sites in a Protected Area of the Central European Lower Montane Zone. Sustainability. 2022b; 14: 20 Paper: 13134 <https://doi.org/10.3390/su142013134>
- [10] Vona, V., Bakos, I. A., Giczi, Zs., Kalocsai, R., Vona, M., Kulmány, I. M., Centeri, Cs.: Múlt-jelen-jövő a Hazai Mezőgazdasági Talajvizsgálatokban. Agrokémia és Talajtan. 2020: 69 (1–2): 127–151. <https://doi.org/10.1556/0088.2020.00061>
- [11] Centeri, Cs., Jakab, G. I., Szabó, Sz., Farsang, A., Barta, K., Szalai, Z., Bíró, Zs.: Comparison of particle-size analyzing laboratory methods. Environmental Engineering and Management Journal. 2015; 14(5): 1125–1135.
- [12] Vona, V., Toth, E. A., Centeri, Cs., Giczi, Zs., Biro, Zs., Jakab, G., Milics, G., Kulmany, I. M., Kalocsai, R., Kovacs, A. J.: The Effect of Soil Physicochemical Characteristics on Zinc Analysis Methods. Soil and Water Research. 2021; 16(3): 180–190. <https://doi.org/10.17221/53/2020-SWR>
- [13] Kalocsai, R., Giczi, Z., Szakál, T., Centeri, C., Bíró, Z., Vona, M., Kubina, L., Zsebő, S., Kulmány, I., Vona, V.: Effect of pH, Carbonate and Clay Content on Magnesium Measurement Methods on Hungarian Soils. Soil Syst. 2024; 8(49) <https://doi.org/10.3390/soilsystems8020049>
- [14] Dorka Vona, V., Kalocsai, R., Tóth, E., Giczi, Zs., Kovács, A.: Spektroszkópiai Módszerek Alkalmazása a Talaj Tápanyagtartalmának Meghatározására: Szakirodalmi Feldolgozás. Acta Agronomica Óváriensis. 2019; 60 (1): 140–164.



VIII. International Symposium-2024

ANALYSIS ON LOW TEMPERATURE SYNTHESIS OF NANO ALPHA ALUMINA POWDER WITH TWO-STEP HYDROLYSIS

Rahele Khosravi Nesiani^{1*}, Meysam Naseri²

Department of Chemical Engineering, Sahand University of Technology, Sahand New City, Tabriz, Iran, r.khosravi66esf@gmail.com , <https://orcid.org/0000-0001-7481-2974>

Faculty of Mining and Processing Engineering, Amirkabir University of Technology, Tehran, Iran, Meysam.naseri94@gmail.com , <https://orcid.org/0000-0002-1005-1886>

Abstract

Motivation/Background: Aluminium oxide (or Aluminium(III) oxide) is a chemical compound of aluminium and oxygen with the chemical formula Al_2O_3 . It is the most commonly occurring of several aluminium oxides and specifically identified as aluminium oxide. It is commonly called alumina and may also be called aloxide, aloxite, or alundum in various forms and applications. It occurs naturally in its crystalline polymorphic phase α - Al_2O_3 as the mineral corundum, varieties of which form the precious gemstones ruby and sapphire. Al_2O_3 is significant in its use to produce aluminium metal, as an abrasive owing to its hardness, and as a refractory material owing to its high melting point. Corundum is the most common naturally occurring crystalline form of aluminium oxide. Rubies and sapphires are gem-quality forms of corundum, which owe their characteristic colours to trace impurities. Rubies are given their characteristic deep red colour and their laser qualities by traces of chromium. Sapphires come in different colours given by various other impurities, such as iron and titanium. An extremely rare δ form occurs as the mineral deltalumite. **Method** The ultra fine alpha-alumina powder has been successfully synthesized via two-step hydrolysis of aluminum isopropoxide. Glucose and polyvinyl pyrrolidone were used as surfactants during the appropriate processing step. The alpha-alumina powder was used as seed particles. Several synthesis parameters, such as the amount of seeds, surfactants, and calcination temperature, were studied by X-ray diffraction (XRD), Fourier transform infrared spectra (FTIR), Thermogravimetry-differential scanning calorimetry (TG-DSC), scanning electron microscopy (SEM) and transmission electron microscopy (TEM). **Results:** The experimental results showed that glucose greatly lower the phase transformation temperature of alpha-alumina by impelling the gamma-alumina transformed to alpha-alumina directly, and the seed could improve the phase transformation rate of alpha-alumina, the polyvinylpyrrolidone have an effect on preventing excessive grain growth and agglomeration of alpha-alumina powder. Comparatively well dispersed alpha-alumina powder with particle size less than 50 nm can be synthesized through this method after calcinations at 1000 °C for 2 h.

Keywords: Oxide, Chemical synthesis, Phase transitions, X-ray diffraction, Nanostructures.

INTRODUCTION

Nano α -alumina is one of the most important oxides for a wide range of applications in ceramic, high strength materials, functional materials, adsorbents, catalysts, catalyst support and transparent armours for ballistic performance [1–4], which are attributed to its excellent performance such as high mechanical strength, good wear resistance, low conductivity, high refractoriness, high hardness and high corrosion resistance. To prepare nano α -alumina powder with good performance, a lot of approaches such as mechanical milling [5], vapor phase reaction [6–7], microemulsions [8–9], precipitation [10], sol–gel [11–12], hydrothermal [13–14] and combustion methods [15] have been developed. However, alumina powder exists in a lot of metastable transition phases, the transformation proceeds of α - Al_2O_3 usually through the following sequence: $\text{g- Al}_2\text{O}_3 \rightarrow \text{s- Al}_2\text{O}_3 \rightarrow \text{u- Al}_2\text{O}_3 \rightarrow \text{ba- Al}_2\text{O}_3$ [16].

While the nanoscale α -alumina powder is difficult to obtain, because of the following reasons: first, the α - Al_2O_3 is the most thermodynamically stable phase after calcination at high temperature, the transformation of α - Al_2O_3 from $\text{u- Al}_2\text{O}_3$ always relates to a significant change in the oxygen sublattice from cubic peaking to hexagonal close packing [17], the reconstructive transformation needs relatively high activation energy compared with $\text{g- Al}_2\text{O}_3 \rightarrow \text{s- Al}_2\text{O}_3 \rightarrow \text{u- Al}_2\text{O}_3$ transformation. As a result, the phase transformation temperature for almost salt-derived aluminum hydroxides and hydrated alumina form to α - Al_2O_3 is always at 1100–1250 °C. the high temperature easily prompt the grain growth of powder, which makes it difficult to get nanoscale particles; secondly, the phase transformation of α - Al_2O_3 from $\text{u- Al}_2\text{O}_3$ is performed by a nucleation and growth mechanism, the α - Al_2O_3 nuclei form within the ultrafine $\text{u- Al}_2\text{O}_3$ matrix, and then rapidly grow to produce α - Al_2O_3 colonies [18], which inevitably results in certain degree of particle coarsening.

For the above reasons, the α -alumina prepared by common methods shows serious agglomeration, so eliminating the agglomeration in the subsequent mechanical treatment is necessary, which inevitably introduced impurities. Thus, lowering the phase transformation temperatures is the target for preparing the nanoscale α - Al_2O_3 . Currently, there are many reports about lowering the phase transformation temperatures of α - Al_2O_3 . Li et al. [19] proposed that citrate polymeric precursor derived from aluminum nitrate and citric acid mixed solution promoted the $\text{g- Al}_2\text{O}_3$ transformed to α - Al_2O_3 directly, which greatly reduced the transformation of α - Al_2O_3 . Some studies [20–22] indicated that phase transformation temperature of $\text{u- Al}_2\text{O}_3$ can be influenced by some metal cations such as Fe^{2+} , Cr^{3+} and Ti^{4+} . However, the addition of inorganic ion inevitably introduced impurities, which reduced the purity of α - Al_2O_3 , therefore limits its application in some areas. The previous studies [23–25] have indicated that the α - Al_2O_3 seeding can provide the nucleation sites in the process of the phase transition to reduce the activation energy and phase transformation temperature, besides, the α - Al_2O_3 seeding can prevent the formation of vermicular structure during sintering. Herein, we present an easily accessible, reproducible, and high throughput method to synthesize high purity and homogenous nano α - Al_2O_3 through two-step hydrolysis of aluminum isopropoxide, the α - Al_2O_3 (<100 nm) seeds were introduced to reduce the transformation temperature of α - Al_2O_3 . In addition, glucose and polyvinyl pyrrolidone were used as surfactants in the process of hydrolysis. Decomposition of the precursor, phase transformation and morphology of the synthesized alumina powder are investigated.

MATERIALS AND METHODS

Aluminum isopropoxide $\text{Al}(\text{OC}_3\text{H}_7)_3$ (Xuancheng Jingrui New Material Co., Ltd), glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) (A.R, Sinopharm Chemical Reagent Co., Ltd), and polyvinylpyrrolidone (k-30) (A.R., Sinopharm Chemical Reagent Co., Ltd) were used as raw materials to prepare α - Al_2O_3 powder. Solution A was prepared by dissolving the aluminum isopropoxide with or without the seed of α - Al_2O_3 (<100 nm) to the mixed solvent of toluene and isopropanol at 80°C by rapid stirring until completely dissolved. Solution B was prepared by adding certain amount of glucose to deionized water, or only composed of deionized water. The molar ratio of aluminum isopropoxide to water was 1:3. First, adding 1/3 solution B dropwise to solution A under stirring for 30 min, then the remaining solution B was slowly added dropwise to form solution D after stirring 4 h at 80°C. Solution C was prepared by adding certain amount of polyvinylpyrrolidone to isopropanol, or just composed of isopropanol. Solution C was slowly added to the solution D with further stirring for 4 h, yellowish sol can be obtained, put the sol in draught cupboard for evaporation process, then the sol turned to stick gel. The gel was heat treated at 110 °C for 2 h, then the fluffy precursor could be obtained. Finally, the prepared fluffy precursor was ground to fine powder and calcined at different temperature for 2 h in muffle furnace. The process steps are illustrated in Fig. 1. Table 1 shows the different experimental synthesis conditions.

Phase identifications were performed by X-ray diffraction (XRD, Bruker D8 instruments) using nickel filtered Cu Ka radiation in the range of $2\theta = 10\text{--}80$ with scanning speed of 5°C/min, Thermal analysis of the precursor was conducted by thermogravimetrydifferential scanning calorimetry (TG-DSC, SDT Q600) on a Mettler STA 449C instrument. The Fourier transform infrared spectra (FTIR, Thermo Nicolet IS-10) using the KBr pellet method. The morphology of samples was observed by scanning electron microscopy (SEM, A Philips XL 20) and transmission electron microscopy (TEM, Tecnai 12). Samples of TEM were prepared by carbon-coated copper grid, the ultrasonic bath was used to suspend the α - Al_2O_3 powder in ethanol, then a drop of the dispersed powder/ethanol mixture was deposited on the grid, then dried the grid in the air.

STATISTICAL ANALYSIS AND GRAPHICAL PRESENTATION

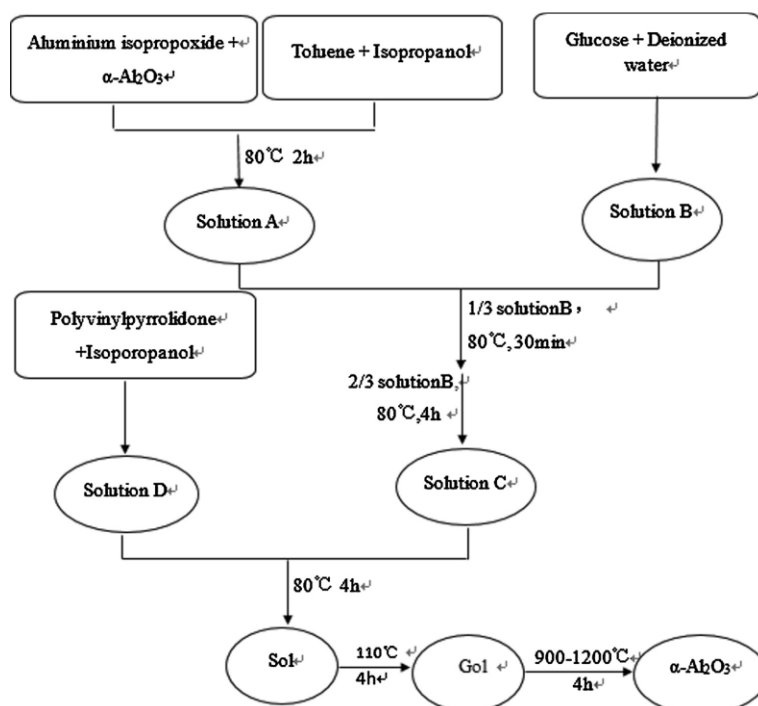


Figure. 1. Flow diagram for preparation of Samples.

Table 1 Synthesis conditions of different samples

Sample	Seed wt%	Glucose wt%	Polyvinylpyrrolidone wt%
Al-1	–	30	–
Al-2	–	–	5
Al-3	–	30	5
Al-4	3.5	30	–
Al-5	3.5	–	5
Al-6	2	30	5
Al-7	3.5	30	5
Al-8	5	30	5

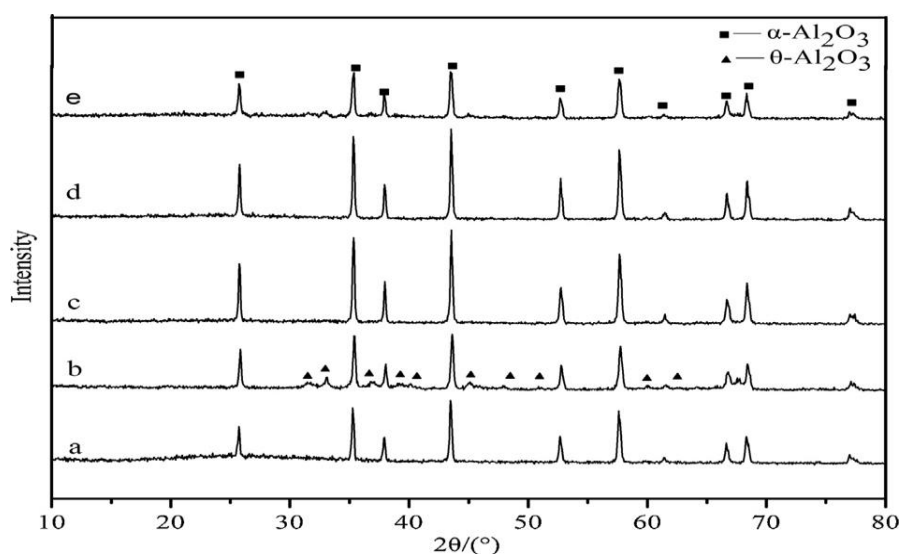


Figure. 2. XRD patterns of samples (a) Al-1, (b) Al-2, (c) Al-3, (d) Al-4, (e) Al-5 after being treated at 1100 °C for 2 h.

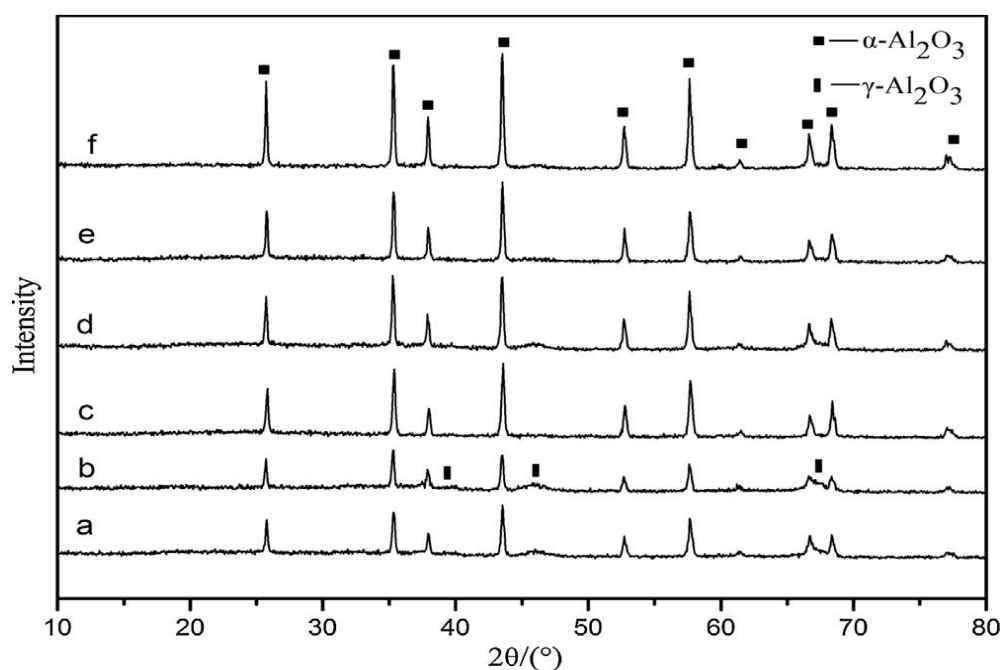


Figure. 3. XRD patterns of samples (a) Al-1, (b) Al-3, (c) Al-4, (d) Al-6, (e) Al-7, (f) Al-8 after sintering at 1000 °C for 2 h.

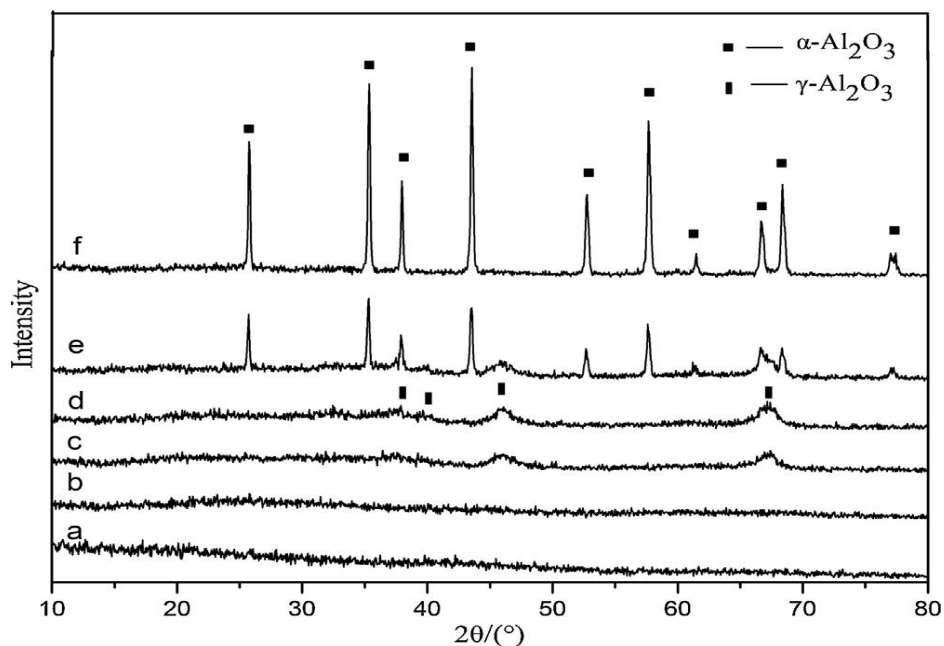


Figure. 4. XRD patterns of sample Al-3 calcined at different temperature (a) 0 °C, (b) 600 °C, (c) 800 °C, (d) 900 °C, (e) 1000 °C, (f) 1100 °C.

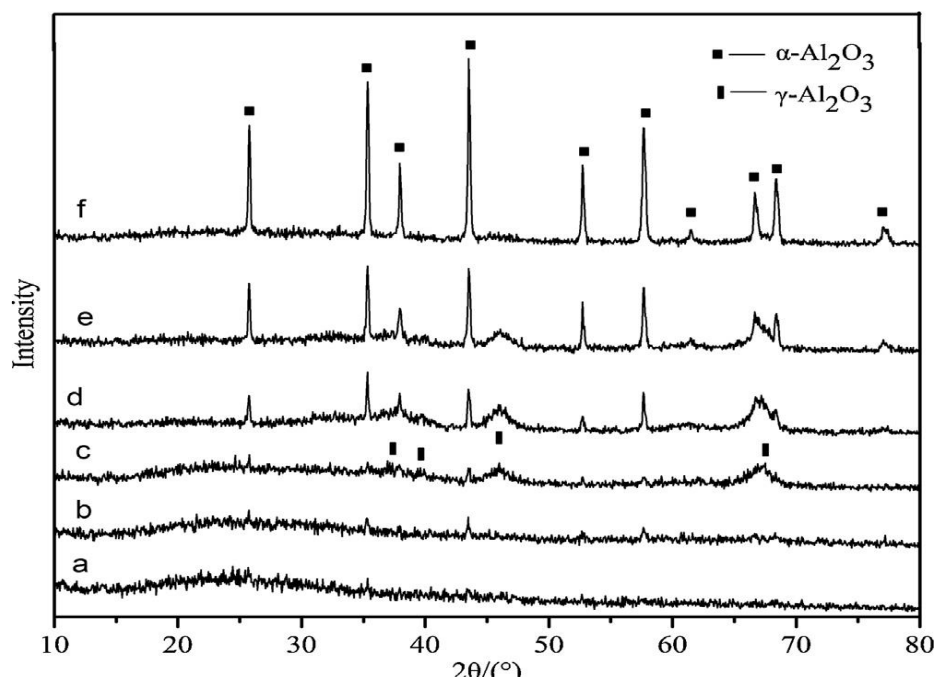


Figure. 5. XRD patterns of sample Al-7 calcined at different temperature (a) 0 °C, (b) 600 °C, (c) 800 °C, (d) 900 °C, (e) 950 °C, (f) 1000 °C.

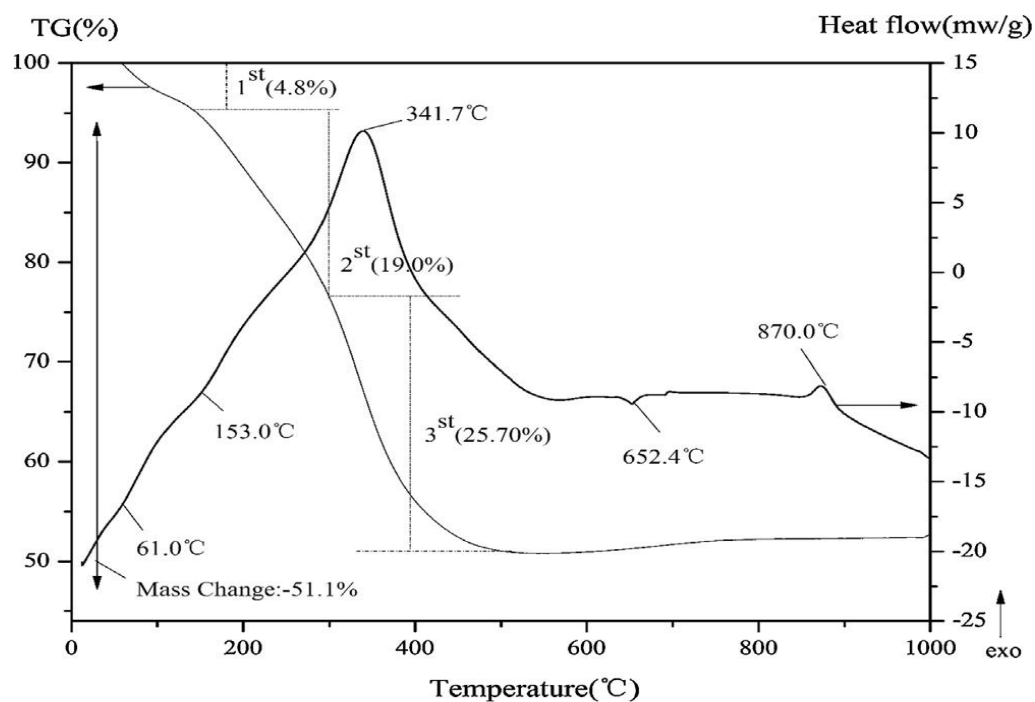


Figure 6. TG-DSC curves of Al-7.

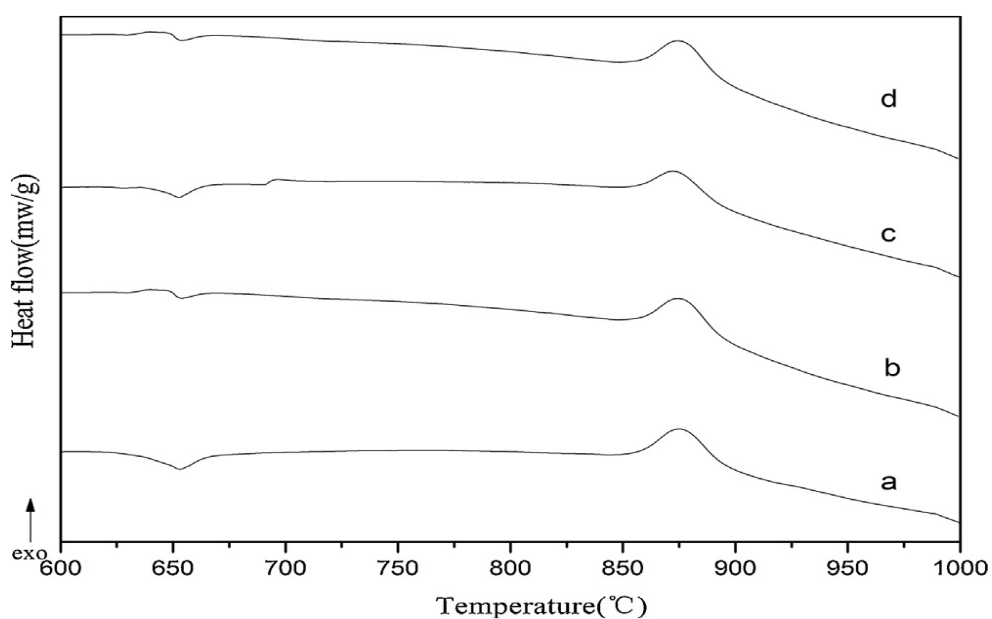


Figure 7. DSC curves of samples with different amount of α - Al_2O_3 seed (a)Al-3, (b)Al-6, (c)Al-7 (d) Al-8.

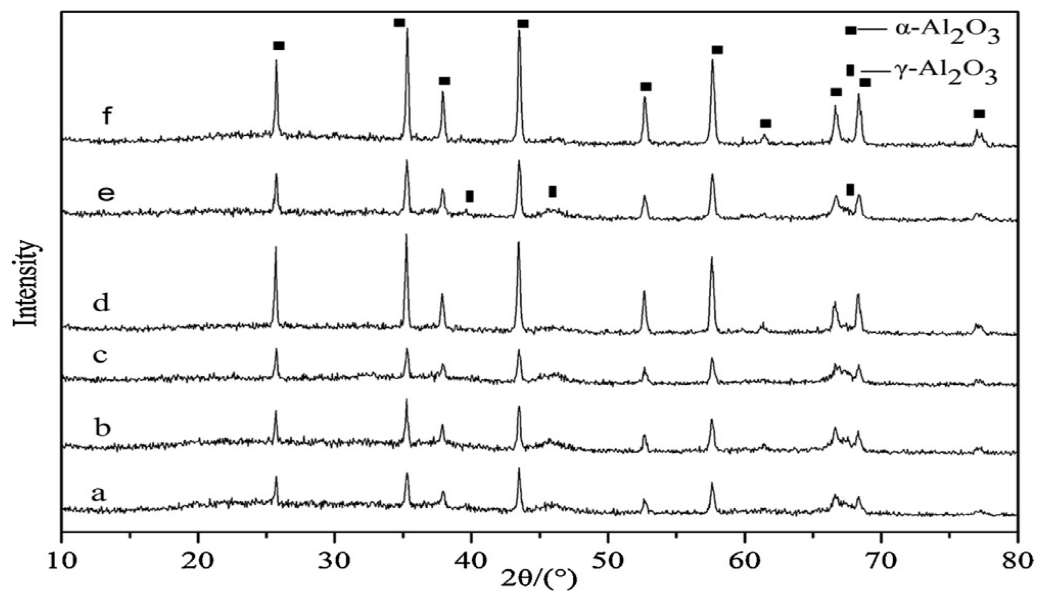


Figure. 8. XRD patterns of sample Al-3 and sample Al-7 calcined at 1000 °C for different time (a)Al-3, 0.5 h, (b)Al-7, 0.5 h, (c)Al-3, 1.5 h, (d)Al-7, 1.5 h, (e)Al-3, 2.5 h, (f)Al-7, 2.5 h.

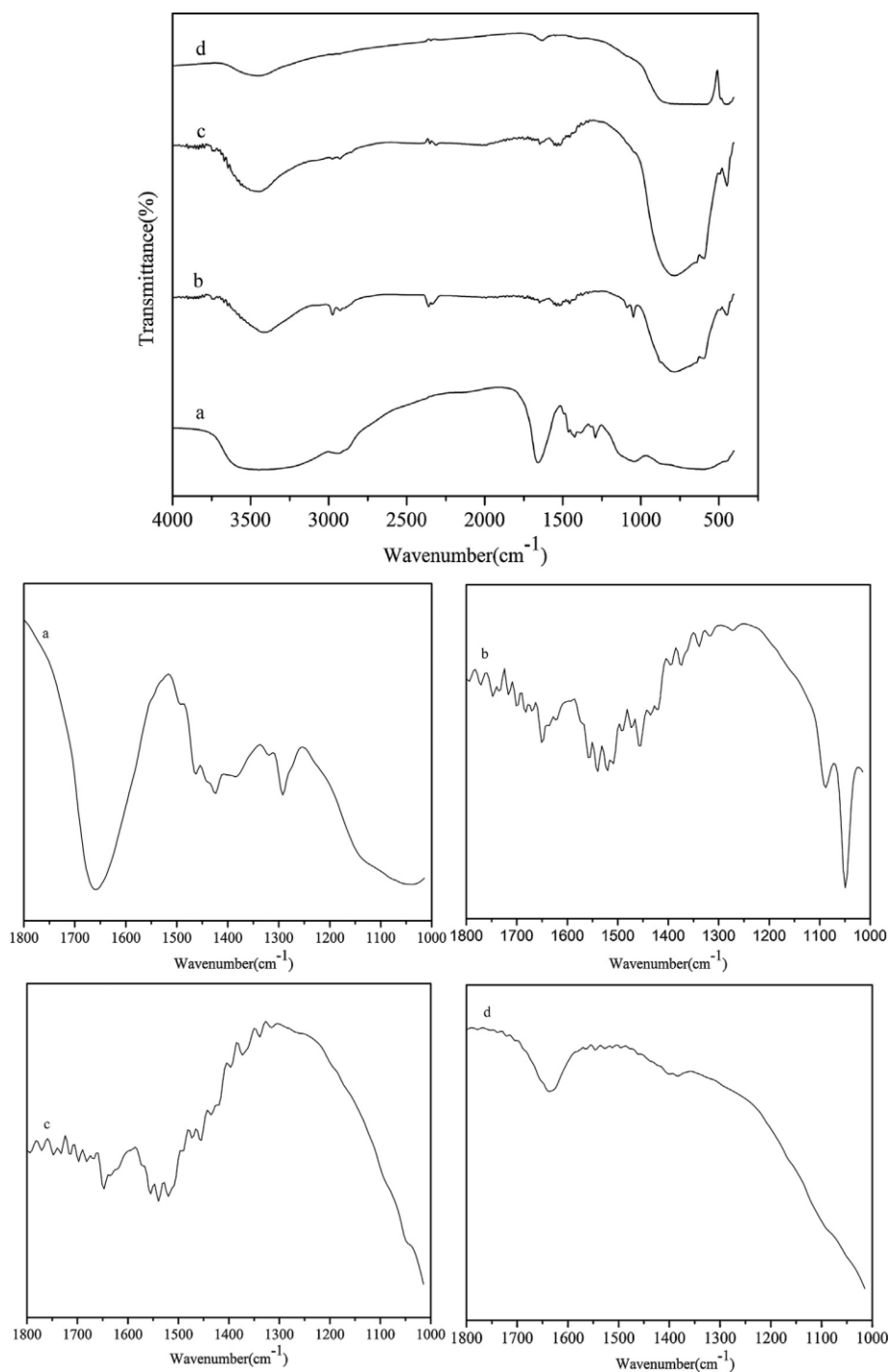


Figure. 9. FTIR spectra for samples prepared from Al-7 calcined at different temperature: (a) 0 °C, (b) 600 °C, (c) 800 °C, (d) 1000 °C.

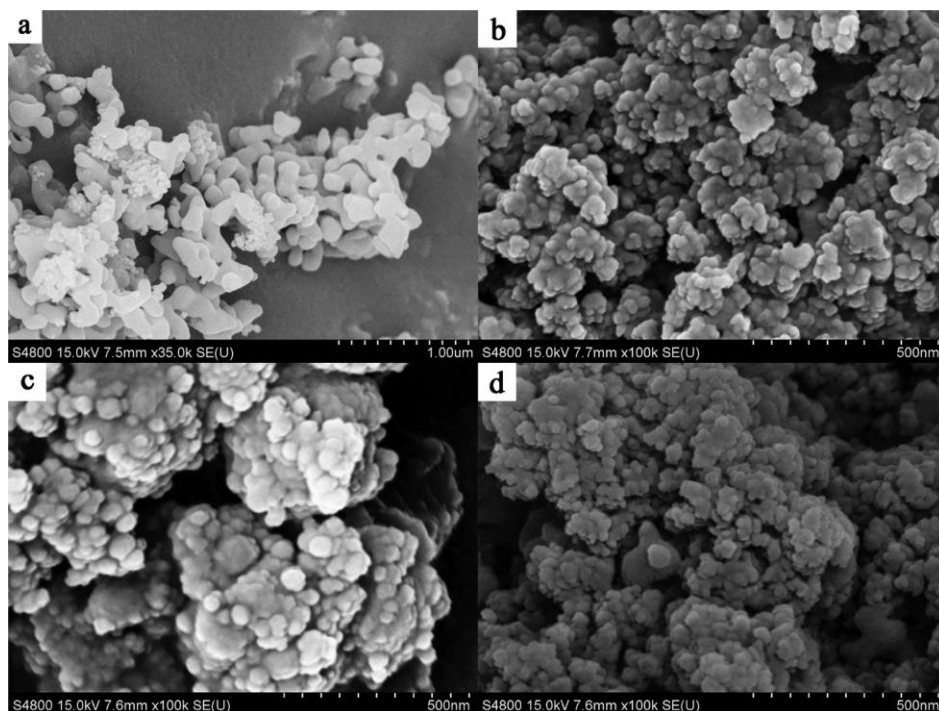


Figure. 10. SEM micrographs of α - Al_2O_3 from different precursors. (a) Al-3, (b) Al-6, (c) Al-7, (d) Al-8.

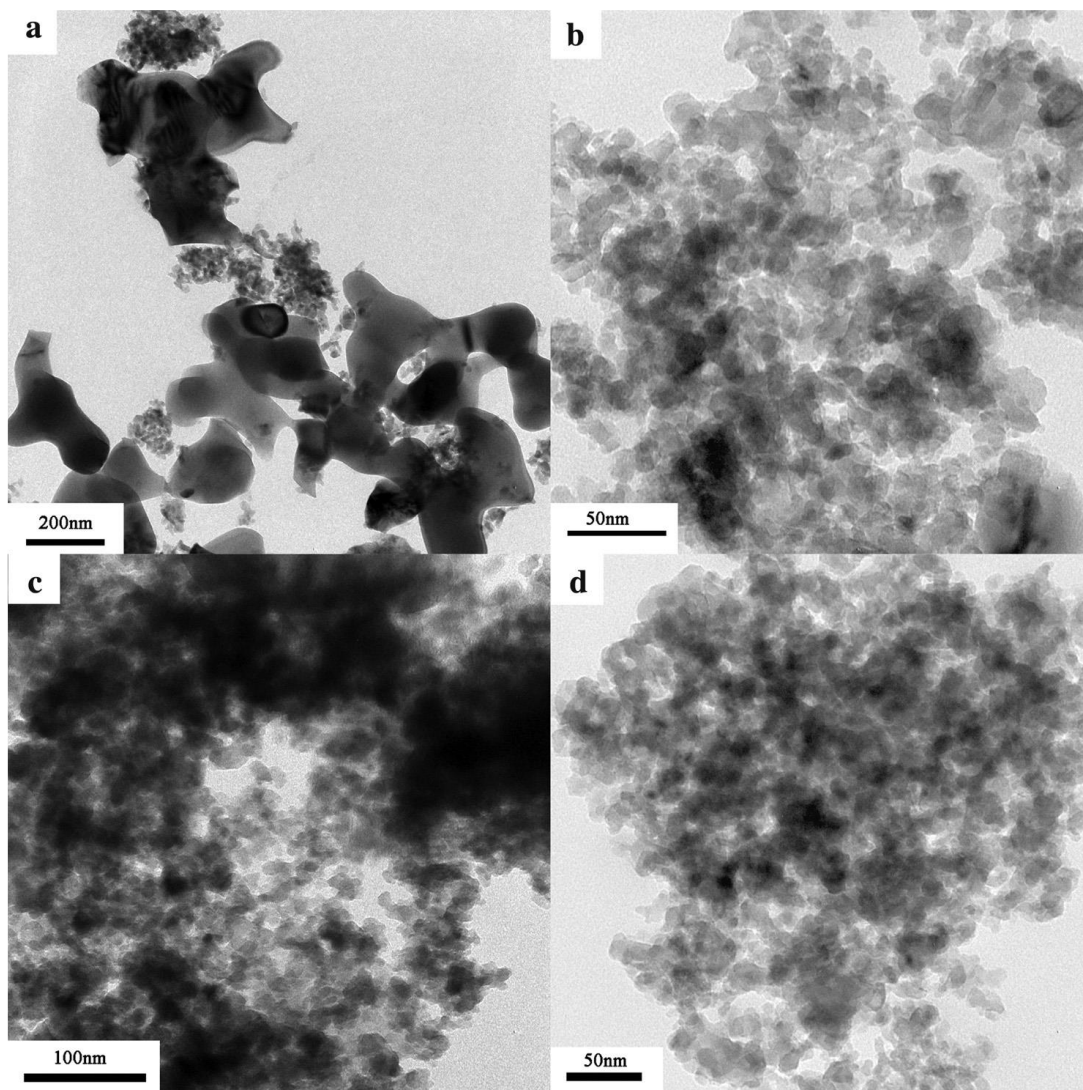


Figure. 11. TEM micrographs of α - Al_2O_3 from different precursors. (a) Al-3, (b) Al-6, (c) Al-7, (d) Al-8.

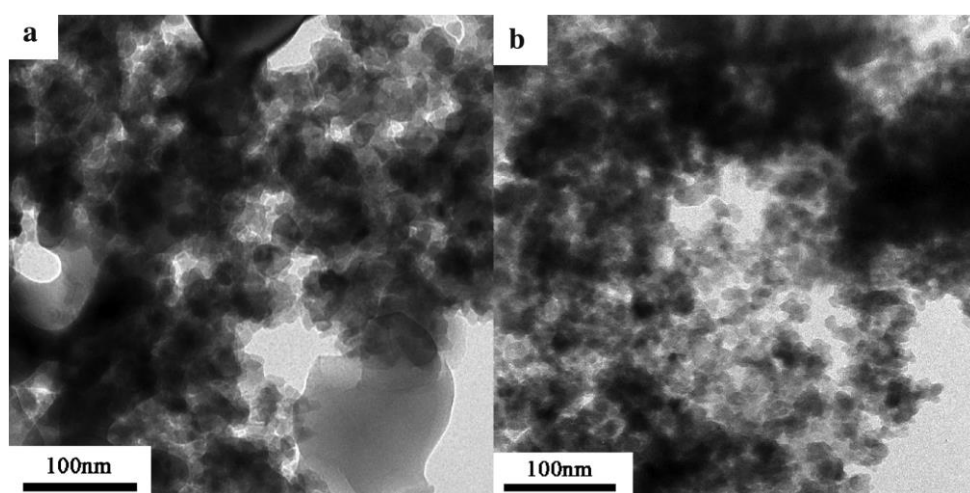


Figure. 12. TEM micrographs of samples (a) Al-4, (b) Al-7 calcined at 1000 C.

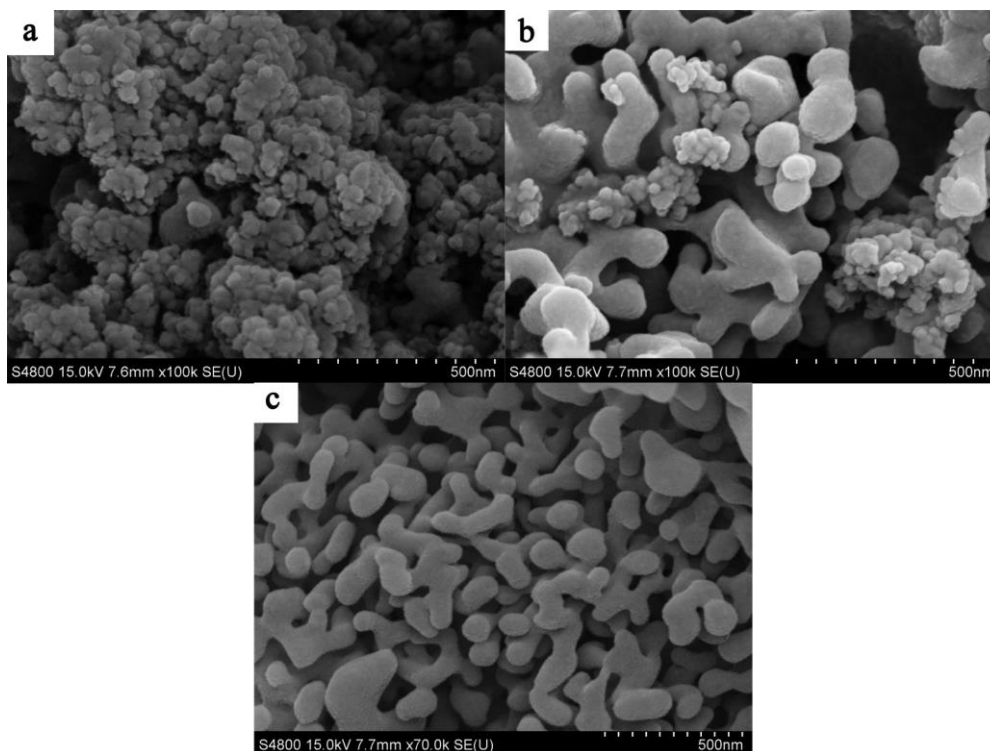
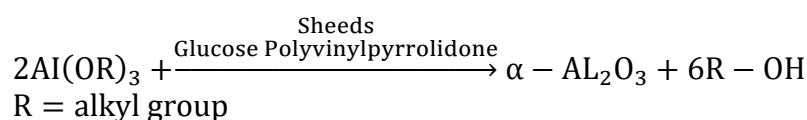


Figure. 13. SEM images of α - Al_2O_3 obtained from the precursor of Al-8 calcined at different temperature. (a) 1000 °C, (b) 1050 °C, (c) 1100 °C.

RESULTS AND DISCUSSION

The synthesis of nano α - Al_2O_3 was carried out through the hydrolysis of aluminum alkoxide with the addition of seeds to improve the transformation rate of α - Al_2O_3 , glucose was used to lower the transformation temperature by impelling the γ - Al_2O_3 transformed to α - Al_2O_3 directly. Polyvinylpyrrolidone was used as surfactants to prevent excessive grain growth and aggregation of nano α - Al_2O_3 . The overall reaction scheme is shown below



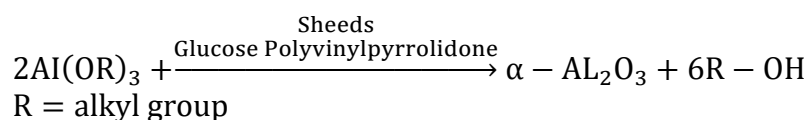
Figs. 2 and 3 show XRD patterns of as synthesized Al_2O_3 powders from different conditions after calcination at 1100 °C and 1000 °C, respectively.

As shown in Fig. 2a–d, only α - Al_2O_3 diffraction peaks were observed at 1100 °C, While, From the Fig. 2b and e, when polyvinylpyrrolidone was added without glucose in the process, α - Al_2O_3 was observed along with γ - Al_2O_3 . Which indicating that the additive of glucose promoted the transformation of α - Al_2O_3 . As shown in Fig. 3, small amounts of γ - Al_2O_3 were observed in Fig. 3a, b and d. From Fig. 3c, e and f. we can find that the powder can be transformed into a single phase from Al-4, Al-7 and Al-8 at a relatively low temperature of 1000 °C. Indicating that there was no benefit of polyvinylpyrrolidone on lowering the phase transformation temperature of α - Al_2O_3 .

With the increasing amount of seed particles, the intensity of γ - Al_2O_3 diffraction peak became weaker, when the amount of seed was more than 3.5%, the pure α - Al_2O_3 can be obtained after calcination at 1000 °C for 2 h. The XRD analysis in Figs. 4 and 5 show the sample Al-3 and sample Al-7 calcined at different temperatures, respectively. As shown in Fig. 4, The obtained precursor from Al-3 was amorphous, Diffraction peaks corresponding to γ - Al_2O_3 appeared at 800 °C. The amount of α - Al_2O_3 increased drastically when the calcination temperature reached to 1000 °C with small amount of γ - Al_2O_3

remained. When the calcination temperature increased up to 1100 °C, the phase transformation of g- Al₂O₃ to α- Al₂O₃ completed. Throughout the calcination, there was no other alumina phase except for g- Al₂O₃ and α- Al₂O₃. Showing the addition of glucose promoted the g- Al₂O₃ transformed to α- Al₂O₃ directing, which is due to the relaxation of amorphous aluminum hydroxide powders reduced the defects and lattice distortion in g- Al₂O₃ powders, which released some energy, thus promoted the nucleation of α- Al₂O₃ [19].

As shown in Fig. 5, When the temperature was lower than 900 °C, weak diffraction peaks of α- Al₂O₃ can be found, which could have attributed to the additive of α- Al₂O₃ seed. Diffraction peaks of g- Al₂O₃ could be found when the calcination temperature reached to 800 °C, which was as same as Fig. 4. Indicating that the α- Al₂O₃ seed have no impact on phase transformation of g- Al₂O₃. Compared to Fig. 4, α-Al₂O₃ seed promoted the g- Al₂O₃ transformed to α- Al₂O₃. The thermal decomposition and phase transition of the precursor (Al-7) have been further studied by TG-DSC analysis. The TG-DSC curves are shown in Fig. 6, There are three stages of weight loss, the first stage ranges from 20 °C to 130 °C was caused by the evaporation of the absorbed water and residual solvent, the second stage ranges from 130 °C to 230 °C referred to the removal of the structural water existing in the precursor. The third stage ranges from 230 °C to 510 °C with a relatively sharp and intense exothermic peak around 341.7°C can be attributed to the decomposition of the glucose and polyvinylpyrrolidone. The small endothermic peak at 652.4 °C was associated with the amorphous aluminum hydroxide decomposed to g- Al₂O₃. The small exothermic peak at 870 °C corresponded to the transformation of g- Al₂O₃ to α- Al₂O₃. Which was consistent with the XRD results. From the results of XRD and TG-DSC, we can conclude that the multi-step process involves the following chemical transformation.



The fig. 7 showed the DSC curves of samples with different amount of α-Al₂O₃ seed at a temperature in the range from 600 °C to 1000 °C. From the curves, we can find that the four samples have the same endothermic peak and exothermic peak, which indicated that the seeds have no effects on the decomposition temperature of amorphous aluminum hydroxide to g-Al₂O₃ and the transformation temperature of g- Al₂O₃ to α- Al₂O₃. The XRD analysis in Fig. 8 showed that the sample Al-3 and sample Al-7 calcined at 1000 °C for different time. As show in Fig. 8, with the increasing of calcining time, the diffraction peaks of g- Al₂O₃ became weaker. The sample Al-7 with 3.5% seed showed the pure diffraction peaks of α- Al₂O₃ when calcined at 1000 °C for 1.5 h, While, the sample Al-3 without seed showed the diffraction peaks of g- Al₂O₃ when calcined at 1000 °C for 2.5 h. Although the additive of seed has no impact on the phase transformation temperature. It improved the phase transformation rate. Which could explained by the nucleation theory [26] The FTIR for the precursor of Al-7 calcined at different temperature are presented in Fig. 9, a wide absorption band at 3450 cm⁻¹ was attributed to the stretching vibration of hydroxylate (O–H), The absorption at 2940 cm⁻¹ was ascribed to the stretching vibration of hydrocarbon(C–H), An increasingly weak peak at 1650 cm⁻¹ was caused by the adsorption of H₂O. From the curve a, b, c, we can find that there were a lot of small peaks situating in the range of 1600–1200 cm⁻¹, attributed to the glucose and polyvinyl pyrrolidone, which indicated that, the surfactants still attached to the surface of alumina when the calcination temperature reached to 800 °C, A small adsorption peak located in 1040 cm⁻¹ in curve b, assigned to stretching vibration of C–O–C, which was due to the oxidation of glucose in the calcination process.

The broad band at 1000–400 cm⁻¹ corresponded to Al–O vibration. Fig. 10 shows the SEM micrographs of the gained α- Al₂O₃ powders from precursors with different amounts of α- Al₂O₃ seed. From the XRD analysis, we know that the pure α- Al₂O₃ can be obtained from Al-3 until the calcination temperature reached to 1100 °C. However, the pure α- Al₂O₃ from Al-7, Al-8 can be gained at 1000 °C. The α- Al₂O₃ from Al-3 (Fig. 10a) has relatively larger grains with seriously hard aggregation than the α- Al₂O₃ powders with various amount of additives (Fig. 10b–d). Fig. 11 shows the TEM micrographs of α- Al₂O₃ from different precursors. The Al₂O₃ from Al-3 had two kinds of particle size, which was caused by agglomeration and growth at high calcination temperature. While, α- Al₂O₃ powders with various

amount of additives have uniform particle size, the average particle size was less than 50 nm. At the same temperature, the amount of seeds has no significant effect on the particle size of α - Al_2O_3 powders. The TEM micrographs of the α - Al_2O_3 particles in Fig. 11 shows that the α - Al_2O_3 prepared from the precursor with seeds additive had irregular sharp. Fig. 12 shows TEM micrographs of sample Al-4 and Al-7 calcined at 1000 °C. From the result of XRD, we know that the pure α - Al_2O_3 can be obtained from sample Al-4 and Al-7. Comparing Fig. 12(a) with Fig. 12(b), we can find that polyvinylpyrrolidone had an important effect on reducing the particle growth and aggregation.

SEM images in Fig. 13 illustrate the influence of the calcination temperature on the morphologies of α - Al_2O_3 obtained from Al-8. It can be seen that as the calcination temperature increased from 1000 to 1100 °C, the morphology of α - Al_2O_3 transformed from approximately spherical sharp to vermiform sharp, besides, the obtained α - Al_2O_3 powder was seriously aggregated and connected with each other. The particle size of α - Al_2O_3 increased from 50 nm to 250 nm. Which was attributed to the particle growth through the coalescence and densification process of the initial particles [26].

CONCLUSIONS AND RECOMMENDATIONS

This article focus on the effects of seed particles and surfactants on the phase transformation and particle morphology of α - Al_2O_3 . The additive of glucose can promote the α - Al_2O_3 transformed from γ - Al_2O_3 directly. Adding 3.5–5 wt% of α - Al_2O_3 powder to aluminum isopropoxide markedly increased the phase transformation rate of γ - Al_2O_3 to α - Al_2O_3 . Polyvinylpyrrolidone played an important role in reducing the particle growth and aggregation. The ultrafine α - Al_2O_3 powder with high degree of homogeneity can be prepared at 1000 °C in the presence of seed, glucose and polyvinylpyrrolidone, via this method, the particle size of the obtained sample was less than 50 nm. Further, aluminum isopropoxide was used as raw material, except the glucose and polyvinyl pyrrolidone, other substances were not introduced, so the obtained α - Al_2O_3 powders had high purity. This two-step hydrolysis method is so simple and the preparation process conditions are easy to control, so it has great potential applications in industrial production.

REFERENCES

- [1] P. Tartaj, J. Tartaj, Preparation, characterization and sintering behavior of spherical iron oxide doped alumina particles, *Acta Mater.* 50 (2002) 5–12.
- [2] E. Straßburger, Ballistic testing of transparent armour ceramics, *J. Eur. Ceram. Soc.* 29 (2009) 267–273.
- [3] A. Krell, J. Klimke, T. Hutzler, Advanced spinel and sub-mm Al_2O_3 for transparent armour applications, *J. Eur. Ceram. Soc.* 29 (2009) 275–281.
- [4] T.D. Isfahani, J. Javadpour, A. Khavandi, R. Dinnebier, M. Goodarzi, H.R. Rezaie, Mechanochemical synthesis of alumina nanoparticles: formation mechanism and phase transformation, *Powder Technol.* 229 (2012) 17–23.
- [5] M.L. Panchula, J.Y. Ying, Mechanical synthesis of nanocrystalline- Al_2O_3 seeds for enhanced transformation kinetics, *Nanostruct. Mater.* 9 (1997) 161–164.
- [6] T.C. Chou, T.G. Nieh, Nucleation concurrent anomalous grain growth of α - Al_2O_3 during γ to α phase transformation, *J. Am. Ceram. Soc.* 74 (1991) 2270–2279.
- [7] H.K. Varma, T.V. Mani, A.D. Damodran, Characteristics of alumina powders prepared by spray-drying of boehmite sol, *J. Am. Ceram. Soc.* 77 (1994) 1597–1600.
- [8] J.G. Ma, B.L. Wu, Effect of surfactants on preparation of nanoscale α - Al_2O_3 powders by oil-in-water microemulsion, *Adv. Powder Technol.* 24 (2013) 354–358.
- [9] O.A. Graeve, H. Fathi, J.P. Kelly, M.S. Saterlie, K. Sinha, G.R. George, R. Kanakala, D.R. Brown, E.A. Lopez, Reverse micelle synthesis of oxide nanopowders: mechanisms of precipitate formation and agglomeration effects, *J. Colloid Interface Sci.* 407 (2013) 302–309.

- [10] K.M. Parida, A.C. Pradhan, J. das, N. Sahu, Synthesis and characterization of nano-sized porous gamma-alumina by control precipitation method, *Mater. Chem. Phys.* 113 (2009) 244–248.
- [11] Y.K. Park, E.H. Tedd, M. Zubris, R. Tannenbaum, Size-controlled synthesis of alumina nanoparticles from aluminum alkoxides, *Mater. Res. Bull.* 40 (2005) 1506–1512.
- [12] R. Aghababazadeh, A.R. Mirhabibi, J. Pourasad, A. Brown, R. Brydson, S. Banijamali, N.A. Mahabad, Economical synthesis of nanocrystalline alumina using an environmentally low-cost binder, *Surf. Sci.* 601 (2007) 2864–2867.
- [13] W.L. Suchanek, Hydrothermal synthesis of alpha alumina (α -Al₂O₃) powders: study of the processing variables and growth mechanisms, *J. Am. Ceram. Soc.* 93 (2010) 399–412.
- [14] S. Ghanizadeh, X. Bao, B. Vaidhyanathan, J. Binner, Synthesis of nano α -alumina powders using hydrothermal and precipitation routes: a comparative study, *Ceram. Int.* 40 (2014) 1311–1319.
- [15] Y.T. O, S.W. Kim, D.C. Shin, Fabrication and synthesis of α -alumina nanopowders by thermal decomposition of ammonium aluminum carbonate hydroxide (AACH), *Colloids Surf. A Physicochem. Eng. Aspects* 313–314 (2008) 415–418.
- [16] J.G. Li, X.D. Sun, Synthesis and sintering behavior of a nanocrystalline α -alumina powder, *Acta Mater.* 48 (2000) 3103–3112.
- [17] G.F. Fu, J. Wang, J. kang, Influence of AlF₃ and hydrothermal conditions on morphologies of α -Al₂O₃, *Trans. Nonferrous Met. Soc. China* 18 (2008) 743–748.
- [18] F.W. Dynys, J.W. Halloran, Alpha alumina formation in alum-derived gamma alumina, *J. Am. Ceram. Soc.* 65 (1982) 442–448.
- [19] J. Li, Y.B. Pan, C.S. Xiang, Q.M. Ge, J.K. Guo, Low temperature synthesis of ultrafine α -Al₂O₃ powder by a simple aqueous sol–gel process, *Ceram. Int.* 32 (2006) 587–591.
- [20] Y.Q. Wu, Y.F. Zhang, G. Pezzotti, J.K. Guo, Influence of AlF₃ and ZnF₂ on the phase transformation of gamma to alpha alumina, *Mater. Lett.* 52 (2002) 366–369.
- [21] M.I.F. Macedo, C.A. Bertran, C.C. Osawa, Kinetics of the gamma $\rightarrow$ α alumina phase transformation by quantitative X-ray diffraction, *J. Mater. Sci.* 8 (2007) 2830–2836.
- [22] J. Li, Y.S. Wu, Y.B. Pan, W.B. Liu, J.K. Guo, Influence of fluorides on phase transition of α -Al₂O₃ formation, *Ceram. Int.* 33 (2007) 919–923.
- [23] R.B. Bagwell, G.L. Messing, P.R. Howell, The formation of α -Al₂O₃ from γ -Al₂O₃: the relevance of a critical size and: diffusional nucleation or synchro-shear? *J. Mater. Sci.* 36 (2001) 1833–1841.
- [24] M. Kumagai, G.L. Messing, Controlled transformation and sintering of a boehmite sol–gel by α -alumina seeding, *J. Am. Ceram. Soc.* 68 (1985) 500–505.
- [25] G.R. Karagedov, A.L. Myz, Preparation and sintering pure nanocrystalline α -alumina Powder, *J. Eur. Ceram. Soc.* 32 (2012) 219–225.
- [26] H.C. Park, Y.J. Park, R. Stevens, Synthesis of alumina from high purity alum derived from coal fly ash, *Mater. Sci. Eng.* 367 (2004) 166–170.



VIII. International Symposium-2024

HYDROGEOCHEMICAL STUDY OF THE GROUNDWATER IN THE COASTAL AREA, NORTHEASTERN OF BENGHAZI, NE LIBYA

Osama A. EL FALLAH^{1*}, Ahmed ABUHARARA²

¹Department of Earth Sciences, Faculty of Science, Benghazi University, Benghazi, Libya.

²Department of Geology, Faculty of Science, Omar Al-Mukhtar University, Al Bayda, Libya.

*osama.elfallah@uob.edu.ly

Abstract:

Libya is in a semi-arid region of North Africa and faces a significant scarcity of water sources, both surface and groundwater, particularly in the northern part of the country. To address the water shortage and preserve the environment while achieving water security in Libya, it is essential to assess, protect, and maintain the integrity of surface and groundwater resources. This study provides valuable insights into the hydrochemistry, water quality, and potential applications of groundwater resources in the coastal area of northeastern Benghazi, Libya. To understand the origin, type, and characteristics of the groundwater, as well as the relationships between different chemical variables, hydrogeochemical analyses and diagrams were employed for six groundwater samples from the study area (S1, S2, S3, S4, S5, and S6). Additionally, Phreeqc software was utilized to determine the saturation index of the groundwater with respect to the minerals of the aquifer's rocks. The saturation index shows over-saturation concerning carbonate minerals and slight saturation for evaporate minerals. However, the groundwater is salty, holding high concentrations of the total dissolved solids (TDS), and is dominated by Sodium and Chloride in the western part of the study area, while holding moderately concentrations of (TDS) and dominated by Bicarbonates and Chloride in the eastern part of the study area due to a response to rock weathering, water-rock interaction and seawater intrusion as they are the most natural processes that controlling chemistry and quality of the groundwater.

Keywords: Groundwater, Water Quality, Saturation Index, Hydrochemistry, Water Type, Irrigation.

INTRODUCTION

Groundwater plays a crucial role as a freshwater source in various regions. It is widely recognized that groundwater resources are less susceptible to external factors compared to surface water. Consequently, the significance of groundwater has been amplified by the effects of global climate change and the recurring occurrences of droughts and floods [1]. Water is an important bioresource for all life; the freshwater resources account for less than 1% of all water present on Earth [2]. Natural resource stress is growing as a result of fast industrialization and population growth, and protecting them is one of humanity's greatest difficulties. Groundwater is a crucial resource for irrigation and drinking [3].

Therefore, human activities and civilizations were focused around these sources of water; these unplanned human activities and increasing economic developments applied vast stresses on groundwater resources. Libya is one of the countries that suffers from a severe shortage of water resources. As it is located in an arid region in the northern part of Africa (Figure 1.a), it is one of those countries that suffer from a severe shortage of water and surface water resources, due to the low rate of precipitation and high evaporation rates which means the search for sources of groundwater and protect it is a very important demand. Monitoring the quality of water used for drinking and irrigation is extremely important because it may include toxins that are harmful to human health. The chemical parameters of groundwater play a significant role in assessing water quality and assessing its suitability for drinking and irrigation [4]; moreover, the geochemical studies of groundwater provide a good understanding of possible changes in quality as development progresses. The suitability of groundwater for domestic and irrigation purposes is determined by its groundwater geochemistry [5]. This work aims to evaluate the quality, chemical properties, and suitability for human and agricultural usages for the groundwater of the study area, northeastern of Benghazi city, NE Libya (Figure 1.b).

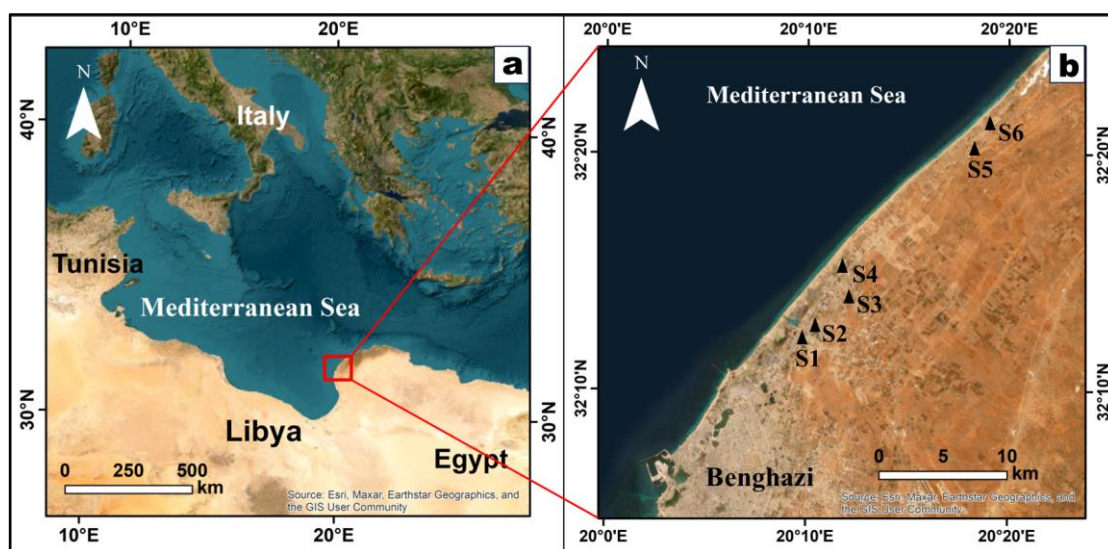


Figure 1: Satellite images showing, a) location of the study area, b) locations of the studied groundwater wells.

GEOLOGICAL SETTINGS

The study area from the lithological approach is composed of carbonate rocks interbedded with clay, gypsum, and dolomite. Stratigraphically [6] classified them in ascending order according to the Benghazi Formation, which is exposed throughout several places in the coastal plain to the south and east of Benghazi city, and characterized by limestone and small patches of green fossiliferous clay. The Wadi al Qattarah Formation, which in places overlains the Benghazi Formation, is mostly characterized by fossiliferous limestone and of oolitic texture [7]. Quaternary sediments: littoral marine deposits, lagoonal (Sebkha) deposits, and alluvial deposits. An important phenomenon contributing to groundwater movement is limestone karstification, which is particularly observed in the Benghazi limestones of the Ar-Rajmah Group [8]. Several doline lakes with brackish water developed in the coastal plain of the Benghazi area are supporting the groundwater movement through a vast cavernous system onto the coast. Hence, the salinity of groundwater becomes more deteriorated throughout the Benghazi plain as you get closer to the sea coast [6,8].

MATERIALS AND METHODS

Six groundwater samples (S1, S2, S3, S4, S5, and S6) were analyzed in the laboratory of the General Water Authority, Benghazi. The concentrations of major cations, Total Hardness (TH), and alkalinity were determined by the titrimetric method, while other anions were measured by a spectrophotometer. The concentration of Total Dissolved Solids (TDS) was estimated by the gravimetric method. In this study, we used Piper, Stiff, Durov, and Gibbs diagrams to determine the origin and type of water and the relationships between the chemical variables. Additionally, the saturation index (SI) was calculated using the PHREEQC interactive code by applying the equation [9]:

$$SI = \log [\text{ion activity product}]/KT \quad (\text{Equation 1})$$

Where: KT is the equilibrium constant at temperature T.

Additionally, we compared the chemical parameters of the studied water with World Health Organization standards [10] and used Wilcox's diagram to assess the suitability of water for different purposes.

RESULTS AND DISCUSSION

Hydrochemistry of the groundwater

The chemical analysis results of the studied samples are shown in Table 1. The TDS values are less than 1000 mg/l in the eastern part of the study area, which indicates that the water is freshwater type, while they are more than 1000 mg/l in the western part of the study area, which indicates that the water is brackish water type. In order to identify the chemistry of the studied water, as well as its type, origin, some diagrams were used to evaluate the water quality and the aquifer's hydrogeochemical conditions. Here, some diagrams were applied to the chemical analyses of the studied groundwater of the study area: Piper's diagram, Stiff's diagram, Durov's diagram, and Gibbs's diagram.

Table 1: Average of the chemical variables of the studied groundwater samples with drinking water standard values of WHO (2018), (EC is in $\mu\text{S}/\text{cm}$, except pH, all Elements concentrations, and TDS are in mg/l).

Parameters	S1	S2	S3	S4	S5	S6	WHO (2018)
EC	8765	7430	1815	1535	930	975	–
pH	7.4	7.6	6.9	7.3	7.5	7.3	6.5 – 8.5
TH	1400	1165	538	450	380	397	–
TDS	5700	4820	1180	985	600	630	500
K^+	49	41	5	6	7	8	50
Na^+	1622	1455	242	176	83	94	200
Mg^{2+}	207	234	68	54	40	38	50
Ca^{2+}	220	262	103	125	86	95	200
Cl^-	3120	2930	470	587	156	173	250
SO_4^{2-}	437	406	154	162	81	86	600
HCO_3^-	92	194	270	154	311	324	600

Piper's trilinear diagram

Piper's diagram [11] is a diagram used to estimate the chemical affinity of water samples and potential effective processes in aquifers based on the equivalent ratios of alkali metals and alkaline earths versus strong and weak acidic anions. In our case, it is clear that the S1, S2, S3, and S4 are located in the portion $\text{Na}^+ - \text{Cl}^-$ water type, resulting from seawater intrusion to the coastal aquifers due to the research area's proximity to the shore, while, it is clear that the S5 and S6 are situated in the portion of mixed type and

indicating that there is not cation-anion pair exceeding 50 %. The alkaline earths ($\text{Ca}^{2+} + \text{Mg}^{2+}$) exceed alkalis ($\text{Na}^+ + \text{K}^+$), and also strong acids exceed weak acids (Figure 2).

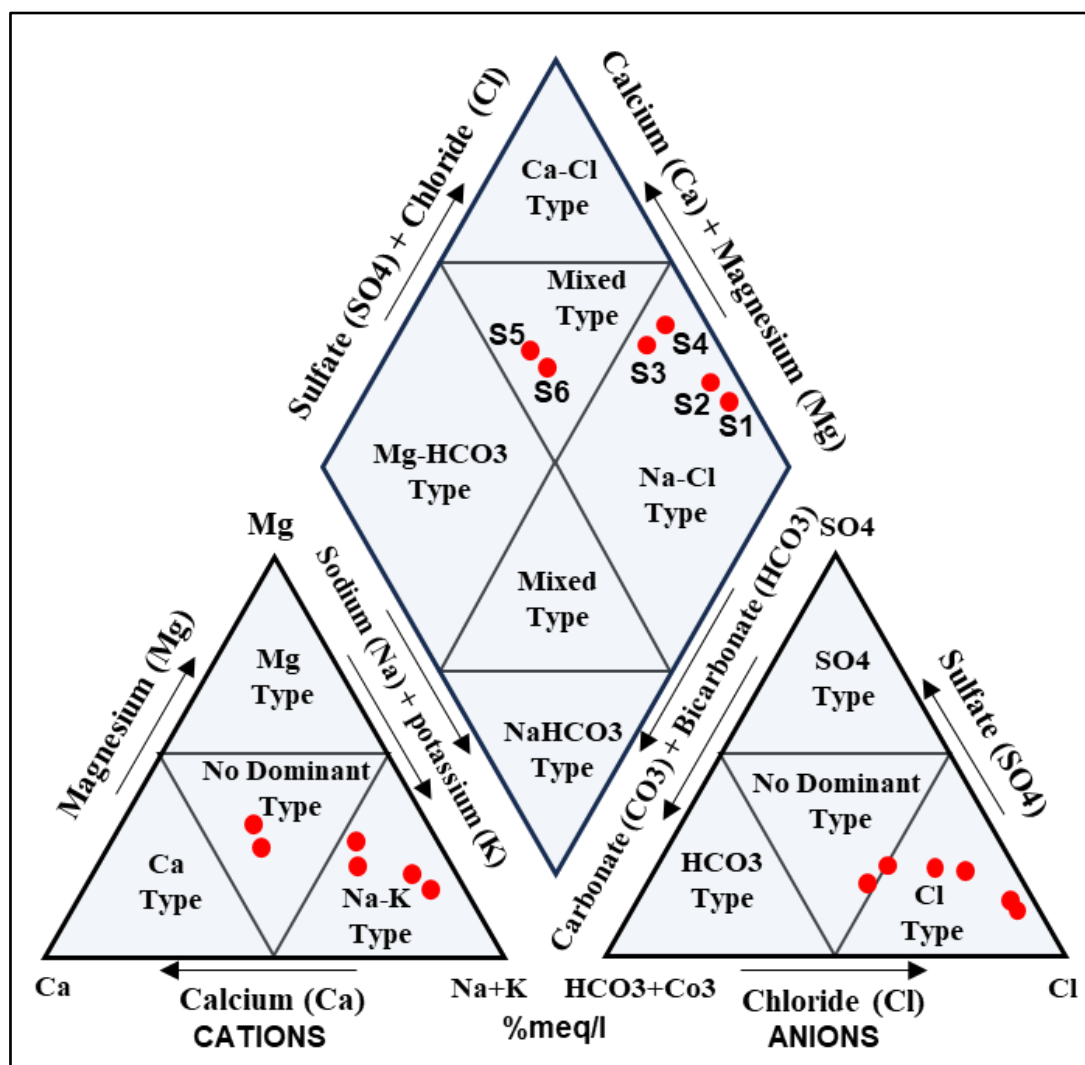


Figure 2: Piper's diagram showing the hydrochemical facies of the studied groundwater samples.

Stiff's diagram

This diagram was set by Stiff in 1951 [12], using the concentrations of cations and anions in meq/l. The cations are shown on the left side of a vertical axis, which represents zero value, while the anions are shown on the right side of this axis. The plotted points are connected, forming a characteristic polygon shape, revealing the abundance of cations and anions. In the studied groundwater samples, the diagram showed that the abundance of cations can be arranged as $\text{Na}^+ + \text{K}^+ > \text{Ca}^{2+} > \text{Mg}^{2+}$, while the arrangement of anions was $\text{Cl}^- > \text{HCO}_3^- > \text{SO}_4^{2-}$ (Figure 3).

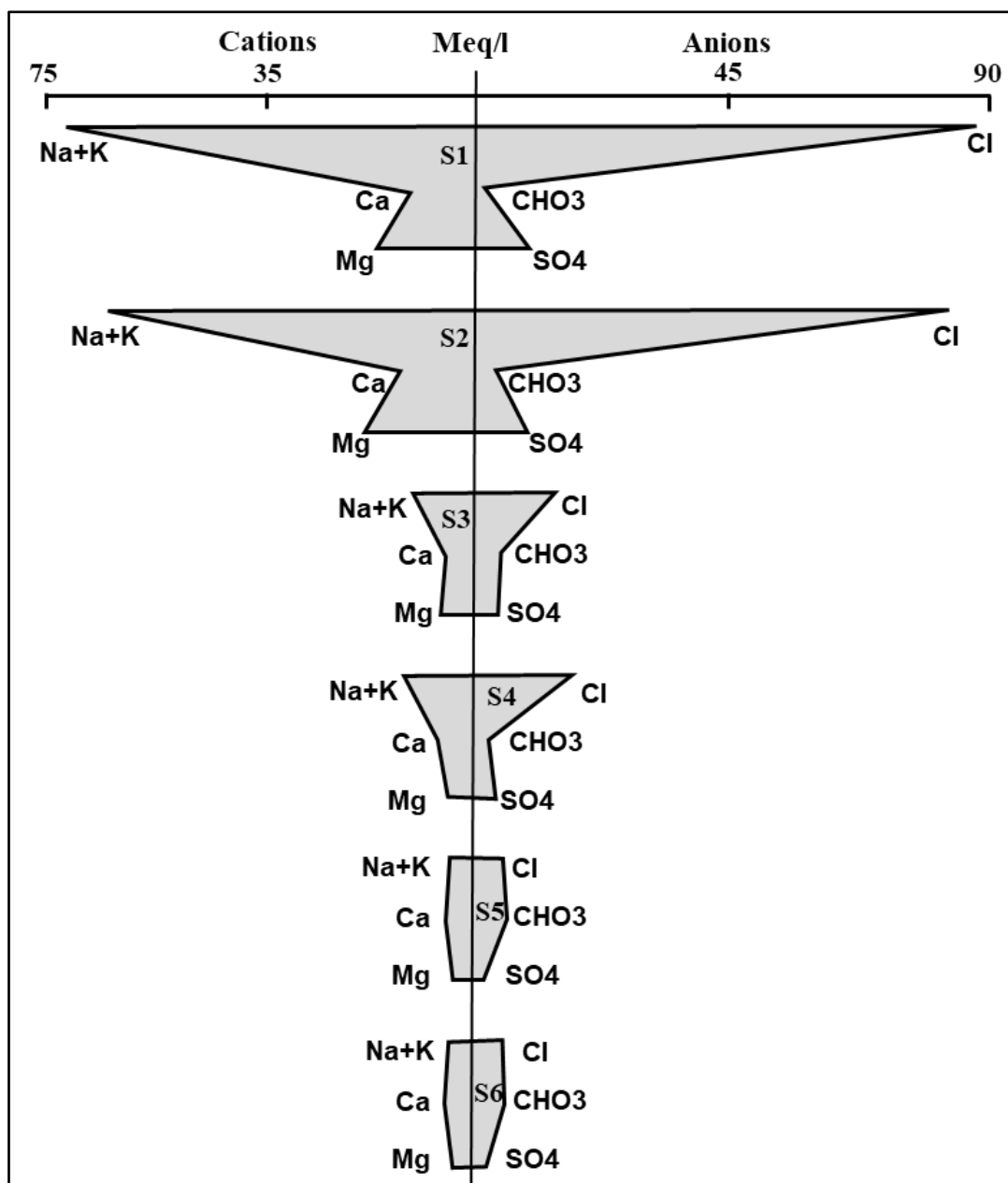


Figure 3: Stiff's diagram showing the average composition of the studied groundwater samples.

Durov's diagram

Durov's diagram is supportive of identifying the hydrogeochemical processes in groundwater aquifers [13]. This diagram contains two basic triangles and one square. The two triangles are divided into one at the top of the diagram, dedicated to anions, and one on the left side to cations. Anions are negatively charged, while cations are positively charged ions. The ion exchange process will take place between the water and the grains of the rocks of the aquifer. In our case, the diagram showed ion exchange in the samples (S1, S2, S3, and S4), and the simple dissolution (or possible mixing) for the samples (S5 and S6) due to the simple dissolution process. The dissolution rate depends on the solubility of a mineral, which indicates that the water experienced a mixing process in several aquifers located at that location (Figure 4). The mixing can also happen in leaking aquifers, resulting in the mixing of groundwater from different aquifers [14].

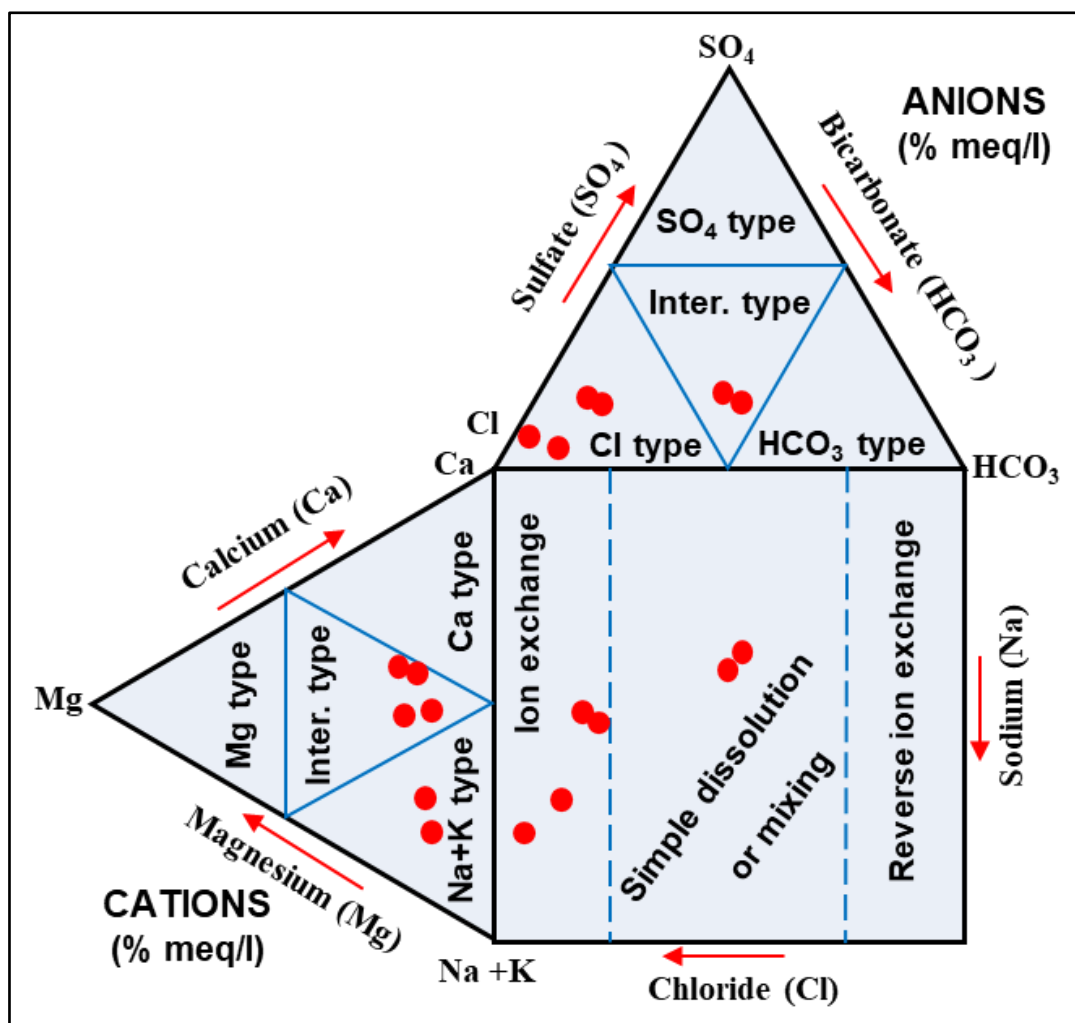


Figure 4: Durov's diagram for the studied groundwater samples

Gibbs's diagram

Gibbs's diagrams are often used to assess the origins of dissolved chemical substances in groundwater and to understand the factors that control groundwater chemistry [15]. In the diagram there are three distinct zones, evaporation crystallization, rock weathering and precipitation it includes two diagrams: one shows the relative concentrations of Cl^- and HCO_3^- on the x-axis and TDS on y-axis with a logarithmic scale, and the second diagram shows the ratio of Na^+ , Cl^- and HCO_3^- on the x-axis and TDS on y-axis with a logarithmic scale. The studied groundwater samples are dominated by Sodium and Chloride, the samples fall in the evaporation crystallization and the rock weathering zone of Gibbs's diagram (Figure 5. a & b), which indicates the evaporation in the study area and water-rock interaction, which are natural processes that control the chemistry of groundwater.

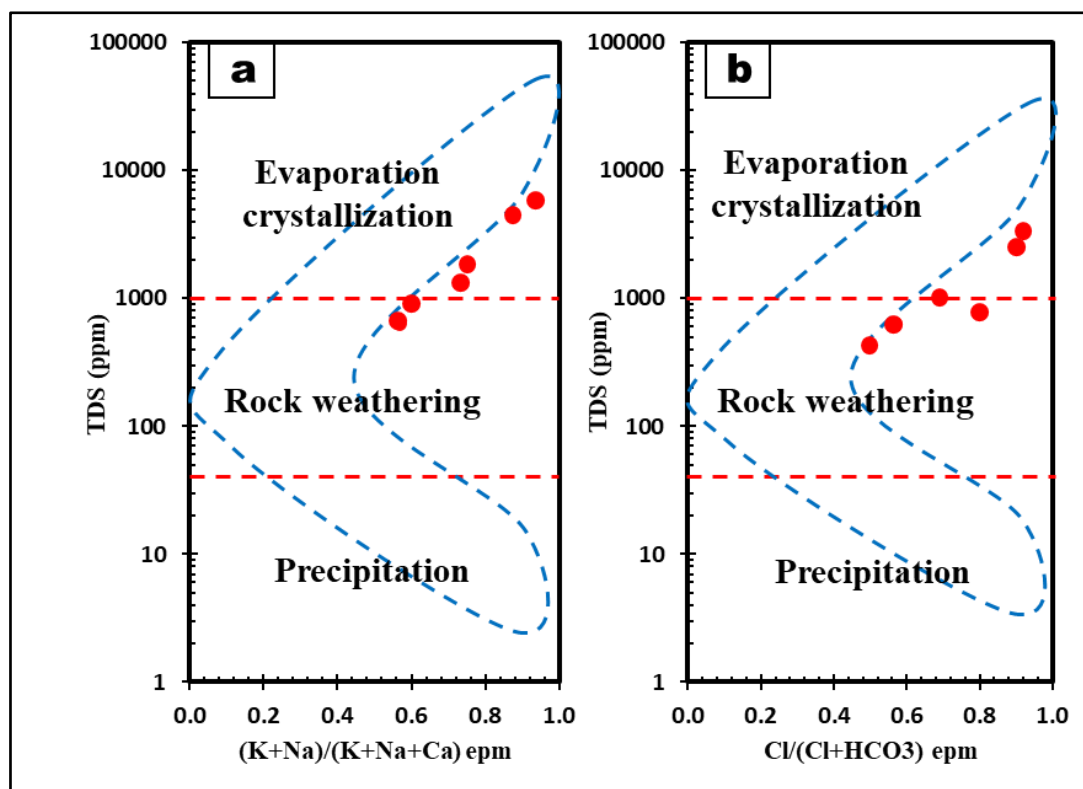


Figure 5: Gibbs's diagram showing the hydrogeochemical processes affecting groundwater chemistry using a) cations and b) anions.

Saturation Indices of the Water

To recognize the evolution of water chemistry along the groundwater flow, a simulation using the PHREEQC interactive code was achieved by applying the equation [9]. This simulation was used to calculate saturation indices (SI) of dissolved minerals in water and to address the speciation of these minerals. The saturation index (SI) is defined as the logarithm of the ratio of ionic activity products (IAP) to the solubility product (Ksp) at a given temperature. The ability of groundwater to dissolve or precipitate minerals could be studied using the saturation indices [16]. Also, the integration of statistical and hydrogeochemical tools helps in water management plans of groundwater [17, 18 & 19]. In general, the water-rock equilibrium is typically attained when $SI = 0$, if SI is less than 0, the water is undersaturated, and mineral dissolution is necessary to achieve equilibrium; while if SI is more than 0, the water is supersaturated, and precipitation of minerals is required to reach equilibrium [20]. All the studied groundwater samples are saturated with respect to aragonite, calcite, and dolomite (Figure 6. a, b, and c) and slightly saturated concerning anhydrite, and gypsum (Figure 6. d and e), while are undersaturated for halite and sylvite (Figure 6. f and g), this results from the interactions between groundwater and the minerals of the surrounding aquifer rocks.

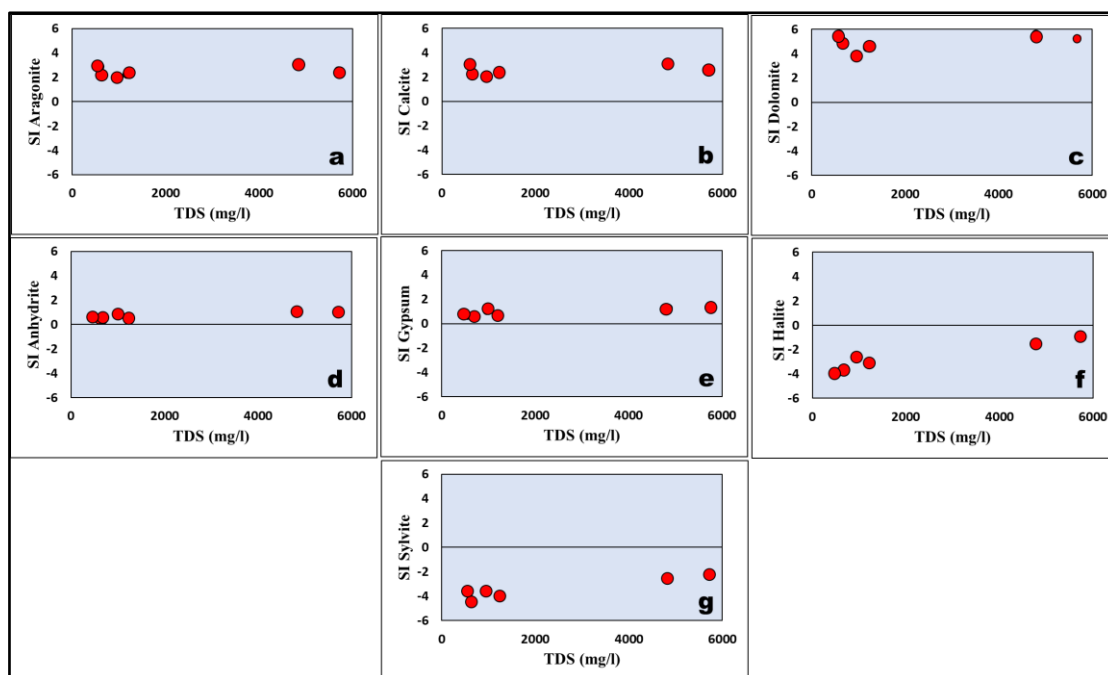


Figure 6: Saturation indices of the studied groundwater samples.

Suitability of water for different purposes

Drinking and domestic usage suitability

The evaluation of the suitability of water for drinking and domestic purposes is based on the total dissolved solids (TDS) and the concentrations of major ions. According to the standard limits for drinking given by the World Health Organization (WHO, 2018), (Table 1): The TDS value of studied groundwater samples in the eastern part of the study area are suitable for drinking where it is within the WHO (2018) permissible limits, while the samples in the western part of the study area are unsuitable for drinking where it is over the WHO (2018) permissible limits. Also, all the pH values of groundwater samples can be considered within the safe range.

Suitability for irrigation purposes

The suitability of water for irrigation could be evaluated using some calculation ratios: e.g., Wilcox's diagram [21]. The Wilcox's diagram shows the association between sodium percent Na% on the Y-axis and EC on the X-axis, it easily visualizes the suitability of water for irrigation purposes. The Na% is calculated using the subsequent equation (where all concentrations are in meq/l):

$$\text{Na (\%)} = (\text{Na}^+ + \text{K}^+) / (\text{Ca}^{2+} + \text{Mg}^{2+} + \text{Na}^+ + \text{K}^+) \quad (\text{Equation 2})$$

The groundwater samples studied fall in different locations on Wilcox's diagram. S1 and S2 fall in the unsuitable class for irrigation, while S2, S3, S4, S5, and S6 fall in the good to permissible class, indicating their suitability for irrigation for most crops and soil types, especially those of high to medium permeability (Figure 7).

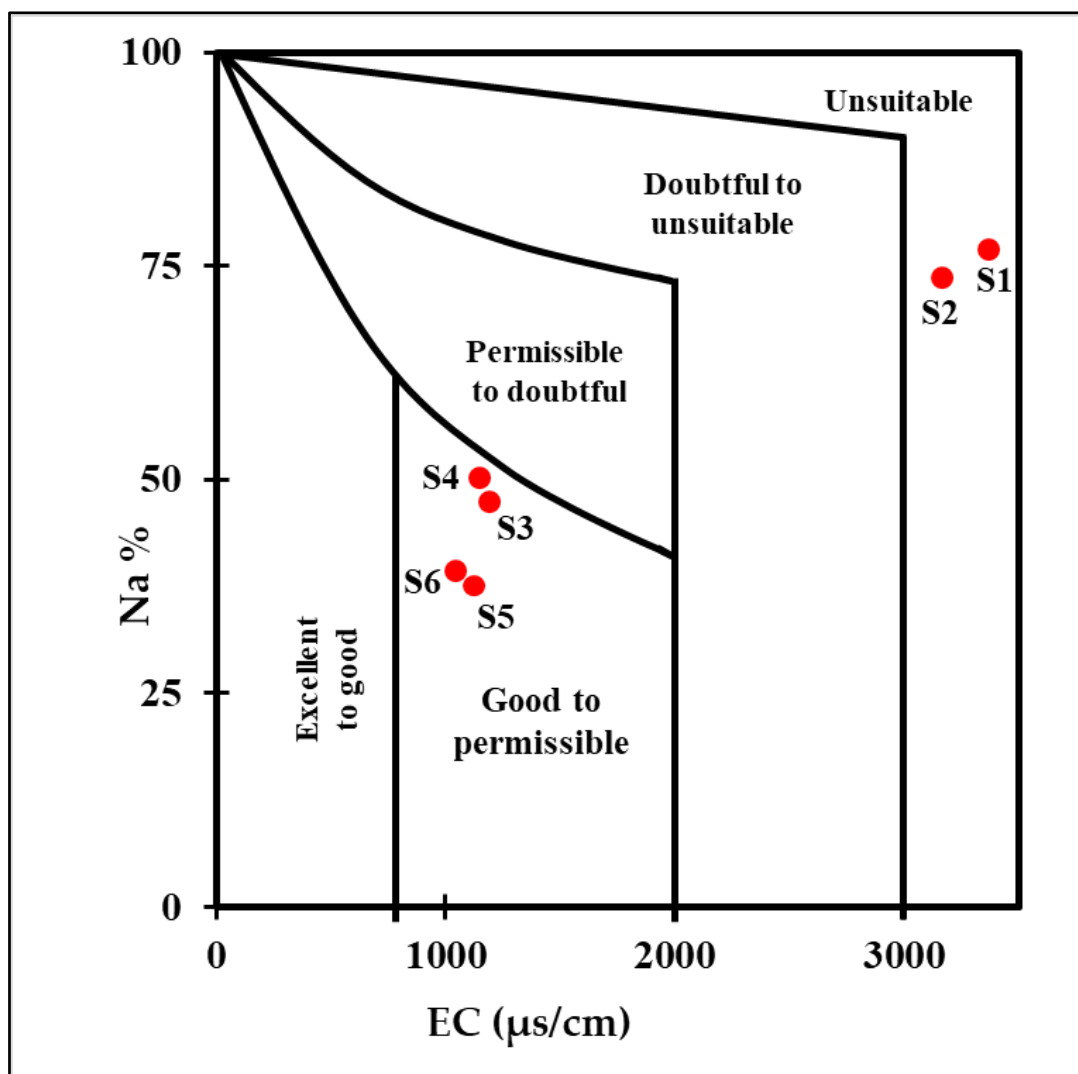


Figure 7: Wilcox's diagram of the studied groundwater samples.

CONCLUSIONS AND RECOMMENDATIONS

The study concluded that, the TDS value of studied water in the western part of the study area is unsuitable for drinking where it is out of the permissible limits of WHO, on the other hand, the water in the eastern part of the study area has an acceptable percentage of dissolved solids and is suitable for drinking and agricultural irrigation, also, the pH value in the whole of the study area can be considered within the safe range. The water is the mixed type in the western part and the sodium chloride type in the eastern part of the study area. The alkalis ($\text{Na}^+ + \text{K}^+$) exceed alkaline earths ($\text{Ca}^{2+} + \text{Mg}^{2+}$), weak acids exceed strong acids in the western part, and quite the opposite in the eastern part of the study area. The abundance of cations can be arranged as $\text{Na}^+ + \text{K}^+ > \text{Ca}^{2+} > \text{Mg}^{2+}$, while the arrangement of anions was $\text{Cl}^- > \text{HCO}_3^- > \text{SO}_4^{2-}$. The groundwater experienced a mixing process in the aquifers located in the study area, which indicates that, due to the water-rock interaction, the groundwater's chemistry is controlled by natural processes. The groundwater is saturated concerning carbonates and evaporite minerals and is suitable for the irrigation of some selected crops. Finally, this study recommends that the understanding and assessment of water quality are essential for maintaining water and the environment and protecting public health; it also helps identify potential risks and develop appropriate water management strategies. Managing the availability of clean and reliable water supplies is vital for supporting several industries, agriculture, and household use. Continued monitoring and management

efforts are necessary to ensure the sustainable use of water resources and maintain water security in the region.

ACKNOWLEDGMENTS

The authors extend their thanks and appreciation to the geologists at the Libyan Water Authority in Benghazi for their cooperation. Also, the regards and gratitude to the chemists at the Chemical Laboratory of the Libyan Water Authority in Benghazi, Libya.

REFERENCES

- [1] Selvam S., Manimaran G. and Sivasubramanian P.: Hydrochemical characteristics and GIS-based assessment of groundwater quality in the coastal aquifers of Tuticorin corporation, Tamil Nadu, India. *Applied Water Sciences*, 2013, 3:145–159.
- [2] Shiklomanov, I.A. World Freshwater Resources. In: *Water in Crisis: A Guide to the World's Freshwater Resources*. Gleick, P.H., (Ed.) New York, 1993; Oxford University Press.
- [3] Tajinder K., Renu B. and Hardwaj S.: Assessment of groundwater quality for drinking and irrigation purposes using hydrochemical studies in Malwa region, southwestern part of Punjab, India, *Applied Water Sciences*, 2016, 7:3301–3316. DOI 10.1007/s13201-016-0476-2.
- [4] Sadashivaiah, C., Ramakrishnaiah, C.R., and Ranganna, G. Hydrochemical analysis and evaluation of groundwater quality in Tumkur Taluk, Karnataka State, India. *Intl. J. Environ. Research and Public Health*. 2008; 5(3): 158-164.
- [5] Pichaiah S., Senthil Kumar G.R., Srinivasamoorthy K. and Sarma V.S. Hydrochemical characterization and quality assessment of Groundwater in Tirupur Taluk, Tamil Nadu, India: *Emph. J. Acad. Indus.* 2013; Res. Vol. 1(12), ISSN: 2278-5213.
- [6] Klen, I.: Geological map of Libya 1:250 000. Sheet. NI 34-14, Benghazi Explanatory Booklet. Industrial Research Center. Tripoli, 1974, 49p.
- [7] Faraj H. Faraj, Fathi, M. Salloum, Ahmed M. Muftah, and Awad A. Bilal.: Unique dolines field in the area between Soluq and Msus, NE Libya: origin and distribution. 4th International Symposium, Karst Evolution in the South Mediterranean Area. *Speleologia Iblea*, Italy, 2016; volume XVI: 51-64. Ragusa, Italy.
- [8] Abdelmalik, M. B. A., El-Moursi, M. E., and Salloum, F. M. The Environmental Impact of the Karstic Features of Ayn Zayanah-Kuwiffia Sector, near Benghazi, Libya. 4th International Symposium, Karst Evolution in the South Mediterranean Area. *Speleologia Iblea*, Italy. 2016; volume 12: 147-152. Ragusa, Italy.
- [9] Parkhurst, D.L., and Appelo, C.A.J. Description of input and examples for PHREEQC version 3—A computer program for speciation, batch-reaction, one-dimensional transport, and inverse geochemical calculations: U.S. Geological Survey Techniques and Methods, 2013; book 6, chap. A43, 497 p., available only at <https://pubs.usgs.gov/tm/06/a43/>
- [10] World Health Organization (WHO). Edition of the drinking water standards and health advisories tables. EPA 822-F-18-001, Office of Water, U.S. Environmental Protection Agency, Washington. 2018; DC; 2018, 12p.
- [11] Piper A. M. A graphic procedure in the geochemical interpretation of water analyses, *Eos, Transactions American Geophysical Union*. 1944; 25(6), 914–928.
- [12] Stiff H.A. The interpretation of chemical water analysis using patterns, *Journal of Petroleum Technology*. 1951; 3, 15-16.
- [13] Kumar A, Singh CK. Characterization of hydrogeochemical processes and fluoride enrichment in groundwater of south-western Punjab. *Water Quality, Exposure, and Health*. 2015; 7:373-387. <https://link.springer.com/article/10.1007/s12403-015-0157-7>
- [14] Dianardi K., Hadian S.D., Iskandarsyah T. Y. W., Muhamadsjah F. Studi Hidrokimia dan Karakteristik Airtanah di Kecamatan Cibiru dan Cileunyi, Bandung, Jawa Barat, Indonesia,

- Bulletin of Scientific Contribution: GEOLOGY. 2018; 16(2), 71-78.
<https://jurnal.unpad.ac.id/bsc/article/view/17812>
- [15] Gibbs, R. J. Mechanisms controlling world water chemistry., Science. 1970; 170(3962), 1088-1090.
 - [16] Redwan M, Moneim AAA, Amra MA. Effect of water–rock interaction processes on the hydrogeochemistry of groundwater west of Sohag area, Egypt. Arab J Geosci. 2016; 9:111. DOI:10.1007/s12517-015-2042. <https://link.springer.com/article/10.1007/s12517-015-2042-x>
 - [17] Kamal T., Thomas M. M., Vajed A., Jamil B., and Reza O. GIS-expert-based approach for groundwater quality monitoring network design in an alluvial aquifer: a case study and a practical guide. Springer Nature Switzerland AG. Environ Monit Assess, 2020; 192: 684. <https://link.springer.com/article/10.1007/s10661-020-08646-y>
 - [18] Abu Salem H, Gemail KS, Nosair AM. A multidisciplinary approach for delineating wastewater flow paths in shallow groundwater aquifers: A case study in the southeastern part of the Nile Delta, Egypt. Journal of Contaminant Hydrology, 2021; 236:103701. <https://www.sciencedirect.com/science/article/abs/pii/S0169772220302904>
 - [19] Abu Salem, H. S., Gemail, K. S., Junakova, N., Ibrahim, A., & Nosair, A. M. An Integrated Approach for Deciphering Hydrogeochemical Processes during Seawater Intrusion in Coastal Aquifers. Water. 2022; 14(7), 1165. <https://www.mdpi.com/2073-4441/14/7/1165>
 - [20] Yidana SM, Yidana A. Assessing water quality using water quality index and multivariate analysis. Environ Earth Sci. 2010; 59:1461– 1473. <https://doi.org/10.1007/s12665-009-0132-3>
 - [21] Wilcox, L.V.: Classification and use of irrigation waters. U.S. Dept. Agric. Circular no. 1955; 969, pp. 19.



VIII. International Symposium-2024

A RELATION BETWEEN EXTREME DAILY PRECIPITATION AND EXTREME SHORT TERM PRECIPITATION

Yanina L. Romero^{1*}, J. Bessembinder², N.C. van de Giesen³, F.H.M. van de Ven³

¹Beuningen, The Netherlands, p.bronkhorst8@upcmail.nl

²Climate Services, Royal Netherlands Meteorological Institute, De Bilt, The Netherlands

³Water Management, Delft University of Technology, Delft, The Netherlands

Abstract:

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. Based on 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 [1], [2]. Urban areas are especially vulnerable to increased rainfall intensities, especially during convective summer storms [3], [4], [5]. 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 many 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 [3], [6]. 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 Fig. 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 analysed with hourly and daily precipitation.

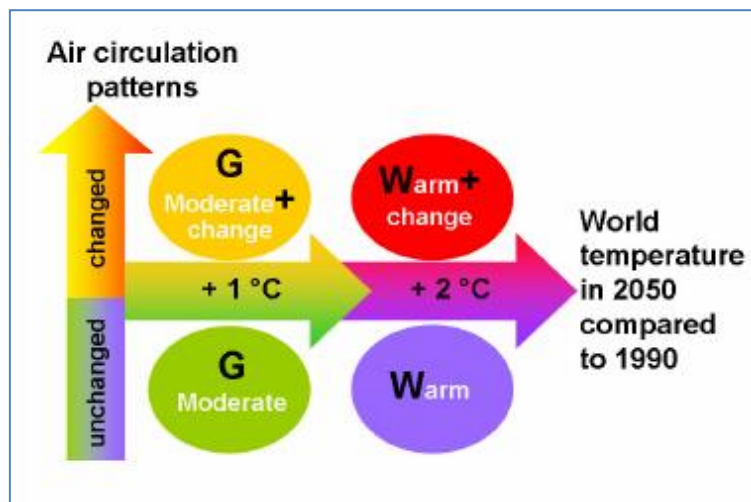


Figure 1: The four KNMI'06 climate scenarios [7]

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 [8], [9], [10]. KNMI concluded that wind direction but not wind velocity was an indicator for precipitation [11]. 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 [12] 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 [3], [13], [14]. 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 [3], [15]. 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 [16]. 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 [6] 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 20°C 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 [17]. The focus of this research is extreme precipitation and therefore these months will be analysed further.

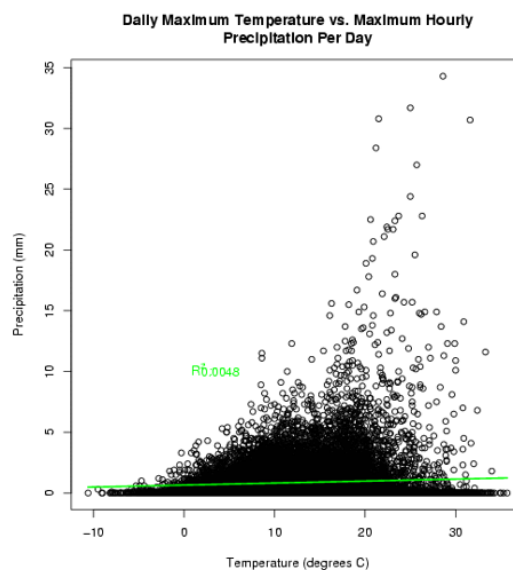


Figure 2: Maximum daily temperature vs. maximum hourly precipitation per day for De Bilt 1958-2006. Green line is the linear regression value of 0.0048.

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. Fig. 3 shows a scatter plot of G-west and daily precipitation for De Bilt during summer months June, July, and August. Fig. 4 is a plot of G-west and maximum hourly precipitation per day.

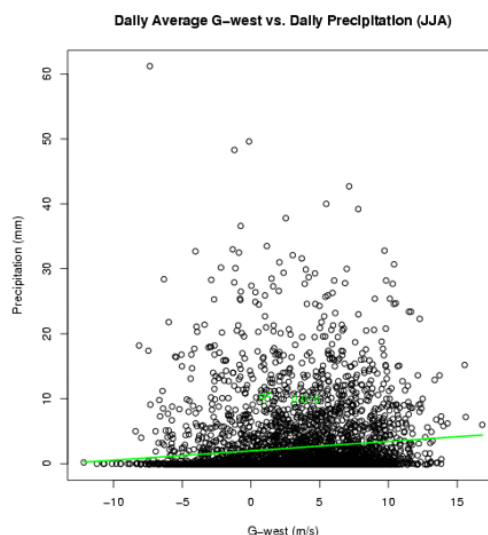


Figure 3: Daily average G-west vs. daily precipitation for summer months (De Bilt 1958-2006). *Green line* is the linear regression with a regression coefficient $r^2=0.015$.

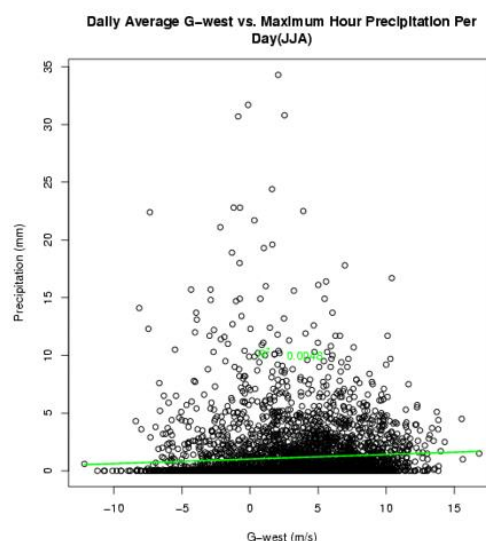


Figure 4: Daily average G-west vs. maximum hourly precipitation per day for summer months (De Bilt 1958-2006). *Green line* is the linear regression value with a regression coefficient $r^2=0.0048$.

Both Fig. 3 and Fig. 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.

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.

Fig. 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 Fig. 5, lines indicate the percentage of data that are below the line (90% quantiles equals 90% below, 10% above). Fig. 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 15°C and 20°C, 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.

Fig. 7 presents a frequency representation of daily G-west and precipitation (only wet days). Fig. 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.

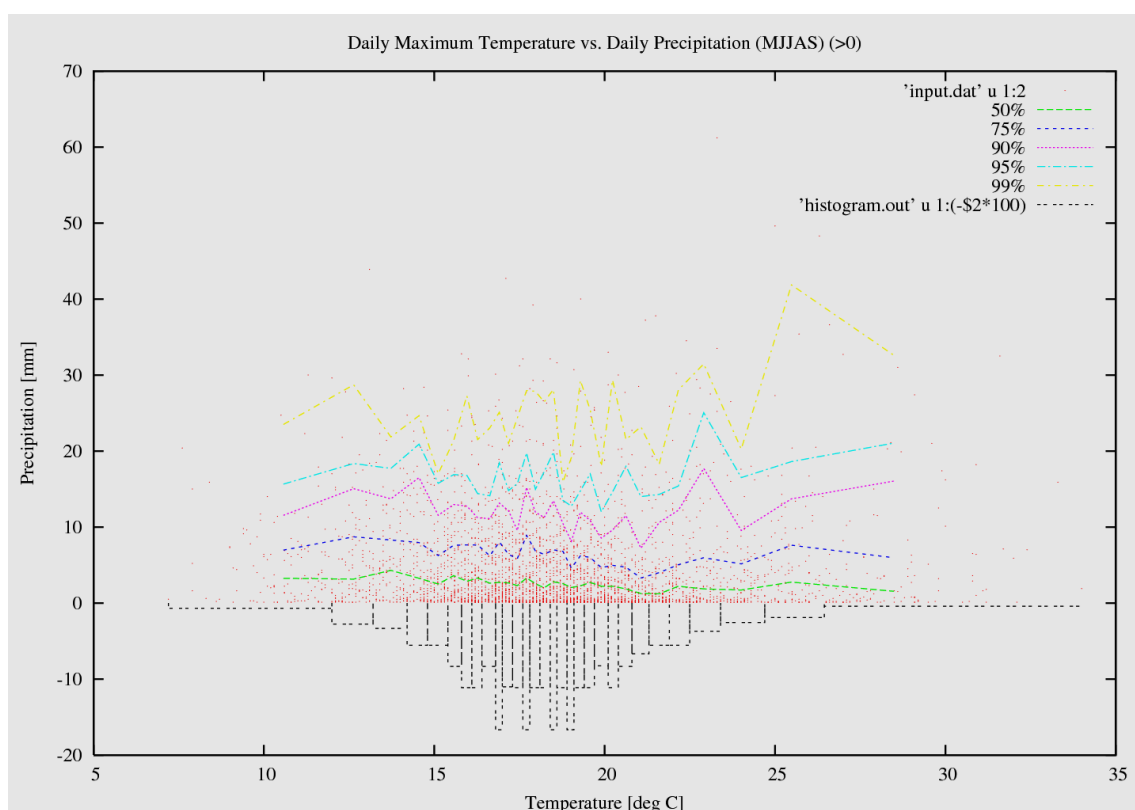


Figure 5: Maximum daily temperature vs. daily precipitation for summer months (May-September)

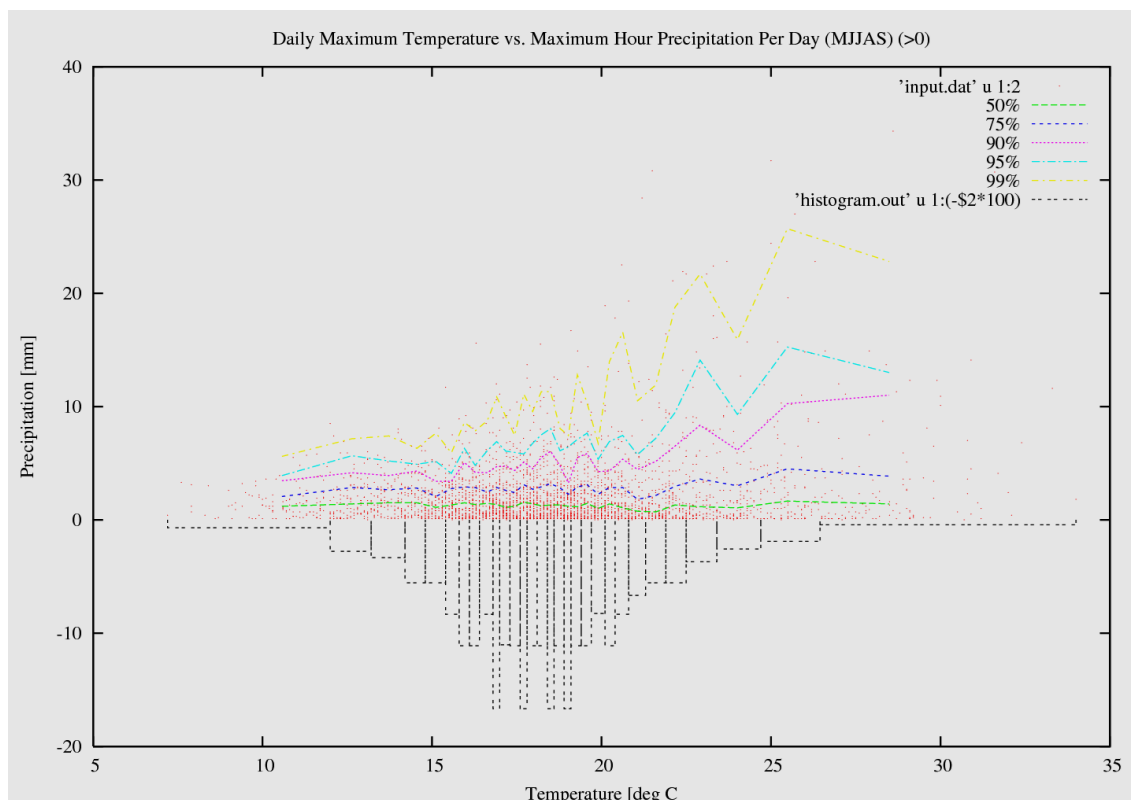


Figure 6: Maximum daily temperature vs. maximum hourly precipitation per day for summer months (May-September)

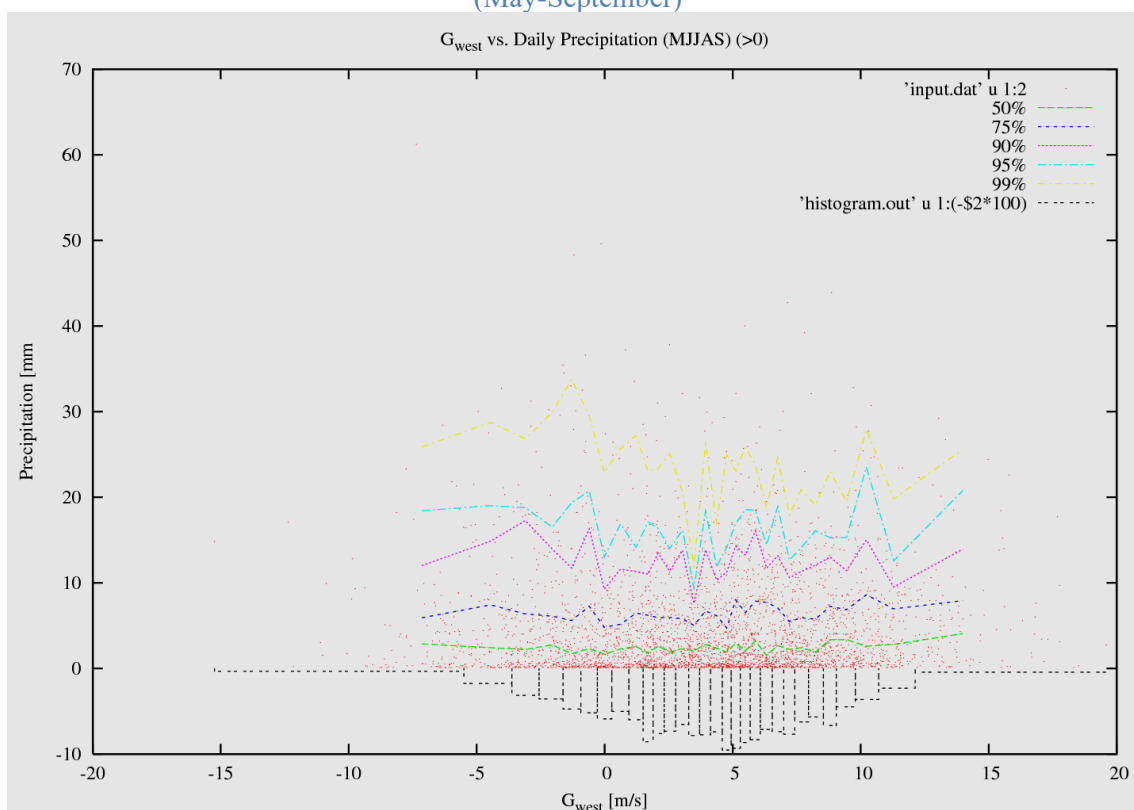


Figure 7: G-west vs. daily precipitation for summer months (May until and including September)

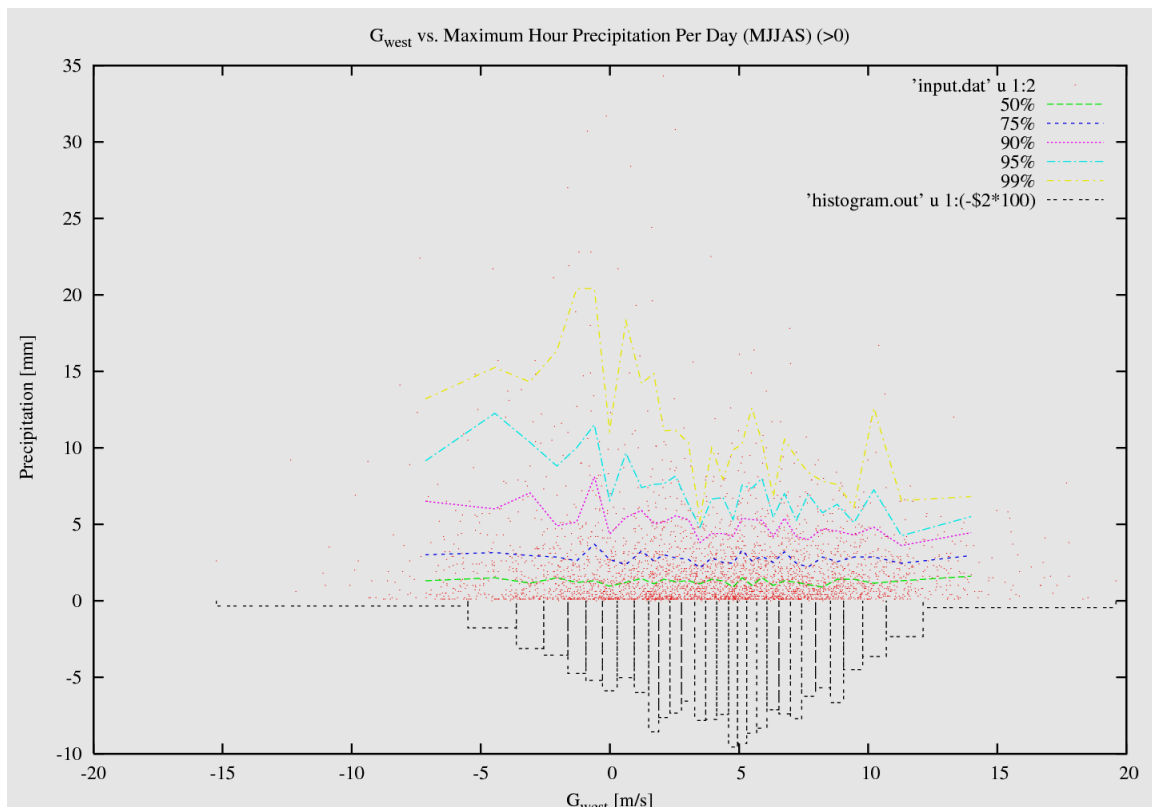


Figure 8: G-west vs. maximum hourly precipitation per day for summer months (May until and including September)

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 Figs. 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.

Fig. 9 is a plot of the relation between daily and maximum hourly precipitation in relation to maximum daily temperature plotted in Fig. 5 and Fig. 6. The thin-dashed line is the 95% ratio. This was constructed by dividing the 95% percentile line for daily precipitation (Fig. 5) by the 95% percentile line for hourly precipitation (Fig. 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 Fig. 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,

$$y_{99} = -0.18x_{99} + 5.78$$

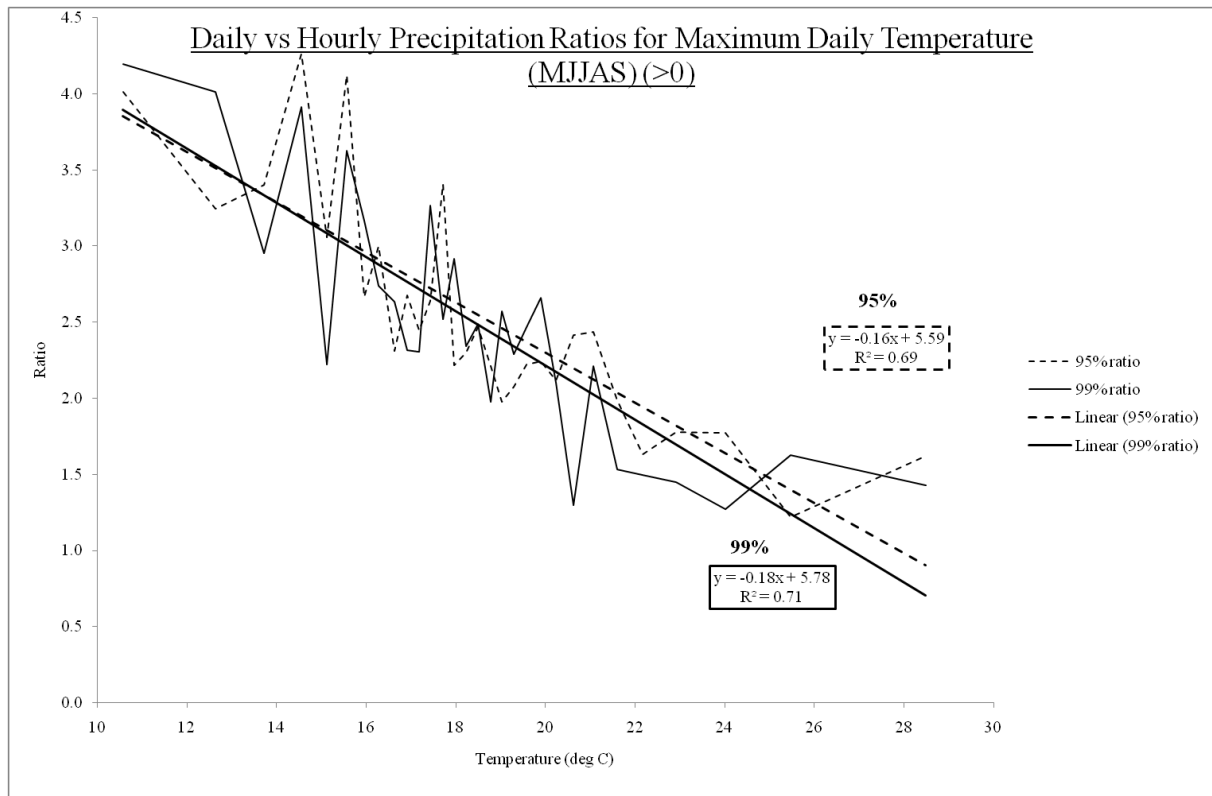


Figure 9: Daily/maximum hourly precipitation ratio in relation to maximum daily temperature for summer months (May-September). The **bold-dashed line** is the regression value of 0.69. The **solid line** is the regression value of 0.71

Fig. 10 is a similar representation as shown in Fig. 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);

$$y_{99} = 0.08x_{99} + 1.92$$

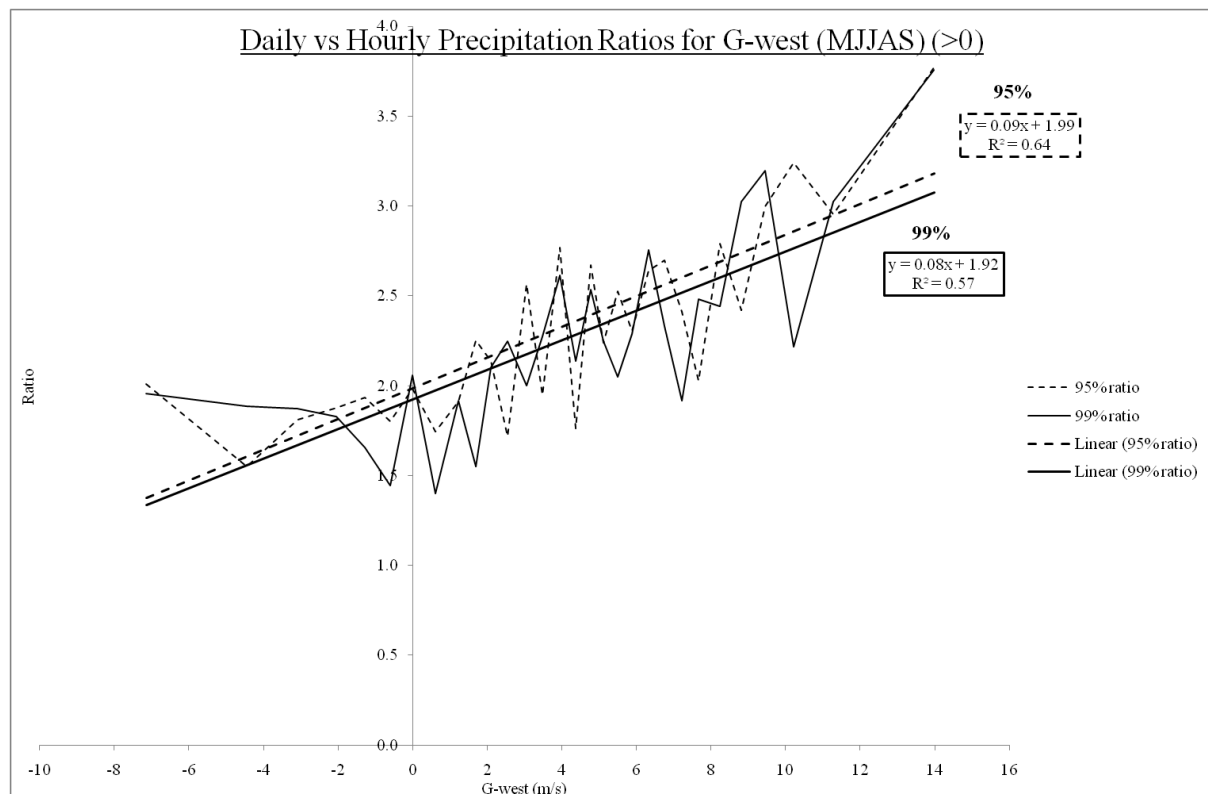


Figure 10: Daily/maximum hourly precipitation ratios in relation to G-west for summer months (May-September). The **bold-dashed line** is the regression value of 0.64. The **solid line** is the regression value of 0.57

Fig. 9 and Fig. 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 analysing 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 considering 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.

REFERENCES

- [1] Meehl, G.A., Arblaster, J.M., Tebaldi, C. Understanding Future Patterns of Increased Precipitation Intensity in Climate Model Simulations. *Geophys. Res. Lett.*, 2005, 32:L18719. DOI:10.1029/2005GL023680
- [2] Meehl, G.A., Stocker, T.F. et al Global Climate Projections. In: Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K.B., Tignor, M., Miller, H.L. (eds) *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, 2007, pp 747-846, Cambridge, UK
- [3] Smith, J. A., Baeck, M.L., Morrison, J.E., Sturdevant-Rees, P., Turner-Gillespie, D.F., Bates, P.D. The Regional Hydrology of Extreme Floods in an Urbanizing Drainage. *J. Hydrometeorol.*, 2002, 3(3):267– 282
- [4] Waters, D., Watt, W.E., Marsalek, J., Anderson, B.C. Adaptation of a Storm Drainage System to Accommodate Increased Rainfall Resulting from Climate Change. *J. Environ. Plan. Manag.*, 2003, 46:755-770
- [5] Kundzewicz, Z.W., Mata, L.J., Arnell, N.W., Döll, P., Kabat, P., Jiménez, B., Miller, K.A., Oki, T., Sen, Z., Shiklomanov, I.A. Freshwater Resources and Their Management. In: Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J., Hanson, C.E. (eds) *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, 2007, pp 173-210, Cambridge, UK
- [6] Ntelekos, A.A., Smith, J.A., Baeck, M.L., Krajewski, W.F., Miller, A.J., Goska, R. Extreme Hydrometeorological Events and the Urban Environment: Dissecting the 7 July 2004 Thunderstorm Over the Baltimore MD Metropolitan Region. *Water Resour. Res.*, 2008, 44:W08446. DOI:10.1029/2007WR006346
- [7] Royal Netherlands Meteorological Institute Climate Change Scenarios 2006 for the Netherlands. Scientific Report, 2006, WR 2006-01. De Bilt, The Netherlands
- [8] Phillips, I.D., McGregor, G.R. The Relationship Between Synoptic Scale Airflow Direction and Daily Rainfall: A Methodology Applied to Devon and Cornwall, South West England. *Theor. Appl. Climatol.*, 2001, 69:179-198
- [9] Gallego, M.C., García, J.A., Vaquero, J.M. The NAO Signal in Daily Rainfall Series Over the Iberian Peninsula. *Clim. Res.*, 2005, 29:103-109
- [10] Mitchell, R.M., Phillips, I.D. Warm Season Extreme Precipitation Events at Sunderland 1940-2000, The Royal Meteorological Society. *Weather*, 2006, 61(8)
- [11] Overeem, A., Buishand, A., Holleman, I. Rainfall Depth-duration-frequency Curves and Their Uncertainties. *J. Hydrol.*, 2008, 348:124-134
- [12] Lenderink, G., van Meijgaard, E. Increase in Hourly Precipitation Extremes Beyond Expectations from Temperature Changes. *Nature Geoscience*, 2008, 1(8)
- [13] Doswell, C.A. III, Brooks, H.E., Maddox, R.A. Flash Flood Forecasting: An Ingredients-based Methodology. *Weather Forecast.*, 1996, 11:560– 581

- [14] Chang, C.B. A Case Study of Excessive Rainfall Forecasting. Meteorol. Atmos. Phys., 1998, 66(3–4):215–227
- [15] Graf, W.L. Network Characteristics in Suburbanizing Streams. Water Resour. Res., 1977, 13(2):459-463
- [16] Heijboer, D., Nellestijn, J. (KNMI), Klimaatatlas Van Nederland, De Normaalperiode 1971-2000. Elmar B.V., 2002, Rijswijk, The Netherlands
- [17] STOWA Statistiek van Extreme Neerslag in Nederland, report nr. 26, Hageman Fulfilment., 2004, Available from: <https://www.stowa.nl/publicaties/statistiek-van-extreme-neerslag-nederland>



VIII. International Symposium-2024

TAXONOMIC OBSERVATIONS AND ENVIRONMENTAL SIGNIFICANCE OF RECENT FORAMINIFERA FROM ANTHONY'S BAY, ROATAN, NORTHEAST HONDURAS

Belkasim Khameiss¹, Makenna Haris²

¹Stratigraphy and Energy Division, Kansas Geological Survey, 1930 Constant Ave, Lawrence, KS 66047, USA

²Department of Geology, University of Kansas, Earth, 1414 Naismith Drive, Room 254 Lawrence, KS 6604, USA

Corresponding email: Belkasimkhameiss@outlook.com

Abstract

*This research focuses on the taxonomic classification and environmental implications of recent benthic foraminifera along the coast of Anthony's Bay, Roatan, Northeast Honduras. Five sediment samples were collected from the beach at a depth of less than 1 meter. Each sample, weighing 300 grams, underwent standard processing methods to isolate foraminifera. From these samples, eleven benthic foraminifera species were identified, including *Archaias angulatus*, *Cibicidoides crebbi*, *Lenticulina formosa*, *Peneroplis pertusus*, *Peneroplis planatus*, *Procerolagena gracilis*, *Pyrgo lucernula*, *Siphonaperta irregularis*, *Spiroloculina tenuiseptata*, *Technitella legumen*, and *Textularia agglutinans*. Additionally, one planktonic foraminifera species, *Orbulina universa*, was recorded. The most abundant species observed were *Peneroplis pertusus* and *Peneroplis planatus*. Across all five samples, a significant presence of coral fragments was noted alongside the benthic foraminifera community. Furthermore, the molluscan composition primarily comprised gastropods, with notable occurrences of bryozoans and echinoderms. The elevated abundance of coral fragments in these samples underscores a substantial ecological concern, indicating potential adverse impacts stemming from both human activities and climate change.*

Keywords: Climate change, Northeast Honduras, benthic foraminifera, recent benthic foraminifera.

INTRODUCTION

Studying recent foraminifera is essential across various scientific disciplines: they serve as indicators for environmental monitoring, providing insights into climate change and ocean acidification; they act as modern analogs for reconstructing past environments, aiding in paleoenvironmental reconstructions and biostratigraphy; their ecological studies help understand marine ecosystems, contributing to conservation efforts; and their shells provide records for paleoclimatology and oceanography, refining our understanding of past climate dynamics and environmental conditions. In the context of the coastal region of Roatan, which presents a complex landscape with deeply indented bays, extensive peninsulas,

and small associated islands, the southern section of the Mesoamerican Barrier Reef System, where Roatan lies, remains largely unexplored in terms of the distribution of unconsolidated surface sediments. Roatan itself stands as a unique example of an oceanic barrier-reef system in the Atlantic domain. However, thorough, and quantitative investigations into the sedimentary characteristics of this reef system are notably lacking. Previous studies on Roatan have primarily delved into its structural geology, the formation history of nearby oceanic basins, and the morphological features of its reef systems, providing valuable insights into the geological makeup of the island and its surrounding waters (McBirney and Bass 1969; Lallemand and Gordon 1999; Fenner 1993; Keck 2004).

The surface waters around Roatan, predominantly originating from the equatorial Atlantic, undergo complex dynamics influenced by the Caribbean Current and the possible formation of a local counterclockwise gyre along the Nicaraguan coast. Within the Gulf of Honduras, additional smaller counter-clockwise gyres impact the Bay Islands during winter months, affecting seasonal variations in sea-surface temperatures and the predominant flow directions of surface water currents in the region (Gordon, 1967; D'Croz et al., 1998; Brenes et al., 1998). In modern tropical reef environments, biological processes play a crucial role in shaping the characteristics of surface carbonates. Carbonate production by organisms and the environmental modification by certain species are fundamental processes. Fore-reef, reef-crest, and reef-flat settings exhibit the highest rates of carbonate production, while production decreases in sand-apron areas. The lagoon area experiences minimal skeletal carbonate formation, while in marginal reef areas, skeletal particles primarily result from the physical degradation of reef fabric (Chave et al. 1972; Scoffin 1992). Furthermore, while Roatan lacks permanent rivers, it boasts over 80 gullies where water flow occurs intermittently, particularly during the rainy season and after storm events, contributing to the hydrological and geomorphological complexity of the region (Mehrtens et al. 2001).

Location

Samples are from Bailey's Cay, Anthony's Key Resort, Roatan, Honduras (16.32952°N,86.57232°W). All samples were collected from the same location. Common marine organisms at Bailey's Cay include stony corals and green algae. Sediments were typically a mixture of skeletal fragments and sand particles. The images below show the beach where samples were collected and typical examples of the surrounding reefs and sediments.

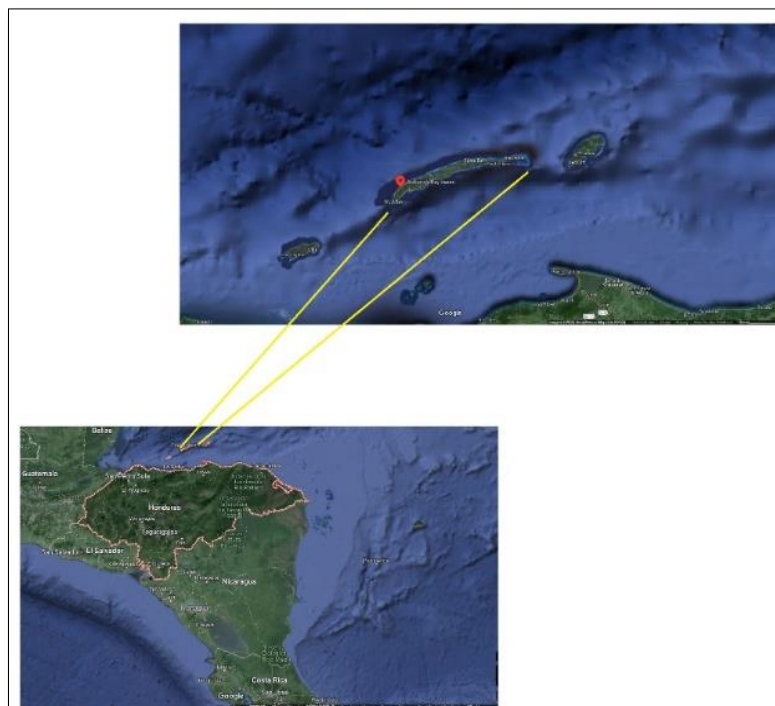


Figure 1: Shows the location of the Study area. Google Earth.

MATERIALS AND METHODS

As part of our investigation, we collected five surface sediment samples from predetermined locations. To accurately assess the sample volumes, we used a wet-sieving technique with a 63 μm sieve. We then dried a portion of the material retained on the sieve at 60°C. After that, we subjected the samples to wet-sieving again to determine the weight percentages across specific size fractions, which included >500 μm - 200 μm , 200 μm - 100 μm , 100 μm - 63 μm , and the <63 μm fraction. We followed this methodical approach carefully to gain a comprehensive understanding of the grain-size distribution of the sediment samples.

RESULTS

The benthic foraminifera species belong to nine families, namely Cibicididae, Hauerinidae, Lagenidae, Peneroplidae, Saccamminidae, Soritidae, Spiroloculinidae, Textulariidae, and Vaginulinidae, as you seen in Figure 2.

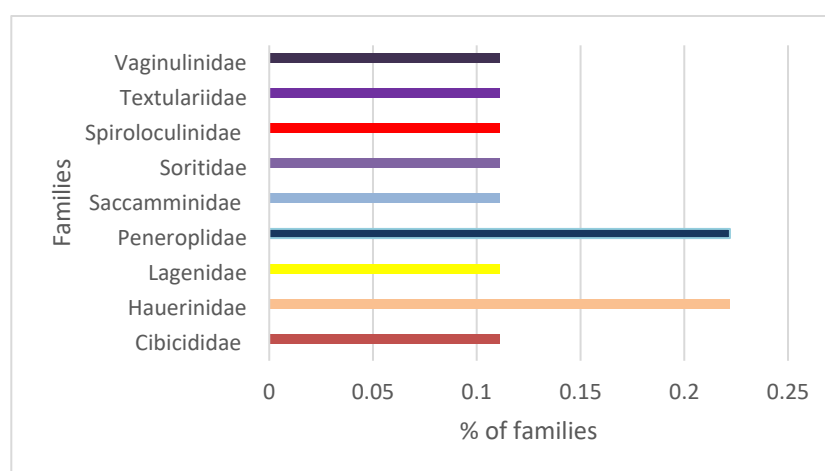


Figure 2: Shows the nine families of benthic foraminifera.

According to the Figure 3, there are eleven documented species of benthic foraminifera: *Archaias angulatus*, *Cibicidoides crebbi*, *Lenticulina formosa*, *Peneroplis pertusus*, *Peneroplis planatus*, *Procerolagena gracilis*, *Pyrgo lucernula*, *Siphonaperta irregularis*, *Spiroloculina tenuiseptata*, *Technitella legumen*, and *Textularia agglutinans*. According to Figure 3. This region exhibits a significant presence of benthic foraminifera species, characterized by numerous broken foraminifera and abnormal test formations, likely due to heavy metal pollution. Observations indicate a declining trend in species abundance, with foraminiferal tests showing signs of corrosion, cavity development, fractured peripheries, and reduced overall growth, all indicative of elevated trace metal levels. This suggests that the environment is experiencing pollution and deteriorating conditions. The total density of foraminifera is also impacted by these factors.

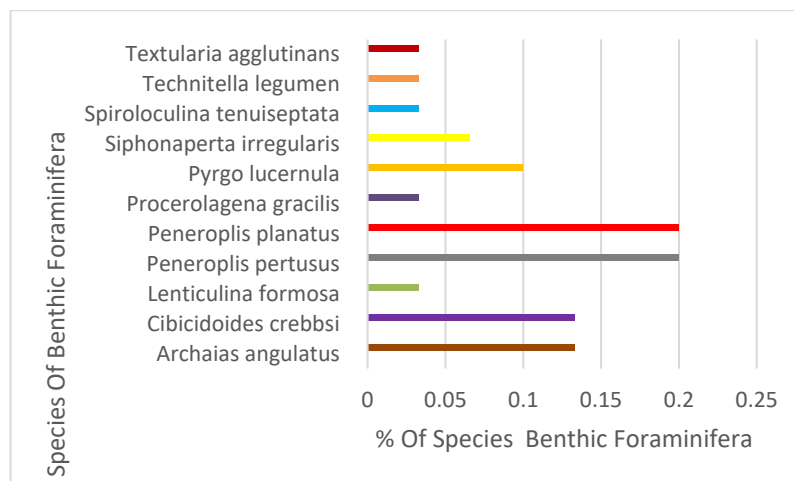


Figure 3: Show the eleven species of benthic foraminifera.

foraminifera, namely Globigerinidae, as you see in Figure 4. Within this family, a singular species has been meticulously documented—*Orbulina universa*, as you see in Figure 5.

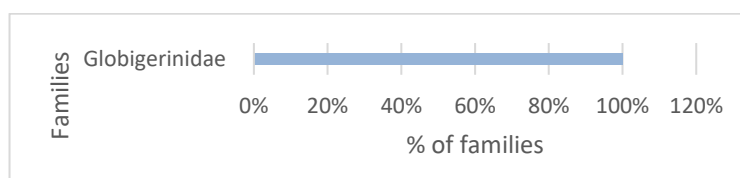


Figure 4: Shows one family of planktonic foraminifera.

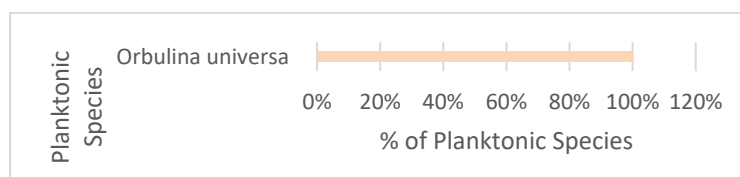


Figure 5: Shows one species of planktonic foraminifera.

Planktonic-benthic foraminifera ratios

In the examined samples, most foraminifera, over 90%, are identified as benthic, while approximately 10% are planktonic, as you see in Figure 5. Notably, benthic foraminifera exhibit diversity in their characteristics and can be categorized into distinct 'functional groups' based on their lifestyle and habitat preferences. These groups encompass smaller foraminifera categorized as 'heterotrophic' and 'stress-tolerant', typically thriving in reefs characterized by elevated nutrient levels or pollutant concentrations. Conversely, there are 'large benthic foraminifera' prevalent in thriving coral reef ecosystems with warm, sunlit, and low-nutrient waters. Analogous to corals, these larger foraminifera harbor symbiotic algae within their tests and may undergo bleaching (the expulsion of resident algae) under stressful conditions. Consequently, the abundance of large benthic foraminifera correlates with the health and vitality of coral reefs, declining in stressful reef environments. Each sample analyzed comprises a mixture of foraminifera tests spanning from the present day to approximately a millennium ago. By meticulously collecting and identifying foraminifera species and functional groups within each sample of reef sand, valuable insights into the historical environmental conditions of these habitats can be gleaned.

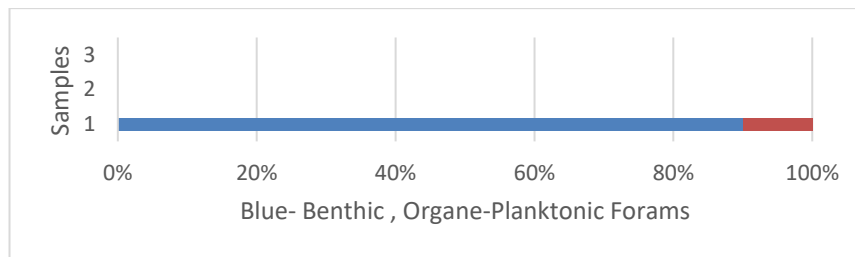


Figure. 6: Shows the P/B Ratios of foraminifera.

Ecological Significance of Coral Fragment Abundance and Invertebrate Composition

In all five samples assessed, a predominant abundance of coral fragments was noted, concurrent with a prevalence of benthic foraminifera within the foraminiferal community. Additionally, the molluscan composition predominantly featured gastropods, alongside notable occurrences of bryozoans and echinoderms, as you see in Figure 7. The elevated presence of coral fragments observed within these samples underscores a significant ecological concern, indicative of deleterious impacts stemming from both anthropogenic activities and climate change.

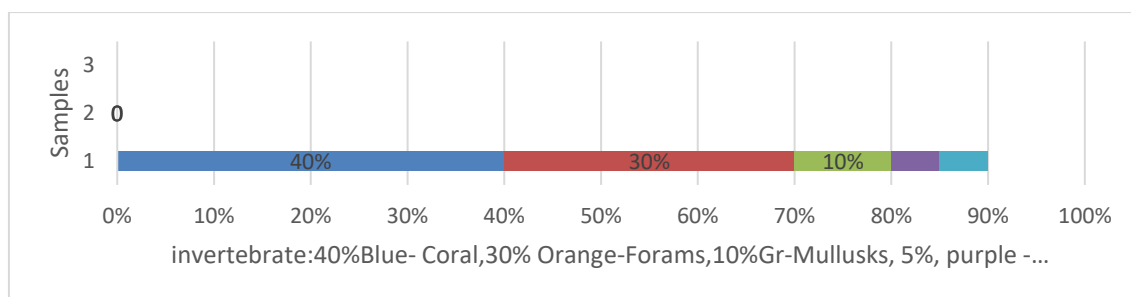


Figure 7: Abundance and invertebrate Compositions.

DISCUSSION

Foraminifera, sedimentary microfossils, and their relationship to the ancient environment. *Archaias angulatus*, a sizable foraminifera, is renowned for its symbiont-bearing characteristics and its production of a Mg-calcite shell. Demonstrating eurytopic behavior, it thrives in a variety of environments, particularly abundant in tranquil, nearshore regions and confined marine habitats within the tropical Western Atlantic Ocean and the Caribbean (Martin, 1986). *Spiroloculina tenuiseptata*, a foraminifera species, inhabits shallow marine environments and is valuable in reconstructing past paleoenvironments, especially warm, shallow seas. In a study utilizing *Spiroloculina tenuiseptata*, its presence in sediment samples from the Gulf of Mexico suggested warm and shallow marine conditions during the late Quaternary period. This species has been reported in various locations globally, including Canada, the United States, the Gulf of Mexico, Panama, the Galapagos, Libya, Algeria, Western Africa, Oman, India, Bangladesh, Germany, and England (Brady, 1884; Jones, 1994; Parker, 1992). *Siphonaperta irregularis* thrived in a shallow marine setting, particularly nearshore environments characterized by warm waters, abundant sunlight, and shallow depths. It likely inhabited the seafloor, engaging in filter-feeding on suspended organic matter (Winters, 1959; Lewis, 1994; Cimerman & Langer, 1991). *Procerolagena gracilis* existed during the Late Cretaceous period, preferring shallow marine environments in warm, tropical waters. These environments were marked by clear, sunlit waters and abundant marine life. *Procerolagena gracilis* likely resided in the upper levels of the water column, near the sea surface, benefiting from sunlight for photosynthesis by its symbiotic algae (Malmgren, 1984; Williamson, 1848; Sen Gupta et al., 2009). Species of the genus *Cibicidoides* are generally unattached, epifaunal to shallow infaunal under toxic conditions, favoring muddy substrates. *C. crebbi*, with a slope distribution, has been found in various locations including the Gulf of Mexico, Libya, Venezuela,

Trinidad, and the Dominican Republic (Katz, 1993; Pezelj et al., 2013; Murray, 1991; Holbourn et al., 2013). *Lenticulina formosa*, a cosmopolitan species, has been described from Miocene to Holocene localities in the Atlantic and Pacific, although it is usually rare (Cushman, 1923; Kender et al., 2008). *Peneroplis pertusus* dwells in the upper photic zone, favoring tropical to temperate shallow marine environments. It has been documented in various locations such as Libya, the Gulf of Mexico, Cuba, Venezuela, Costa Rica, Florida, Hawaii, Spain, France, India, and Sri Lanka (Khameiss & Zubi, 2020; Khameiss & Zubi, 2024). *Textularia agglutinans* is found in lagoons, backreef-reefs, forereefs, and inner and outer shelves, distributed across South America, the USA, Canada, Japan, South Asia, Australia, and the Mediterranean Sea (d'Orbigny, 1839a; Hayward & Gross, 2014). *Pyrgo lucermula* is distributed worldwide, inhabiting various marine depths, from the middle depths of the ocean to the abyssal zone (van Morkhoven et al., 1986). *Technitella legumen* is relatively rare in samples, with living forms reported by Norman (1878). The only planktonic foraminifera species, *Orbulina universa*, is abundant in modern oceans, spanning from temperate to subpolar regions and low to high latitudes (Aze et al., 2011; Kennett & Srinivasan, 1983).

The Ecological Significance of Coral Fragment Abundance and Invertebrate Composition emphasizes the crucial role played by coral sites in the studied area. Coral reefs in the Caribbean region are facing an increased risk of heat stress, which has raised concerns about extensive coral bleaching events and subsequent mass coral mortality. The situation is further exacerbated by the persistent warm conditions prevailing in the Caribbean Sea, coinciding with the transition from winter to spring in the Southern Hemisphere, potentially leading to a global bleaching event. Historical data shows that fluctuations in atmospheric CO₂ levels have corresponded to increased algal growth, commonly known as "algal blooms," over geological epochs. In addition, geological activities such as tectonic movements and continental adjustments have been linked to rising sea levels. Alterations in ocean salinity and variations in coral species composition cause bleaching phenomena, which pose significant risks to the structural integrity and vitality of coral reef ecosystems. The bleaching process leads to cellular degeneration within coral organisms, breaking down the intricate coral reef framework. Given these circumstances, it is essential to document coral fragment abundance and invertebrate composition across various coral sites within the study area. Such data are vital in understanding the dynamics of coral reef ecosystems and formulating strategies for their conservation and management amidst ongoing environmental challenges.

SYSTEMATIC PALEONTOLOGY

In the realm of systematic paleontology, foraminiferal species are categorized according to their physical attributes, encompassing characteristics like test shape, wall composition, ornamentation, chamber shape, and numbers. In our investigation, we employed established classification frameworks developed by Loeblich & Tappan, 1988; Kaminski, 2004; Hottinger et al., 1993; Cimerman, & Langer, 1991; Milker and Schmidel, 2012; Khameiss and Zubi, 2024 to identify and classify the foraminiferal assemblages. We meticulously documented the distribution of species within the analyzed samples.

Phylum Foraminifera d'Orbigny, 1826

Family Textulariidae Ehrenberg, 1838

Genus Textularia DeFrance, 1824

Textularia agglutinans (d'Orbigny, 1839) Figure 9-A.

Family Spiroloculinidae Wiesner, 1920

Genus Spiroloculina d'Orbigny, 1826

Spiroloculina tenuiseptata (Brady, 1884) Figure 9-B.

Family Lagenidae Reuss, 1862

Genus Procerolagena Puri, 195

Procerolagena gracilis (Williamson, 1848) Figure 9-F.

Family Hauerinidae Schwager, 1876

Genus Siphonaperta Vella, 1957

Siphonaperta irregularis (d'Orbigny in Terquem, 1878) Figure 9-C.

Family Hauerinidae Schwager, 1876
 Genus Pyrgo DeFrance, 1824
Pyrgo lucernula (Schwager, 1866) Figure 9-G.
 Family Peneroplidae Schultze, 1854
 Genus Peneroplis Montfort, 1808
Peneroplis planatus (Fichtel & Moll, 1798) Figure 9-D.
 Family Saccamminidae Brady, 1884
 Genus Technitella Norman, 1878
Technitella legumen (Norman, 1878) Figure 8-D.
 Family Soritidae Ehrenberg, 1839
 Genus Archaia Montfort, 1808
Archaia angulatus (Fichtel & Moll, 1798) Figure 8-C.
 Family Cibicididae Cushman, 1927
 Genus Cibicidoides Thalmann, 1939
Cibicidoides crebbi (Hedberg, 1937) Figure 8-F.
 Family: Peneroplidae Schultze, 1854
 Genus Peneroplis Montfort, 1808
Peneroplis pertusus (Forsskål in Niebuhr, 1775) Figure 9-G.
 Family : Globigerinidae Carpenter, Parker, and Jones, 1862
 Genus Orbulina d'Orbigny, 1839a.
Orbulina universa (d'Orbigny, 1839a) Figure 8-B.
 Family : Vaginulinidae Reuss, 1860
 Lenticulina Lamarck, 1804
Lenticulina formosa (Cushman, 1923) Figure 8-A.

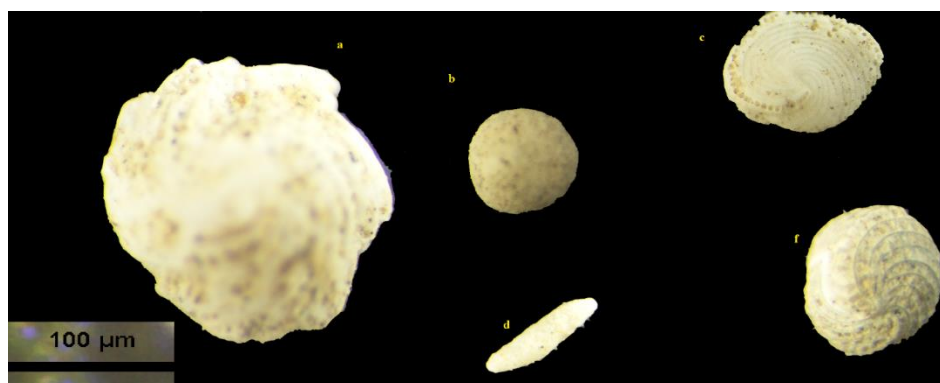


Figure 8: A-*Lenticulina formosa*, B-*Orbulina universa*, C-*Archaia angulatus*, D-*Technitella legumen*, F-*Cibicidoides crebbi*.



Figure 9: A -*Textularia agglutinans*, B- *Spiroloculina tenuiseptata*, C- *Siphonaperta irregularis*, E- *Peneroplis planatus*, F- *Procerolagena gracilis*, G- *Pyrgo lucernula*, D- *Peneroplis pertusus*.

CONCLUSION

After conducting an extensive investigation of foraminifera populations and sediment characteristics in the coastal region of Roatan, Honduras, several significant conclusions can be drawn: **Environmental Degradation and Pollution:** The presence of abnormal foraminiferal test formations, such as corrosion, cavity development, and fractured peripheries, suggests elevated trace metal levels. This indicates environmental pollution and deteriorating conditions. This trend is further supported by the declining abundance of foraminifera species and the prevalence of broken foraminifera in sediment samples. **Anthropogenic and Climate Impacts on Coral Reefs:** The abundance of coral fragments alongside a predominant presence of benthic foraminifera highlights the ecological concern regarding deleterious impacts on coral reefs. These impacts are likely due to both anthropogenic activities and climate change, leading to coral bleaching events and consequent mass coral mortality.

Dynamics of Foraminifera Communities: The examination of foraminifera communities reveals a high abundance of benthic foraminifera compared to planktonic foraminifera. This indicates the importance of benthic foraminifera in this ecosystem. The diversity of benthic foraminifera, categorized into different functional groups based on habitat preferences, reflects the complex dynamics within reef ecosystems. **Historical Environmental Reconstruction:** By analyzing foraminifera species and functional groups within sediment samples, valuable insights into the historical environmental conditions of reef habitats can be obtained. These insights aid in reconstructing past environmental changes. This contributes to our understanding of long-term climate dynamics and environmental conditions in the region.

Taxonomic Diversity and Distribution: The investigation reveals a diverse array of foraminifera species belonging to multiple families, distributed across different habitats within the study area. This diversity underscores the importance of foraminifera as bioindicators for environmental monitoring and paleoenvironmental reconstructions. **Methodological Significance:** The systematic documentation and classification of foraminifera species using established frameworks contribute to the field of systematic paleontology. This meticulous approach ensures accuracy and reliability in identifying and analyzing foraminifera populations. In conclusion, the study provides significant insights into the environmental, ecological, and paleontological aspects of the coastal region of Roatan. It emphasizes the importance of foraminifera as valuable proxies for understanding past and present environmental conditions and their role in coral reef ecosystems. The findings underscore the urgency of conservation efforts to mitigate the impacts of environmental degradation and climate change on marine ecosystems.

REFERENCES

- [1] Brady, H. B.: Report on the Foraminifera dredged by H.M.S. Challenger during the Years 1873-1876. Report on the Scientific Results of the Voyage of H.M.S. Challenger during the years 1873–76. Zoology. 1884. 9 (part 22), pp.1-814.
- [2] Brenes, CL., Gallegos, A., and Coen, E.: Variacion annual de la temperatura superficial en el Golfo de Honduras. 1998, pp. 187–197. Rev Biol Trop 46.
- [3] Carpenter, W. B., Parker, W. K., and Jones, T. R.: Introduction to the study of Foraminifera. 1862, pp. 1-319. Published for the Ray Society by R. Hardwicke, London.
- [4] Cimerman, F., Langer, M.R.: Mediterranean Foraminifera. Academia Scientarium et Aritium Slovenica, Dela, 1991. Opera 30, Classis IV: Historia Naturalis, pp.118.Opera 30, Classis IV: Historia Naturalis
- [5] Chave, KE., Smith, SV., and Roy, KJ.: Carbonate production by coral reefs.1972., pp.123–140. Mar Geol 12.
- [6] Cushman, A.: An outline of a re-classification of the foraminifera. 1927a. pp.1-105. Contributions from the Cushman Laboratory for Foraminiferal Research 3:1.
- [7] Cushman, J. A.: The Foraminifera of the Atlantic Ocean pt. 4: Lagenidae. 1923. (104): i-228. p.110. Bulletin of the United States National Museum.

- [8] D'Croz, LD., Jackson, JBC., and Best, MMR.,: Siliciclastic-carbonate transitions along the shelf transects trough the Cayos Cochonis Archipelago, Honduras. 1998. pp.57–66. *Rev Biol Trop* 46.
- [9] Defrance, J.L.M.,: *Mineralogie et Geologie* In:). 1804-1845. Paris. Vol. 1-2 [1804]. Vol. 3-4 [1806]. Suppl. 1 [1816]. Vol. 5-9 [1817]. Vol. 10-12 [1818]. Vol. 13-15 [1819]. Vol. 16-17 [1820]. Vol. 18-22 [1821]. Vol. 23-25 [1822]. Vol. 26-29 [1823]Vol. 30-33 [1824]. Vol. 34-38 [1825]. Vol. 39-44 [1826]. Vol. 45-51 [1827]. Vol. 52-53 [1828]. Vol. 54 [1829]. Vol. 55-57 [1828]. Vol. 58-59 [1829]. Vol. 60 [1830]. Vol. 61 [1845] *Dictionnaire des Sciences Naturelles dans lequel on traite méthodiquement des différents êtres de la nature* (par plusieurs professeurs du Jardin du Roi, F[rédéric] Cuvier, ed.
- [10] d'Orbigny, A.,: Foraminifères. In, de la Sagra, R. (ed.) *Histoire physique et naturelle de l'Ile de Cuba*. A. 1839a. pp.1-22. Bertrand, Paris, France.
- [11] d'Orbigny, A. D.,: *Tableau méthodique de la classe des Céphalopodes*. 1826. 96-169, 245-314. p. 298. *Annales des Sciences Naturelles* vol. 7.
- [12] Ehrenberg, G.,: Ueber dem blossen Auge unsichtbare Kalkthierchen und Kieselthierchen als Hauptbestandteile der Kreidegebirge. 1838., pp. 192-200. *Berichte der Königlich-Preussischen Akademie der Wissenschaften zu Berlin* 3.
- [13] Ehrenberg, G.,: 1839. Ueber die Bildung der Kreidefelsen und des Kreideemergels durch unsichtbare Organismen., pp.59-147. *Abhandlungen der Königlich-Preussischen Akademie der Wissenschaften zu Berlin*.
- [14] Fenner, DP.,: Some reefs and corals of Roatan (Honduras), 1993, pp.1–30. *Cayman Brac, and Little Cayman* Berlin.. *Il Res Bull* 388.
- [15] Fichtel, L., and Moll, J.P.C.,: *Testacea microscopia, aliaque minuta ex generibus Argonauta et Nautilus, ad naturam delineata et descripta*. 1798. A. Pichler, Wien, pp.123.
- [16] Gordon, AL.,: Circulation of the Caribbean Sea. 1967. 72, pp. 6207–6223. *J Geophys Res*.
- [17] Gross, O.,: Foraminifera, in: Costello, M.J. et al. (Ed.) (2001). 2001. European register of marine species: a check-list of the marine species in Europe and a bibliography of guides to their identification., pp. 60-75. *Collection Patrimoines Naturels*, 50.
- [18] Hedberg, H. D.,: 1937. Foraminifera of the Middle Tertiary Carapita Formation of Northeastern. 11, pp. 661-697. Venezuela. *Journal of Paleontology*.
- [19] Hottinger, L., Halicz, E., and Reiss, Z.,: Recent Foraminifera from the Gulf of Aqaba, Red Sea. 1993., 33, pp.179. *Opera Sazulj*ubljana.
- [20] Katz, M., and Miller, K.,: Latest Oligocene to Earliest Pliocene Benthic Foraminiferal Biofacies of the Northeastern Gulf of Mexico .1993. No. 4, pp. 367-403. *Micropaleontology*, Vol. 39.
- [21] Kender., S. Kaminski, M., and Jones.,: Early to middle Miocene foraminifera from the deep-sea Congo Fan, offshore Angola. 2008., pp. 477-568. *Micropaleontology*, vol. 54, no. 6.
- [22] Kaminski, M.A.,: The Year 2000 Classification of the Agglutinated Foraminifera. In: Bubik, M. & Kaminski, M.A. (eds) *Proceedings of the Sixth International Workshop on Agglutinated Foraminifera*. 2004., pp. 237-255. Grzybowski Foundation Special Publication.
- [23] Keck, J.,: Changes in coral populations on the northwest coast of Roatan, Bay Islands, Honduras, subsequent to the 1998 bleaching event and Hurricane Mitch. M.Sc.-thesis. 2004. Nova Southwestern University, Ft. Lauderdale, Florida, USA.
- [24] Khameiss, B.,: Marine Reef and Age Dating of Tertiary Section, Northeastern Libya. 2012, , Boulder, 15-16 August 2012, pp. 3-4. *Colorado Scientific Society Conference 2012*.
- [25] Khameiss, B., Hoyt, W., El Ebadi, S., Muftah, A., Klaus, J. and Budd, A.,: A Preliminary Documentation of the Coral Reefs from Libya. 2016. 6, pp. 260-269. *Open Journal of Geology*.
- [26] Khameiss, B., Fluegeman, R., Moore, E. and Hastings, A., : Fossil Corals from the Lower-Upper Miocene from Atlantic Deposits in Delaware and Florida, USA. 2017., pp.49-8. *Geological Society of America Abstracts with Programs*, 49.

- [27] Khameiss, B.: Paleogene foralgal reefs: paleontological and paleoecological analyses of the Tertiary foralgal-reefs . 2020, pp.21,24. Ball State University ProQuest Dissertations Publishing, 2020.
- [28] Khameiss, B., and Zubi, H.: Diversity, Ecology, and Environmental Significance of Foraminifera in Al Hamama and Susah Coastal Region, Northeastern Libya: Insights from Holocene Sediments. 2024. pp.13-25. Journal of Environmental Protection, 15.
- [29] Khameiss, B., Fluegeman, R., Hoyt, W., Malone, S. and Muftah, A.: Competition between Coral and Algae in Tertiary and Quaternary Reefs: Greenhouse to Icehouse Transitions. 2024., pp. 94-107. Journal of Environmental Protection, 15
- [30] Lallemand, HG., Gordon, M.: Deformation History of Roatan Island: implications for the origin of the Tela Basin (Honduras). In: Mann P (ed) Caribbean basins. 1999. pp. 197–218. Sedimentary basins of the world, vol. 4. Elsevier Science, Netherlands.
- [31] Lamarck, de.,: Suite des mémoires sur les fossiles des environs de Paris. 1804. Annales du Muséum pp. 28-36. d'Histoire Naturelle. 5.
- [32] Loeblich, A.R., and Tappan, H.N.: Foraminiferal Genera and Their Classification. 1988.
- [33] Martin, R. E.: Habitat and distribution of the foraminifer *Archaias angulatus* (Fichtel and Moll) (Miliolina, Soritidae). 1986. pp. 201-206. Northern Florida Keys. Journal of Foraminiferal Research, 16.
- [34] Malmgren, B. A.: Evolutionary changes in Late Cretaceous planktonic foraminiferal faunas: Biostratigraphy, paleoecology, and paleobiogeography. 1984. pp.786-813. Geological Society of America Bulletin, 95(7).
- [35] Mehrtens, CJ., Rosenheim, B., Modley, M., Young, RS.: Reef morphology and sediment attributes, Roatan, Bay Islands, Honduras. 2001. pp.131–140. Carbonates Evaporites 16.
- [36] McBirney, AR., Bass, MN.: Geology of the Bay Islands, Gulf of Honduras. In: McBirney AR (ed) Tectonic Relationship of Northern Central America and the Western Caribbean—the Bonaca Expedition. 1969. pp. 229–243. American Association of Petroleum Geologists, Memoirs, vol 11.
- [37] Milker, Y., and Schmiedl, G.: A taxonomic guide to modern benthic shelf foraminifera of the western Mediterranean Sea. 2012. pp.1-134. Palaeontologia Electronica, 15.
- [38] Montfort, P.: Conchyliologie systématique et classification méthodique des coquilles. 1808-1810. p. 258-259. Paris: Schoell. Vol. 1.
- [39] Niebuhr, C.: Descriptiones animalium avium, amphibiorum, piscium, insectorum, vermium; quae in itinere orientali observavit Petrus Forskål. 1775.. P, 125. Post mortem auctoris edidit Carsten Niebuhr. Hauniae.
- [40] Norman, A.M.: On the Genus *Haliphysema*, with Descriptions of several Forms apparently allied to it. 1878. pp. 265-284. Annals and Magazine of Natural History. (5) 1(4).
- [41] Parker, W.C.: Late Quaternary Stratigraphy and Environments in the Northern Gulf of Mexico: an Overview". 1992. pp. 1-20. Marine Geology, 103
- [42] Puri, H. S.: Contribution to the study of the Miocene of the Florida panhandle. 1954 pp.1-345. Bulletin Florida State Geological Survey 36.
- [43] Reuss, A. E.: Die Foraminiferen der westphälischen Kreideformation. Sitzungsberichte der mathematisch-naturwissenschaftlichen Classe der kaiserlichen Akademie der Wissenschaften. 1860. 40 (8), pp. 147-238.
- [44] Reuss, A. E.: Paläontologische Beiträge. Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften. Mathematisch-Naturwissenschaftliche Classe. 1862.. 44, pp.301-342. Abt. 1, Mineralogie, Botanik, Zoologie, Anatomie, Geologie und Paläontologie.
- [45] Sen Gupta, B. K.; Smith, L. E.; Machain-Castillo, M. L.: Foraminifera of the Gulf of Mexico in Felder, D.L. and D.K. Camp (eds.), Gulf of Mexico—Origins, Waters, and Biota. Biodiversity. 2009. pp. 87-129. Texas A&M Press, College Station, Texas.
- [46] Schultze, M. J. S.: Über den Organismus der Polythalamien (Foraminiferen), nebst Bemerkungen über die Rhizopoden im allgemeinen. Ingelmann. 1854. pp.1-68. Leipzig.
- [47] Schwager, C.: Fossile Foraminiferen von Kar Nikobar. Reise der Österreichischen Fregatte Novara um die Erde in den Jahren 1857, 1858, 1859 unter den Befehlen des Commodore B.

- von Wüllerstorff-Urbair. 1866. pp.187-268. Geologischer Theil (Zweite Abtheilung, Paläontologische Mittheilungen) 2(2).
- [48] Schwager, C.,: Saggio di una classificazione dei foraminiferi avuto riguardo alle loro famiglie naturali, Bolletino R. 1876. pp. 475-485. Comitato Geologico d'Italia 7.
- [49] Scoffin, TP.,: Taphonomy of coral reefs: a review. 1992. pp.57–77. Coral Reefs 11.
- [50] Terquem, O.,: Les Foraminifères et les Entomostracés Ostracodes du Pliocene Supérieur de l'île de Rhodes. 1878. pp.1-84. Mémoires de la Société Géologique de France. (3)1.
- [51] Thalmann, H. E.,: Bibliography and index to new genera, species, and varieties of foraminifera for the year 1936. 1939. pp. 425-465. Journal of Paleontology 13.
- [52] Vella, P.,: Studies in New Zealand Foraminifera; Part I- Foraminifera from Cook Strait. Part II- Upper Miocene to Recent Species of the Genus Notorotalia. 1957. pp. 1-64. New Zealand Geological Survey Paleontological Bulletin. 28.
- [53] Williamson, W. C.,: On the Recent British species of the genus Lagenella. 1848. pp.1-20. Annals and Magazine of Natural History. (2) 1 (1).
- [54] Wiesner, H.,: Zur Systematik der Miliolideen. 1920. pp. 13-2. Zoologischer Anzeiger. 51 (1/2).
- [55] Robert E. Lewis, Joanne H. Lewis.,: Siphonaptera of North America North of Mexico: Vermipsyllidae and Rhopalopsyllidae. 1994. pp 82–98. Journal of Medical Entomology, Volume 31, Issue 1,1.
- [56] van Morkhoven, F. P. C. M., Berggren, W. A., Edwards, A. S.,: Cenozoic cosmopolitan deep-water benthic foraminifera. 1986. pp. 1-421. . Bulletin des Centres de Recherches Exploration-Production Elf-Aquitaine. Memoire 11.



VIII. International Symposium-2024

DETAILED ANALYSIS AND UNDERSTANDING OF CARBON/IRON COMPOSITE MICROFIBER CATALYSTS DERIVED FROM BLOOD HEMOGLOBIN PROTEIN FOR LITHIUM-OXYGEN BATTERIES

Rahele Khosravi Nesiani^{1*}, Meysam Naseri²

Department of Chemical Engineering, Sahand University of Technology, Sahand New City,
Tabriz, Iran, r.khosravi66esf@gmail.com, <https://orcid.org/0000-0001-7481-2974>
Faculty of Mining and Processing Engineering, Amirkabir University of Technology, Tehran, Iran,
Meysam.naseri94@gmail.com, <https://orcid.org/0000-0002-1005-1886>

Abstract:

Motivation/Background: Hemoglobin is the protein that makes blood red. It is composed of four protein chains, two alpha chains and two beta chains, each with a ring-like heme group containing an iron atom. Oxygen binds reversibly to these iron atoms and is transported through blood. The lithium–air battery (Li–air) is a metal–air electrochemical cell or battery chemistry that uses oxidation of lithium at the anode and reduction of oxygen at the cathode to induce a current flow. Pairing lithium and ambient oxygen can theoretically lead to electrochemical cells with the highest possible specific energy. Indeed, the theoretical specific energy of a non-aqueous Li–air battery, in the charged state with Li₂O₂ product and excluding the oxygen mass, is ~40.1 MJ/kg = 11.14 kWh/kg of lithium. This is comparable to the theoretical specific energy of gasoline, ~46.8 MJ/kg. In practice, Li–air batteries with a specific energy of ~6.12 MJ/kg = 1.7 kWh/kg of lithium at the cell level have been demonstrated. This is about 5 times greater than that of a commercial lithium-ion battery and is sufficient to run a 2,000 kg electric vehicle for ~500 km (310 miles) on a single charge using 60 kg of lithium (i.e. 20.4 kWh/100 km). However, the practical power and cycle life of Li–air batteries need significant improvements before they can find a market niche. Understanding the catalyzed formation and evolution of lithium-oxide products in Li–O₂ batteries is central to the development of next-generation energy storage technology. Catalytic sites, while effective in lowering reaction barriers, often become deactivated when placed on the surface of an oxygen electrode due to passivation by solid products. Recycling of bio-waste sources for synthesis of functional electrode materials is an eco-friendly and sustainable approach to realize next-generation energy-storage systems. Method: In this study, we present a fabrication method of Fe/C composite microfibers derived from electrospinning of hemoglobin blood protein, and subsequent calcination, and investigate its functionality as an oxygen electrode catalyst for Li–O₂ batteries. We elucidate the thermal decomposition behavior of raw hemoglobin protein and structural evolution after calcination at different temperatures. We successfully fabricated Fe/C composite microfibers with a uniform and flattened shape by electrospinning of a hemoglobin precursor and thermal treatment. Results: Finally, we demonstrated that Li–O₂ cells in which the Fe/C composite microfiber catalyst was incorporated in the oxygen electrodes exhibited improved electrochemical performance compared to a pristine reference cell without the catalyst.

Keywords: Lithium–oxygen batteries, catalytic membrane, product morphology, nanoparticles, oxygen evolving catalyst.

INTRODUCTION

Future energy-storage alternatives should provide a high energy capability exceeding that of current Li-ion batteries [1]. Lithium–oxygen (Li–O₂) batteries have attracted significant interest for next-generation energy storage owing to their high theoretical energy density, which is comparable to that of gasoline [2–5]. Li–O₂ batteries can be realized by satisfying certain requirements, such as a high efficiency, low environmental impact, and cost-efficiency [6]. Current Li–O₂ batteries suffer from a low reversibility, which is caused by the formation of insulating lithium–oxide products (i.e., LiO₂, Li₂O₂) for discharging and sluggish decomposition for reverse charging ($2\text{Li}^+ + \text{O}_2 + 2\text{e}^- \leftrightarrow \text{Li}_2\text{O}_2$, $E^0 = 2.96\text{ V}$ versus Li/Li⁺) [7–9]. Consequently, the large overpotential of over 1 V followed by slow kinetics should be addressed for the realization of Li–O₂ batteries [10,11]. Studies have been performed to overcome these issues by developing catalyst materials decorated on an oxygen electrode in a Li–O₂ cell [12–14]. In this regard, various solid catalyst materials (e.g., metal and metal oxides) have been introduced to improve the kinetic properties and reversibility of the batteries [3,15–21]. Nevertheless, further suitable catalyst alternatives should be developed for a greener and cheaper Li–O₂ battery technology. The direct utilization of sustainable natural resources as a precursor is a preferred approach to synthesize functional catalyst materials for future energy applications [22,23]. For example, blood bio-wastes could be recycled for eco-friendly and cost-effective productions of the catalyst materials [24–28]. It is known that hemoglobin, a core component in blood, consists of four globular protein subunits bound by a non-protein prosthetic heme group [29]. The hemoglobin structure includes various organic-based atomic species (e.g., carbon, oxygen, nitrogen, iron, etc.), which can be transformed into components of a catalyst molecule, thereby providing functional properties. By controlling synthetic conditions, various Fe-based inorganic materials with tailored morphologies can be successfully fabricated from a hemoglobin precursor [30]. The materials derived from blood protein are expected to be utilized as efficient catalysts for future Li–O₂ batteries. In this study, we report an iron/carbon (Fe/C) composite microfiber material prepared using hemoglobin blood protein and investigate its potential as an oxygen electrode catalyst for Li–O₂ batteries. The Fe/C microfibers can be successfully fabricated by electrospinning of a hemoglobin-containing solution and subsequent calcination under a reducing atmosphere (Fig. 1).

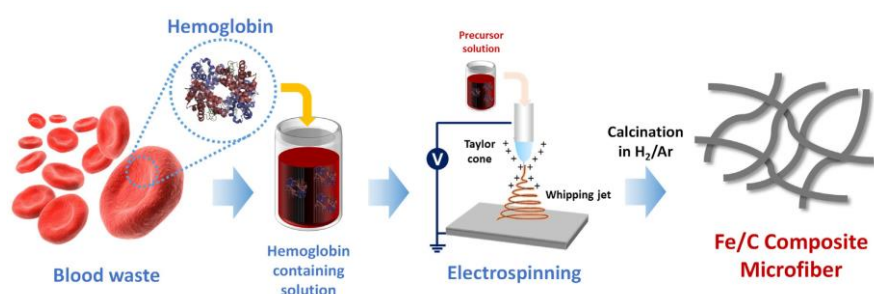


Figure. 1. Schematic illustration of the synthetic procedure of Fe/C microfibers from hemoglobin using electrospinning and calcination under a reducing atmosphere.

We investigate the thermal decomposition behavior and morphologies of Fe/C derived from the hemoglobin precursor source. In addition, we observe morphological and structural features of the Fe/C microfibers. Finally, the electrochemical properties of the Fe/C microfibers are evaluated to demonstrate its catalytic activity as a potential oxygen electrode catalyst for Li–O₂ cells. The results of this study could be useful for the synthesis of various types of blood-derived materials and their applications

MATERIALS AND METHODS

Materials and chemicals

Hemoglobin from bovine blood was purchased from Sigma-Aldrich and used as received. In order to dissolve the hemoglobin for electrospinning, 2,2,2-trifluoroethanol (TFE, 99%) was used, purchased from Alfa-Aesar.

Synthesis of Fe/C powder

In the heat treatment, 0.2 g of hemoglobin was treated under an H₂/ Ar (5%/95%, v/v) atmosphere at 650, 800, and 950 °C for 2 h by increasing the temperature at a rate of 10 °C min⁻¹. Each calcined sample was weighted to estimate the composition.

Synthesis of Fe/C microfiber

In order to prepare the electrospinning solution, 1.3 g of hemoglobin was dissolved in 5 mL of TFE under stirring with a magnetic bar (200 rpm) at room temperature for 12 h. The electrospinning solution was filled in a plastic syringe, which was fixed at 12 cm from a stainless foil wrapped on a cylinder collector. For the electrospinning, a voltage of 18 kV was applied using a high-voltage DC power supply and a rotation speed of 100 rpm was set with a rotating drum collector. Asspun hemoglobin microfibers were then obtained. The collected microfibers were calcined at 250 °C for 1 h under O₂ atmosphere at 10 °C/ min to burn out residues in hemoglobin. A post-heat-treatment of the pre-calcined hemoglobin microfibers was then performed at 650 °C for 2 h under the H₂/Ar (5%/95%, v/v) atmosphere to carbonize and deoxidize hemoglobin.

Material characterizations

The obtained Fe–C powder and microfibers were characterized by powder X-ray diffraction (XRD, SmartLab, Rigaku) using Cu-K α ($\lambda = 1.54 \text{ \AA}$) radiation. The surface morphologies of the calcined hemoglobin were observed with a scanning electron microscope (SEM, JSM-7600F, JEOL). Thermogravimetric (TGA, TG209 F3) and differential thermal (DSC, DSC404C) measurements were performed at a heating rate of 10 °C.min⁻¹ under an inert-gas atmosphere. Raman spectroscopy (LabRam Aramis, Horiba Jobin Yvon) was employed to analyze molecular vibrations. Surface characteristics of the microfiber sample were investigated by X-ray photoelectron spectroscopy (XPS, Kalpha, Thermo U. K.).

Electrochemical characterization

For the preparation of the oxygen electrodes, the following procedures were employed. Slurry was prepared by mixing 65 wt% of multiwalled carbon nanotubes (MWCNTs), 25 wt% of microfiber, and 10 wt% of poly (vinylidene fluoride) (PVDF) binder in an 1-methyl-2- pyrrolidinone (NMP) solvent. A flattened Ni-mesh was then covered by the slurry and dried under vacuum at 80 °C for one day. The average mass loading of electrodes was 0.045 g per 12 mm diameter Ni foam. A Li-metal foil was used as an anode; the separator was a Whatman GF/A glass microfiber. The electrolytes were produced by mixing 1 M lithium bis(trifluoromethanesulfonyl)imide (LiTFSI) in diethylene glycol dimethyl ether (DEGDME) and stirring overnight. Swagelok cells were used; the cells were assembled in a glove box filled with a high-purity argon and purged with dry O₂ out of the glove box. The electrochemical performances of the obtained fiber samples were investigated using cyclic voltammetry (CV) and full charge/discharge tests. The CV tests were performed in the voltage range of 2.0–4.5 V at different scan rates. The full charge/discharge tests were performed between 4.5 V and 2.3 V under a current density of 100 mA g⁻¹.

RESULTS AND DISCUSSION

In order to investigate the thermal behavior and structural feature of the hemoglobin protein after calcination, Fig. 2(a)–(c) show the morphologies of the samples obtained by burning hemoglobin at

different temperatures under a reducing atmosphere. The samples prepared by calcination of hemoglobin protein exhibit planar structures with smooth surfaces. The sizes of the powder samples are approximately sub-hundred micrometer owing to agglomeration of the hemoglobin precursor during the thermal treatment. There is no significant morphological change with the increase of the calcination temperature from 650 °C to 950 °C. XRD results of the samples prepared at different calcination temperatures are shown in Fig. 2(d). The XRD peaks of all of the samples correspond to the carbon and cubic Fe phases (Joint-Committee-on-Powder-Diffraction-Standards (JCPDS) no. 26- 1076 and no. 06-0696, respectively) without any impurities.

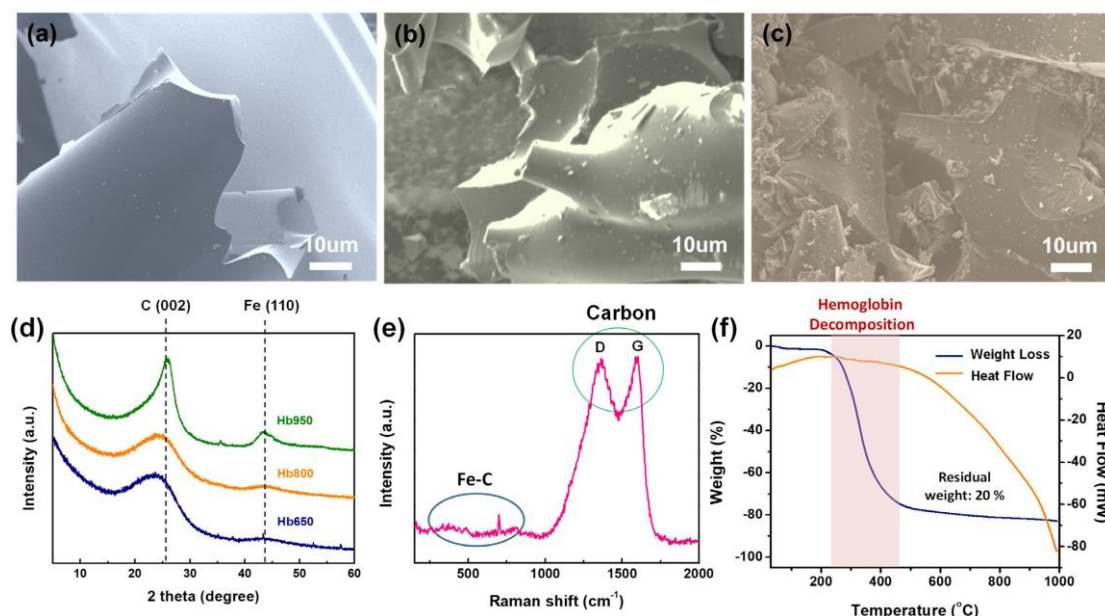


Figure. 2. SEM images of hemoglobin heat treated under the reducing atmosphere at (a) 650, (b) 800, and (c) 950 °C. (d) XRD patterns of the reduced hemoglobin under different temperatures. (e) Raman spectra of hemoglobin reduced at 650 °C showing Fe–C peaks and carbon D and G peaks. (f) TGA and DSC thermograms of the hemoglobin under N₂ atmosphere.

Considering the various carbon sources in the protein, the partial phase in the sample could be the mixed structure of Fe and C (such as Fe₃C) structure as well as separated phases of sole C and Fe [31]. The peak intensity and crystallinity increase with the calcination temperature. There is no phase change or sub-peak related to impurities after calcination at the high temperature of 950 °C. We performed a Raman spectroscopy analysis of the sample prepared at 650 °C to further investigate structural information and carbon residues (Fig. 2(e)). We observed a weak Fe–C vibration mode related to mixture phase of Fe and C in the low wavenumber region. The weak peak feature of the Fe–C vibration mode is associated to the crystallinity. Distinct D and G peaks corresponding to the carbon phase appear at 1364 cm⁻¹ and 1601 cm⁻¹, respectively [3,31].

The burned hemoglobin does not show a high crystallinity of the mixed Fe–C composite phase even after the calcination at 950 °C. It means that a large carbon amount involved in the hemoglobin protein exists with a low Fe amount in the sample. The carbon residues prohibit agglomeration and severe crystallization to FeC complex. The thermal behaviors of the hemoglobin blood protein during the calcination were investigated to elucidate the synthetic mechanism. The TGA and DSC thermograms of the hemoglobin powder are presented in Fig. 2(f). After slight water evaporation at 100 °C, decomposition of the protein species and formation of a crystalline Fe phase occur near 230 °C. An extensive weight loss is observed, due to the endothermic hemoglobin decomposition. Iron and carbon residue (20 wt%) remained after the decomposition reaction, maintained with the increase of the temperature. We employed an electrospinning process to prepare the hemoglobin precursor material with one-dimensional (1D) fiber features [32,33].

The final morphologies of materials are highly dependent on the precursor morphologies [34]. Therefore, we tried to synthesize hemoglobin precursor fiber through electrospinning to fabricate 1D Fe/C fiber materials. Electrospinning is a well-known versatile simple method to prepare 1D nanofiber materials with various compositions [20,35]. The Fe/C microfibers were prepared using thermal treatment of the hemoglobin precursor fibers under the reducing atmosphere (H_2/Ar).

Fig. 3(a) and (b) show the morphologies of the as-spun hemoglobin precursor fibers. The as-spun fibers exhibit a uniform and flattened microstructure with a diameter of approximately $5\ \mu m$. The microfiber features were successfully maintained after the thermal treatment, with a slight decrease in the diameter of the obtained Fe/C microfibers due to the protein decomposition (Fig. 3(c) and (d)). The fiber diameter is in the range of $3\text{--}4\ \mu m$.

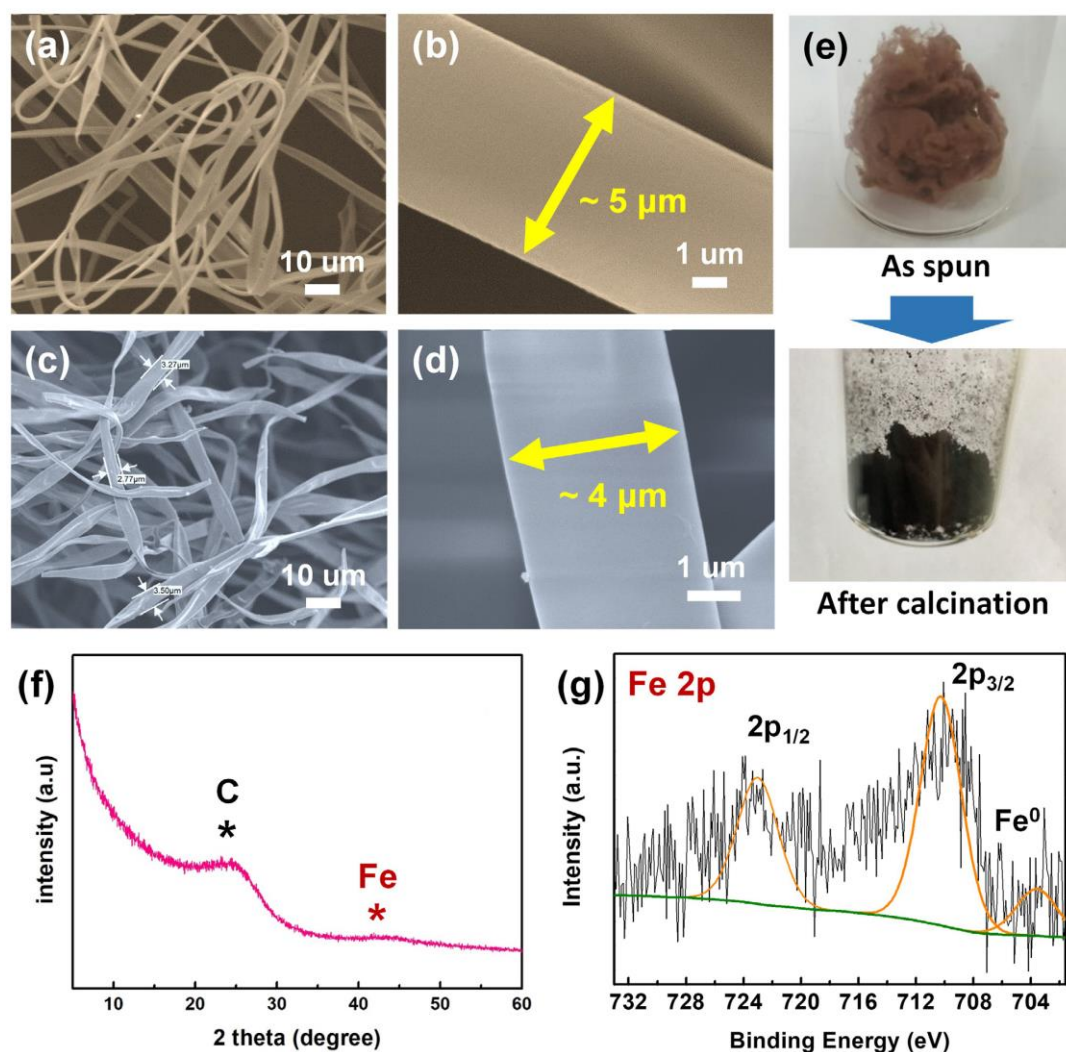


Figure. 3. SEM images of (a and b) as-spun hemoglobin microfibers obtained by the electrospinning method, and (c and d) Fe/C microfibers obtained by a two-step calcination of the as-spun microfibers. (e) Appearance and color change of as-spun hemoglobin microfibers and calcined Fe/C microfibers. (f) XRD pattern of the obtained Fe/C microfiber. (g) XPS spectra obtained from Fe/C microfibers in Fe 2p.

The as-spun hemoglobin fiber was red, as the hemoglobin powders (Fig. 3(e)). After the calcination, the Fe/C microfiber sample transformed to a black fiber sample. In addition, we investigated the crystalline phase of the calcined fibers obtained from the as-spun hemoglobin fibers (Fig. 3(f)).

Although the peak intensity is low owing to the low crystallinity of the fibers, the peaks near 25° and 45° indicate a typical carbon and iron phases, corresponding to the XRD results obtained from the

calcined hemoglobin powders shown in Fig. 2(d). X-ray photoelectron spectroscopy (XPS) characterization of the Fe/C microfiber is carried out to further elucidate chemical structure of Fe component in the fiber sample (Fig. 3(g)). Although the peak signals are weak due to low Fe amount, the Fe 2p core level XPS spectra of the Fe/C microfiber had three peaks corresponding to the characteristic Fe 2P1/2 (~ 722 eV), Fe 2P3/2 (~ 710 eV), and Fe 2P3/2 (~ 704 eV) peaks.

Lower binding energy of XPS spectra indicates existence of Fe metal phase in the fibers. Fe component in the microfiber would show various mixture phase including Fe and Fe₃C. The results verified that the Fe/C microfiber can be successfully synthesized by utilizing the hemoglobin blood protein precursor. Further, we performed electrochemical characterizations of the Fe/C microfibers to assess their potential as an oxygen electrode catalyst for Li–O₂ batteries. In order to understand the electrochemical behavior and catalytic function of the Li–O₂ cells employing the Fe/C microfibers, Fig. 4(a) presents CVs of the Fe/C microfiber in a typical Li–O₂ cell environment. The CV data were collected in the voltage window between 2.0 V and 4.5 V using the Li–O₂ cells. For a pristine cell using an MWCNT oxygen electrode, broad peaks appear in both cathodic and anodic regions near 2.0 V and 3.5 V, respectively. These peaks are associated with the typical formation and decomposition of Li₂O₂ products for discharging and charging [24].

The onset potential values for the cathodic and anodic regions are approximately 2.59 V and 3.21 V, respectively. With the incorporation of the Fe/C microfiber in the oxygen electrode, the peaks were observed at higher cathodic voltage and lower anodic voltage, compared to those of the pristine cells. The onset potential values for the cathodic and anodic regions were approximately 2.7 V and 3.1 V, indicating a reduced overpotential and catalytic facilitation upon the introduction of the Fe/C microfiber component.

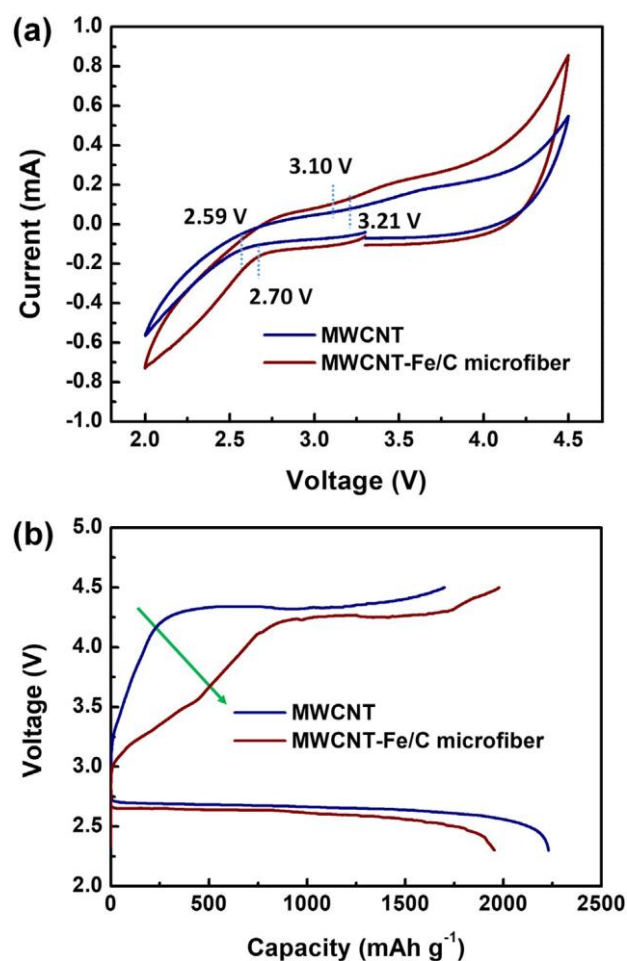


Figure. 4. (a) CV of the Li–O₂ cell using the MWCNT electrode with and without the Fe/C microfiber at a scan rate of 10 mV s⁻¹ within the voltage window of 4.5–2.0 V. (b) Initial charge–discharge

voltage curves of the Li–O₂ cell using the MWCNT and MWCNT–Fe/C microfiber electrodes. The cell tests were performed in the voltage window between 4.5 V and 2.3 V at a current density of 100 mA g^{−1}.

In addition, the peak intensities for the cell employing the Fe/C microfiber/MWCNT became higher than those of the pristine reference as the Li–O₂ reactions for discharging and charging are promoted by the Fe/C microfiber catalyst into the MWCNT oxygen electrode. We evaluate the electrochemical performance of the full Li–O₂ cell with the Fe/C microfiber catalyst to estimate its practical advantages. Fig. 4(b) shows the first charge/discharge profiles of the MWCNT electrodes collected between 4.5 V and 2.3 V at a current density of 100 mA g^{−1} in the LiTFSI + DEGDME electrolyte with and without the Fe/C catalyst. The pristine Li–O₂ cells exhibit a slightly higher discharge capacity of 2231 mAh g^{−1} than the cells with the Fe/C microfiber catalyst (1953 mAh g^{−1}). However, the charge capacity of the cell without the Fe/C microfiber catalyst was reduced to 1698 mAh g^{−1} compared to its discharge capacity. On the other hand, the Li–O₂ cells employing the Fe/C microfiber catalyst successfully maintain the capacity value (1978 mAh g^{−1}) for reverse charging. The Coulombic efficiency of the Li–O₂ cell with the Fe/C microfiber catalyst was almost 100%, higher than that of the reference cell without the catalyst (76%). In addition, we observed a lower-voltage profile of the cell with the Fe/C microfiber catalyst in the charging region, compared to that of the pristine MWCNT cell. This result corresponds to the CV result related to the reduced overpotential. The lower charge voltage is related to facile evolution of discharge products promoted by the Fe/C catalysts. Although the Fe/C microstructure seems very large as a sole catalyst component, we expected that MWCNTs are loaded on the Fe/C microfiber, subsequently making numerous line contacts between the Fe/C microfiber surface and MWCNTs. We suggested an efficient and sustainable approach to utilize the hemoglobin protein in blood waste as a precursor for catalyst synthesis. The catalysts could be useful for various applications including other next-generation energy systems as well as Li–O₂ batteries.

CONCLUSIONS AND RECOMMENDATIONS

We presented a synthetic strategy to prepare Fe/C composite microfiber materials through electrospinning of hemoglobin blood protein and subsequent thermal treatment under a reducing atmosphere. We studied their catalytic activities as a component in an oxygen electrode for Li–O₂ batteries. In addition, we investigated the thermal behavior and structural change of the hemoglobin after calcination to find optimal synthetic conditions for the fabrication of the Fe/C microfiber. 1D Fe/C microfibers with continuous and flattened morphologies were successfully obtained by electrospinning and calcination. Finally, we demonstrated the improved electrochemical activity of the Fe/C microfibers as an oxygen electrode catalyst in Li–O₂ cells. We presented an alternative method to recycle hemoglobin protein obtained from blood waste for efficient and environmentally-friendly catalyst materials for future energy-storage systems.

REFERENCES

- [1] S. Chu, Y. Cui, N. Liu, The path towards sustainable energy, *Nat. Mater.* 16 (2016) 16–22.
- [2] J. Lu, Y.J. Lee, X.Y. Luo, K.C. Lau, M. Asadi, H.H. Wang, S. Brombosz, J.G. Wen, D.Y. Zhai, Z.H. Chen, D.J. Miller, Y.S. Jeong, J.B. Park, Z.Z. Fang, B. Kumar, A. Salehi-Khojin, Y.K. Sun, L.A. Curtiss, K. Amine, A lithium-oxygen battery based on lithium superoxide, *Nature* 529 (2016) 377–+.
- [3] W.H. Ryu, T.H. Yoon, S.H. Song, S. Jeon, Y.J. Park, I.D. Kim, Bifunctional composite catalysts using Co₃O₄ nanofibers immobilized on nonoxidized graphene nanoflakes for high-capacity and long-cycle Li–O₂ batteries, *Nano Lett.* 13 (2013) 4190–4197.
- [4] P.G. Bruce, S.A. Freunberger, L.J. Hardwick, J.M. Tarascon, Li–O₂ and Li–S batteries with high energy storage, *Nat. Mater.* 11 (2012) 19–29.

- [5] H.D. Lim, B. Lee, Y. Bae, H. Park, Y. Ko, H. Kim, J. Kim, K. Kang, Reaction chemistry in rechargeable Li-O₂ batteries, *Chem. Soc. Rev.* 46 (2017) 2873–2888.
- [6] H.G. Jung, J. Hassoun, J.B. Park, Y.K. Sun, B. Scrosati, An improved high-performance lithium-air battery, *Nat. Chem.* 4 (2012) 579–585.
- [7] D. Kundu, R. Black, B. Adams, L.F. Nazar, A highly active low voltage redox mediator for enhanced rechargeability of lithium-oxygen batteries, *ACS Cent. Sci.* 1 (2015) 510–515.
- [8] Y. Chen, S.A. Freunberger, Z. Peng, O. Fontaine, P.G. Bruce, Charging a Li-O(2) battery using a redox mediator, *Nat. Chem.* 5 (2013) 489–494.
- [9] R.S. Kalubarme, H.S. Jadhav, D.T. Ngo, G.E. Park, J.G. Fisher, Y.I. Choi, W.H. Ryu, C.J. Park, Simple synthesis of highly catalytic carbon-free MnCo₂O₄@Ni as an oxygen electrode for rechargeable Li-O₂ batteries with long-term stability, *Sci. Rep.-UK* 5 (2015).
- [10] Z.W. Chang, J.J. Xu, X.B. Zhang, Recent progress in electrocatalyst for Li-O₂ batteries, *Adv. Energy Mater.* 7 (2017).
- [11] F.S. Gittleston, K.P.C. Yao, D.G. Kwabi, S.Y. Sayed, W.H. Ryu, Y. Shao-Horn, A.D. Taylor, Raman spectroscopy in lithium-oxygen battery systems, *Chemelectrochem* 2 (2015) 1446–1457.
- [12] B.J. Bergner, M.R. Busche, R. Pinedo, B.B. Berkes, D. Schroder, J. Janek, How to improve capacity and cycling stability for next generation Li-O₂ batteries: approach with a solid electrolyte and elevated redox mediator concentrations, *ACS Appl. Mater. Interfaces* 8 (2016) 7756–7765.
- [13] Z. Guo, C. Li, J. Liu, Y. Wang, Y. Xia, A long-life lithium-air battery in ambient air with a polymer electrolyte containing a redox mediator, *Angew Chem. Int. Ed. Engl.* 56 (2017) 7505–7509.
- [14] F.S. Gittleston, W.H. Ryu, A.D. Taylor, Operando observation of the gold-electrolyte interface in Li-O₂ batteries, *ACS Appl. Mater. Interfaces* 6 (2014) 19017–19025.
- [15] W.H. Ryu, F.S. Gittleston, J.Y. Li, X. Tong, A.D. Taylor, A new design strategy for observing lithium oxide growth-evolution interactions using geometric catalyst positioning, *Nano Lett.* 16 (2016) 4799–4806.
- [16] W.H. Ryu, F.S. Gittleston, M. Schwab, T. Goh, A.D. Taylor, A mesoporous catalytic membrane architecture for lithium-oxygen battery systems, *Nano Lett.* 15 (2015) 434–441.
- [17] M. Asadi, B. Kumar, C. Liu, P. Phillips, P. Yasaei, A. Behranginia, P. Zapol, R.F. Klie, L.A. Curtiss, A. Salehi-Khojin, Cathode based on molybdenum disulfide nanoflakes for lithium-oxygen batteries, *ACS Nano* 10 (2016) 2167–2175.
- [18] A. Eftekhari, B. Ramanujam, In pursuit of catalytic cathodes for lithium-oxygen batteries, *J. Mater. Chem. A* 5 (2017) 7710–7731.
- [19] K.R. Yoon, D.S. Kim, W.H. Ryu, S.H. Song, D.Y. Youn, J.W. Jung, S. Jeon, Y.J. Park, I.D. Kim, Tailored combination of low dimensional catalysts for efficient oxygen reduction and evolution in Li-O₂ batteries, *Chemsuschem* 9 (2016) 2080–2088.
- [20] J.W. Jung, C.L. Lee, S. Yu, I.D. Kim, Electrospun nanofibers as a platform for advanced secondary batteries: a comprehensive review, *J. Mater. Chem. A* 4 (2016) 703–750.
- [21] F.S. Gittleston, W.H. Ryu, M. Schwab, X. Tong, A.D. Taylor, Pt and Pd catalyzed oxidation of Li₂O₂ and DMSO during Li-O₂ battery charging, *Chem. Commun.* 52 (2016) 6605–6608.
- [22] M.K. Panda, K. Ladomenou, A.G. Coutsolelos, Porphyrins in bio-inspired transformations: light-harvesting to solar cell, *Coord. Chem. Rev.* 256 (2012) 2601–2627.
- [23] I. Willner, Biomaterials for sensors, fuel cells, and circuitry, *Science* 298 (2002) 2407–2408.
- [24] W.H. Ryu, F.S. Gittleston, J.M. Thomsen, J.Y. Li, M.J. Schwab, G.W. Brudvig, A.D. Taylor, Heme biomolecule as redox mediator and oxygen shuttle for efficient charging of lithium-oxygen batteries, *Nat. Commun.* 7 (2016).
- [25] C.S.F. Bah, A.E.A. Bekhit, A. Carne, M.A. McConnell, Slaughterhouse blood: an emerging source of bioactive compounds, *Compr. Rev. Food Sci. F.* 12 (2013) 314–331.
- [26] D.M. Leitner, Water-mediated energy dynamics in a homodimeric hemoglobin, *J. Phys. Chem. B* 120 (2016) 4019–4027.
- [27] F. Wang, C.H. Yang, C.Y. Duan, D. Xiao, Y. Tang, J.F. Zhu, An organ-like titanium carbide material (MXene) with multilayer structure encapsulating hemoglobin for a mediator-free biosensor, *J. Electrochem. Soc.* 162 (2015) B16–B21.

- [28] J. Maruyama, J. Okamura, K. Miyazaki, Y. Uchimoto, I. Abe, Hemoglobin pyropolymer used as a precursor of a noble-metal-free fuel cell cathode catalyst, *J. Phys. Chem. C* 112 (2008) 2784–2790.
- [29] K.L. Bren, R. Eisenberg, H.B. Gray, Discovery of the magnetic behavior of hemoglobin: a beginning of bioinorganic chemistry, *P. Natl. Acad. Sci. USA* 112 (2015) 13123–13127.
- [30] R. Sridhar, R. Lakshminarayanan, K. Madhaiyan, V.A. Barathi, K.H.C. Limh, S. Ramakrishna, Electrospayed nanoparticles and electrospun nanofibers based on natural materials: applications in tissue regeneration, drug delivery and pharmaceuticals, *Chem. Soc. Rev.* 44 (2015) 790–814.
- [31] L. Cao, Z.-H. Li, Y. Gu, D.-H. Li, K.-M. Su, D.-J. Yang, B.-W. Cheng, Rational design of N-doped carbon nanobox-supported Fe/Fe₂N/Fe₃C nanoparticles as efficient oxygen reduction catalysts for Zn–air batteries, *J. Mater. Chem. A* 5 (2017) 11340–11347.
- [32] W.H. Ryu, H. Wilson, S. Sohn, J.Y. Li, X. Tong, E. Shaulsky, J. Schroers, M. Elimelech, A.D. Taylor, Heterogeneous WSX/WO₃ thorn-bush nanofiber electrodes for sodium-ion batteries, *ACS Nano* 10 (2016) 3257–3266.
- [33] S. Agarwal, J.H. Wendorff, A. Greiner, Use of electrospinning technique for biomedical applications, *Polymer* 49 (2008) 5603–5621.
- [34] W.H. Ryu, S.J. Lim, W.K. Kim, H. Kwon, 3-D dumbbell-like LiNi_{1/3}Mn_{1/3}Co_{1/3}O₂ cathode materials assembled with nano-building blocks for lithium-ion batteries, *J. Power Sources* 257 (2014) 186–191.
- [35] J.W. Jung, W.H. Ryu, S. Yu, C. Kim, S.H. Cho, I.D. Kim, Dimensional effects of MoS₂ nanoplates embedded in carbon nanofibers for bifunctional Li and Na insertion and conversion reactions, *ACS Appl. Mater. Interfaces* 8 (2016) 26758–26768.



VIII. International Symposium-2024

INTERNATIONAL COOPERATION IN THE FIELD OF WATER SECURITY: KAZAKHSTAN ON THE WAY OF STABILITY

Madina IGIBAYEVA

*PhD Candidate in Military Science, University of Public Service – Ludovika, Budapest, Hungary
madina.igibayeva@gmail.com*

Abstract

Water security is a concept that encompasses a wide range of aspects related to access to clean water, water resource management, protection against water – related threats and the sustainability of water systems. By enabling hygienic standards in the handling of water, it will contribute to the prevention of waterborne diseases. Efficient use, allocation, and protection of water resources considering environmental, social, and economic sustainability, will help to protect against floods, droughts, and pollution of water bodies, as well as prevention of water-related risks.

The issue of international cooperation in the field of water security is important for Kazakhstan, given its geographical location and dependence on transboundary water resources. Cooperation between countries to manage transboundary water problems and resolve conflicts related to water use will help with water security and is critical for human health, sustainable development and world stability, as water is a key resource affecting many aspects of human life and activities.

Keywords: *Water security, Kazakhstan, Central Asia, Global warming, Water resources*

INTRODUCTION

Water is an extremely limited resource and the struggle for the possession of its sources is already becoming the most important factor of geopolitics, being one of the causes of tension and conflicts on the planet. The problem of water supply is acute in our country. We lack quality drinking water. A number of regions are in dire need of it. There is also a geopolitical aspect to this problem. Already now we are faced with a serious issue of using water resources of transboundary rivers. Despite the complexity of this issue, we must not allow it to become politicised.

Currently, more than 2 billion people in the world do not have access to sufficient clean water. This number is projected to roughly double in the next few years, reaching 4-4.5 billion people. And by 2025, this figure will reach 5.5 billion people. [[1]]

Global consumption of drinking water has increased eightfold in the last 60 years and will grow exponentially in the coming decades. Clean water itself is one of the scarcest and most valuable

resources and, like any basic resource, will affect prospects for economic growth, either as a catalyst for conflict or as a basis for cooperation.

Access to water is recognised as a fundamental human right and this was enshrined in the UN General Assembly Resolution No. 64/292 on the human right to water and sanitation adopted in July 2010. [[2]]

Water security can thus be defined as the right of everyone to have reliable access to safe drinking water at a reasonable price, and the ability of populations to conserve ecosystems and conserve sufficient water of acceptable quality.

The UN Conference on Sustainable Development, held in Rio de Janeiro in 2012, concluded that water security is the foundation of sustainable development because without healthy freshwater systems, poverty and inequality cannot be defeated. Water security is also an integral part of the Millennium Development Goals (MDGs). [[3]]

WATER SECURITY IN KAZAKHSTAN

Kazakhstan's geographical location, its dependence on transboundary rivers, environmental degradation, and local climate change. Therefore, the Kazakh government has redoubled its efforts to ensure water security by adopting the Green Economy Concept and the State Water Resources Management Programme, as well as a number of other initiatives.

The main threats and challenges in the field of water supply of the republic are global and regional climate change, inconsistency of interstate water relations, use of water-consuming technologies and imperfect technical means of water regulation and water distribution. The consequences of water hazards can be aggravation of interstate water contradictions, development of new hotbeds of environmental instability, failure of socio-economic development programmes (fig. 1).

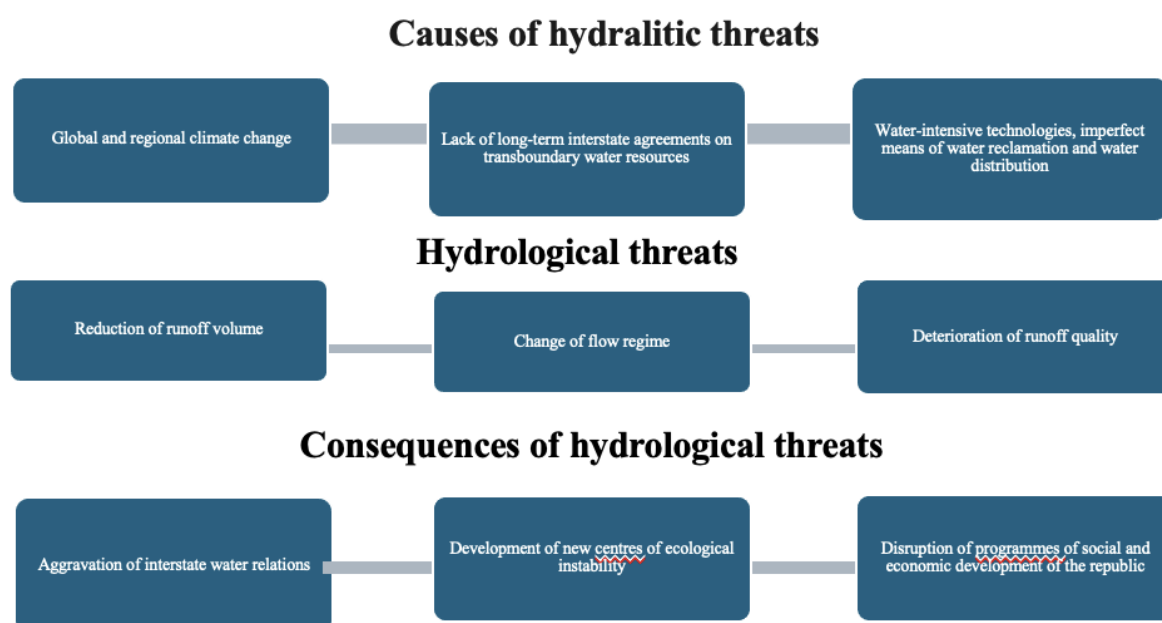


Figure 1: Hydrological threats: causes and consequences

Kazakhstan has never viewed water security as a given, for a number of reasons.

Firstly, Kazakhstan is the largest country in the world without access to the World Ocean. The nearest access point to the World Ocean is the Iranian port of Bandar Abbas, 2,500 kilometres away from central Kazakhstan. The problem is further aggravated by the fact that most of Kazakhstan's territory is semi-desert.

Secondly, the collapse of the Soviet Union destroyed the system of water and energy exchange between the Soviet republics of Central Asia. In the post-Soviet period, regional co-operation was required to ensure water security for all participants.

Third, almost 50 per cent of Kazakhstan's water resources are unregulated runoff from transboundary rivers. [[4]] In other words, almost half of the water comes from neighbouring countries, which makes independence in water supply extremely difficult or even impossible. For example, excessive water withdrawal for irrigation from the Amu Darya and Syr Darya rivers has turned the Aral Sea, formerly rich in life, into a barren desert. This has already led to an ecological catastrophe. And it threatens to worsen if the issue of water withdrawal from these rivers is not resolved. The only possible remedy would be to reduce irrigation of fields, which consumes 92 per cent of water withdrawals. However, four of the five former Soviet republics in the Aral Sea basin (except Kazakhstan) intend to increase irrigation of farmland - mainly to feed their growing populations. [[5]]

Moreover, the construction of the Rogun HPP will actually shallow the Amu Darya to such an extent that its waters will simply not reach Kazakhstan. The situation with the Syr Darya is similar. If additional dams are built, the Syr Darya will simply not reach Kazakhstan, which will further aggravate the environmental situation. [[6]]

Fourthly, the water resources available on the territory of Kazakhstan are extremely vulnerable from the climatic point of view. According to available forecasts, a significant part of currently existing arable land and pastures will turn into deserts or, at best, semi-deserts in the next 15 years. This scenario threatens to reduce Kazakhstan's water supply by almost one third. I am not talking about cattle mortality and crop failure.

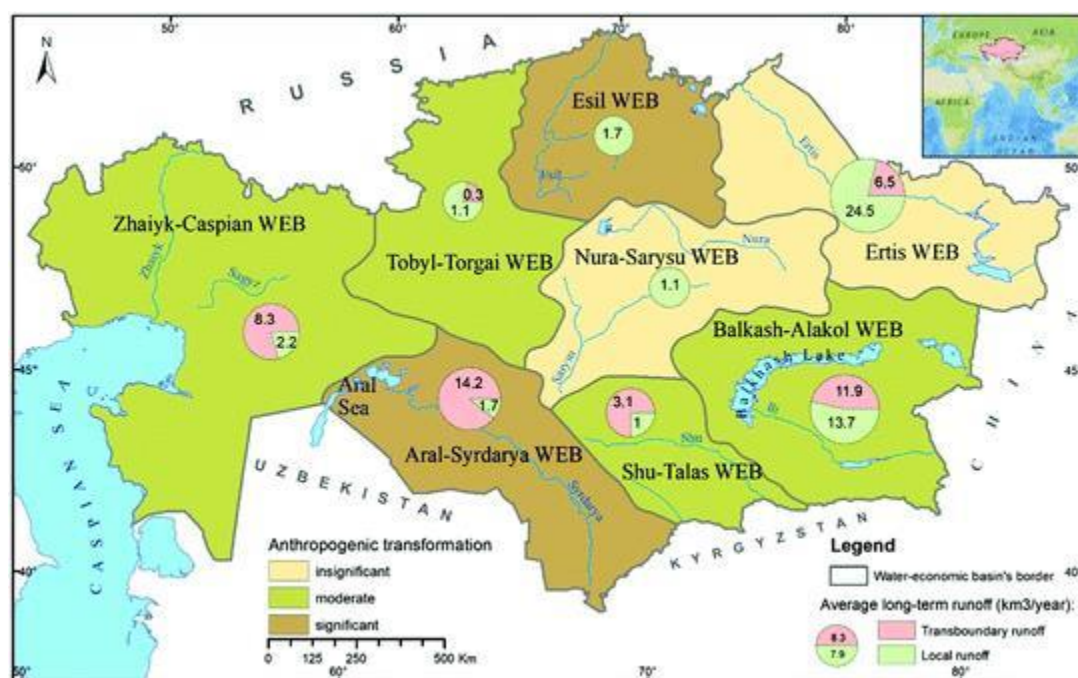
Fifthly, water resources on the territory of Kazakhstan are distributed extremely unevenly. The eastern region accounts for 34.5% of resources, south-eastern region - 24.1%, southern region - 21.2%, western region - 13.4%, northern region - 4.2%, central region - 2.6%. East Kazakhstan oblast is the most supplied with water - 290 thousand m³ per km². At the same time, there is an acute deficit in Atyrau, Kyzylorda and especially in Mangystau oblast, where there are practically no sources of fresh water. [[7]]

The problem of water security of the Republic of Kazakhstan (security of water-related life activity) under conditions of limited and vulnerable water resources is considered as a component of national security. This is determined by the fact that fresh water is the most important natural resource, without which no human activity is possible and cannot be replaced by anything. On the other hand, water is an integral part of the whole nature and the main component of the environment. Finally, water is a threatening natural element that brings destruction and disasters. This determines the great complexity of interaction between society and water environment, which has many peculiarities for different regions of Kazakhstan and undergoes significant changes as society develops and climatic conditions change.

CO-OPERATION ON TRANSBOUNDARY RIVERS

The availability and condition of water resources is a vital factor affecting the economic development of the country. At the same time, the general condition and quality of water resources in the Republic of Kazakhstan are significantly deteriorating, and their intensive pollution can have a devastating impact on the environment.

At present, the main attention should be focused on the state of water resources of the main water arteries - the Syr Darya, Irtysh and Ili rivers.



Picture 1. Water supply of river basins in Kazakhstan. Prognosis for 2030.
Source: https://link.springer.com/chapter/10.1007/978-981-13-0929-8_2

By 2030, water resources in Kazakhstan are expected to decrease from 100 to 85 billion cubic metres, i.e. by 15%. One of the main reasons for the decline in water resources is the geographical location of Kazakhstan, which is located in the lower reaches of major transboundary rivers. [[8]] The neighbouring states annually increase water consumption, reducing the level in our rivers.

Within Kazakhstan, 2.5 million people live in the Irtysh basin, large industrial centres for mining and processing of minerals - Ust-Kamenogorsk, Semipalatinsk, Pavlodar - are located in the North-Eastern and Central regions, further development of energy, industry and agriculture is directly related to the use of resources of this river. [[9]]

Rational use of transboundary water resources is not only economically and environmentally significant, but also of great political and international importance. In Kazakhstan, the use of water resources of transboundary rivers is a rather serious problem. The condition of transboundary water bodies of the Republic of Kazakhstan is particularly alarming. The level of pollution of these rivers in recent years has begun to exceed the level of maximum permissible concentration several times.

Many problems of water resources allocation and water pollution, which used to be of intra-state nature during the Soviet Union, have now acquired a transboundary context.

This requires a new and harmonised legal and regulatory framework for water management among sovereign states, which will take some time to establish. There is a generally positive attitude towards establishing co-operation on transboundary water issues in the Central Asian region, and much has already been done since the collapse of the Soviet Union.

The problems of water allocation in the region are far from being fully resolved, and moreover, they have been exacerbated in recent years. In particular, the Kyrgyz Republic and the Republic of Tajikistan (the most water-secure countries in Central Asia) consider it necessary to revise the previously existing criteria and principles of inter-State use of transboundary watercourses

in terms of water allocation and management, rational use and protection. The most acute contradictions arise over the operation regime of the Toktogul reservoir (located on the territory of the Kyrgyz Republic), which is the largest in the Syr Darya basin and in the whole of Central Asia. The interests of three Central Asian states - the Kyrgyz Republic, the Republic of Uzbekistan and the Republic of Kazakhstan - have clashed here. Two states located in the lower reaches of the Syrdarya River are interested in preserving the irrigation regime of the Toktogul reservoir, while the Kyrgyz Republic benefits from the energy regime of its operation. [[10]]

The People's Republic of China unilaterally starts implementing plans to increase the use of water resources of the Irtysh and Ili rivers on its territory. It is envisaged to increase water intake in the upper reaches of the Ili River for agricultural needs. The transfer of part of the Irtysh and Ili rivers is aimed at providing water resources to the rapidly developing economic region, where the growing industry, primarily oil industry, as well as newly built settlements are experiencing an acute shortage of water. In addition, the increase in water consumption is linked to the planned significant increase in grain and cotton cultivation in Xinjiang. China's planned diversion of water from rivers may have serious consequences for the economy and ecology not only of the Republic of Kazakhstan, but also of the Russian Federation. Water withdrawal from the Black Irtysh, given the existing sources of pollution, will also lead to the deterioration of water quality and the state of the ecosystem of the Irtysh River, which is already assessed as very unfavourable. [[11]]

The very problem of water supply and shared use of transboundary water resources is one of the main conflict nodes that pose a real threat to the regional security of the Central Asian states. It is noteworthy that such problems are characteristic not only for the countries of the region under consideration. The problem of preventing water pollution has long ago transcended the borders of individual states and even entire continents, has acquired an international character and has become common for practically all states of the world. This is due, first of all, to the fact that harmful substances entering water bodies are spread over vast areas without regard to state borders. [[12]]

It seems that these conflict situations should be resolved on the basis of interstate agreements, negotiations, consultations, through the creation of interstate integration associations, as well as the development of conceptual frameworks for joint state management of transboundary watercourses of the Central Asian countries.

Co-operation between States is conditioned by the fact that the largest water bodies, due to the objectively inherent properties of water resources, in physical-geographical and economic terms act as single objects - water basins. Intensive use or significant change of hydrological regime or pollution of water resources in one part of one or another basin, as a rule, affects the condition of another or other parts of the basin and thus affects the interests of the states located in this basin, which, thus, find themselves mutually interested in coordinating the volumes and methods of water use, types, timing and scale of hydraulic works, in the exchange of information on the state of the water body, etc.. [[13]]

To solve transboundary water use problems in the Central Asia region, the assistance of international financial institutions is actively attracted: the World Bank, Asian and Islamic Development Banks, UNDP, USAID and others. Such countries as Germany, Japan, France, Great Britain, Austria, Kuwait provide assistance and support in solving water problems in the republic.

The multilateral Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki, 17 March 1992) is the international legal basis for State cooperation. The Convention was prepared under the auspices of UNECE and entered into force on 6 October 1996. It plays an important role in promoting co-operation on transboundary

waters in many parts of the UNECE region. The Protocol on Water and Health to the Convention aims to prevent, control and reduce water-related disease. [[14]]

Many years have passed since the Convention was signed, but there are still issues that have not been definitively resolved through negotiations and that need to be further developed. Landscape protection, ecosystem approach, flood protection, water allocation are just some examples of such issues. Future work under the Convention could both address these areas and aim at extending the scope of the Convention outside the UNECE region, as is already happening with some UNECE Protocols.

The Parties to the Convention are the Republic of Kazakhstan, the Russian Federation, Great Britain, Germany and other countries, while the People's Republic of China, the Republic of Tajikistan, Turkmenistan, the Kyrgyz Republic and the Republic of Uzbekistan are not Parties to this Convention. In accordance with the preamble, the Parties to this Convention realise that the protection and use of transboundary watercourses and international lakes are important and urgent tasks, the effective solution of which can be ensured only through close cooperation. The Parties to the Convention emphasise the need to strengthen national and international measures to prevent, control and reduce the release of hazardous substances into the aquatic environment and to reduce effluence and acidification as well as pollution of the marine environment, particularly in coastal marine areas, from land-based sources. [[14]]

The recognition by the other Central Asian states of this convention should be considered as one of the important stages in the system of interstate relations regulating the joint use of water resources. In the future, this will make it possible to develop a unified approach to the subjects of international law or participants in the treaty process of the Central Asian countries. Unfortunately, this stage of interstate relations in the field of shared water use has not yet been properly developed in regional cooperation. [[15]]

All these problems put Kazakhstan in the last place among all CIS countries in terms of water availability. In the scenario of inertial development, the national water shortage may reach 14 billion cubic metres by 2030 and 20 billion cubic metres over the next two decades, which is up to 70% of the total water demand. [[16]]

The costs of inaction are extremely high because, according to Kazakhstan's Green Energy Concept, the resulting economic losses from water scarcity will reach the level of \$6-7 billion per year by 2030. In other words, water security is not only about meeting human needs, but also a necessary foundation for Kazakhstan's economic development. These two goals are inextricably linked. [[16]]

To remedy the situation, a number of measures have been outlined and adopted. By 2030, the Government of Kazakhstan has budgeted \$10 billion to improve water use efficiency and \$1-2 billion for the construction and modernisation of water treatment plants. The expected cost of transition from a water-scarce economy to a more water-efficient economy is between \$500 million and \$1 billion per year. [[16]]

Active work is being done in this area: programmes are being implemented to improve water use efficiency among agricultural, industrial and municipal users; standards for improving water quality and safety, similar to those in developed countries, have been adopted; and Water Committees operating at the basin level have been given executive powers to maintain a balance between water supply and consumption.

CONCLUSION

Reflecting on the multilateral Conventions, it should be emphasised that they laid the foundations for the concept of sustainable development, which is "one of the basic concepts of

international environmental law". This concept "should permeate all areas of state activity and have a determining influence on the economic and social functions of the state. In this regard, ensuring sustainable development becomes a universal primary task of the state, realised through all areas of its activities. Therefore, in my opinion, the participation of states in international treaties on environmental protection and, in particular, treaties on the protection and use of transboundary watercourses seems to be an important issue.

Thus, international legal co-operation of the Central Asian states in the field of protection and use of transboundary watercourses began to intensify only towards the end of the 1990s of the last century. This stage is characterised by the fact that "water management agencies of the region began to take into account in their practice the deterioration of the environmental situation under the influence of water management activities and hence the transformation of the natural environment into a factor of destabilisation of the socio-economic situation in the region or its separate parts. It was understood that the main condition for transition to sustainability of natural and natural-anthropogenic cycles is minimisation of negative factors of interaction between rivers and irrigated areas, as well as interaction between surface and groundwater". [[17]] It is in this period, under conditions of increasing water scarcity in transboundary river basins and deterioration of their water quality, that legal measures are developed to regulate water relations between states, taking into account the interests of each party and aimed at maintaining an environmentally safe regime of these rivers.

However, in spite of all political, legal and economic measures taken, there is an acute shortage of water resources in the countries of the Central Asian region due to their irrational use and inadequate protection.

Based on my research in conclusion, it seems that in order to solve this problem it is necessary to:

- development of international cooperation to resolve transboundary environmental problems, to establish direct contacts between environmental organisations and regions of EurAsEC member states;
- Within the framework of international co-operation between Central Asian countries in the protection and use of transboundary watercourses, it is necessary to develop ways of influencing states to participate in international treaties on the protection of water bodies located in the territory of different states.
- within the framework of interstate integration cooperation, to implement a unified institutional approach to the development and establishment of common environmental standards and environmental norms, and to agree on the methodology for their development, which will make it possible to create a comprehensive quality system for transboundary water bodies;
- developing co-operation in combating national environmental problems: water pollution, radiation and toxic pollution, air pollution, reduction of biodiversity and land degradation;
- intensification of interaction within the framework of multilateral cooperation, CAEA, SCO and CES in the field of environmental security, with regional and sub-regional organisations, including the Eurasian Economic Community;
- Legislators should develop and include in international treaties on the protection and use of transboundary waters norms regulating the types and forms of international legal responsibility of states for transboundary pollution of water bodies.
- At the domestic level, it is necessary to improve norms on the protection and use of transboundary water bodies, as well as to develop the most effective mechanisms for their implementation.

Thus, insufficient development of the mechanism for ensuring environmental security in Kazakhstan complicates the process of resolving these threats.

To prevent and solve environmental problems will require not only ratification of international conventions, but also constant coordination of joint actions with transboundary countries. The solution of political and economic issues will provide an opportunity to focus common attention on a problem that is already global in nature - environmental degradation.

Environmental security as a whole can be achieved only as a system of measures representing a set of social, legislative, technical, technological, medical, biological and other measures aimed at maintaining a balance between the biosphere and anthropogenic as well as natural external pressures.

REFERENCES

- [1] WHO/UNICEF, 2023. URL: <https://www.un.org/ru/global-issues/water> (accessed: 01.06.2024)
- [2] The human right to water and sanitation. URL: https://www.un.org/waterforlifedecade/human_right_to_water.shtml#:~:text=The%20human%20right%20to%20water%20and%20sanitation&text=On%2028%20July%202010%2C%20through,realisation%20of%20all%20human%20rights. (accessed: 01.06.2024)
- [3] From MDGs to SDGs. URL: [https://www.sdgfund.org/mdgs-sdgs#:~:text=The%20Rio%2B20%20conference%20\(the,global%20development%20framework%20beyond%202015](https://www.sdgfund.org/mdgs-sdgs#:~:text=The%20Rio%2B20%20conference%20(the,global%20development%20framework%20beyond%202015). (accessed: 01.06.2024)
- [4] The climate change impact on water resources in Kazakhstan. October 26, 2021. URL: <https://www.undp.org/kazakhstan/stories/climate-change-impact-water-resources-kazakhstan> (accessed: 01.06.2024)
- [5] World of change: Shrinking Aral Sea. URL: <https://earthobservatory.nasa.gov/world-of-change/AralSea> (accessed: 01.06.2024)
- [6] Micklin P., Efforts to revive the Aral sea. The Aral Sea, January 2014., pp. 361-380
- [7] Nugumanova L., Frey M., Yemelina N., Yugay S., Environmental problems and policies in Kazakhstan: Air pollution, waste and water., IOS Working Papers, No. 366., Leibniz Institute for East and Southeast European Studies, Regensburg., 2017.
- [8] Government approves concept of Water Resources Management Program for 2020-2030., Official Information Source of the Prime Minister of the Republic of Kazakhstan. URL: <https://primeminister.kz/en/news/pravitel-stvo-utverdilo-koncepciu-programmy-upravleniy-vodnymi-resursami-rk-na-2020-2030-gody> (accessed: 01.06.2024)
- [9] Kaukenov A., Water diplomacy. How Kazakhstan solves the problem of transboundary rivers., September 5, 2022., URL: <https://zonakz.net/2022/09/05/vodnaya-diplomatiya-kak-kazakhstan-reshaet-problemu-transgranichnyx-rek/> (accessed: 01.06.2024)
- [10] Putz C., Worrying Water Levels at Kyrgyzstan's Critical Toktogul Reservoir., March 5, 2024., The Diplomat. URL: <https://thediplomat.com/2024/03/worrying-water-levels-at-kyrgyzstans-critical-toktogul-reservoir/> (accessed: 01.06.2024)
- [11] Duskaev K. K., Transboundary problems of water relations of the Republic of Kazakhstan // Ecology and Sustainable Development. -No2, February, 2004., pp. 19-21.
- [12] Kaverin A. M., Legal protection of waters from pollution. - M., "Yuridicheskaya Literatura", 1977., p. 103.
- [13] Kolbasov O.S. Water legislation in the USSR., "Yuridicheskaya Literatura", 1972., p. 216.
- [14] Helsinki Convention: preventing pollution in international watercourses and lakes., URL: <https://eur-lex.europa.eu/EN/legal-content/summary/helsinki-convention-preventing-pollution-in-international-watercourses-and-lakes.html#:~:text=This%20is%20known%20as%20the,impartial%20use%20of%20transboundary%20waters>. (accessed: 01.06.2024)

- [15] Water Resources of Kazakhstan in the New Millennium. Publication in support of the Millennium Development Goals. Goal 7 - Ensuring environmental sustainability., Almaty, 2004., p. 132.
- [16] Zholdayakova S., Abuov Y., Zhakupov D., Suleimenova B., Kim A., Kazakhstan on the way to hydrogen economy., Asian Development Bank., October 2, 2023., 7-chapter. URL: <https://www.adb.org/publications/toward-a-hydrogen-economy-in-kazakhstan> (accessed: 01.06.2024)
- [17] Kipshakbaev N. K. K., Sokolov V. I., Rakhimov Sh. H. Water resources of the Aral Sea basin: formation and use // Ecology and Sustainable Development., pp. 22-27



VIII. International Symposium-2024

DELEGATED PUBLIC DRINKING WATER SERVICES IN THE MUNICIPALITY OF DASSA-ZOUME (BENIN)

Léocadie ODOULAMI¹, Rene Ayeman ZODEKON²

*Laboratoire Pierre PAGNEY, Climat, Eau, Ecosystème et Développement (LACEEDE)
DGAT/FASHS/ Université d'Abomey-Calavi (UAC), 03BP :1122 Cotonou, République du Bénin
(Afrique de l'Ouest), leocadieo@yahoo.com*

Abstract

The delegation of water services is one of the alternative methods used by the habitants of Dassa-Zoumé municipality to access to drinkable water supply networks. But this water technic services has in front of some irregularities. This research analyzes the functioning of modes of water services delegation in this commune.

The documentation on the water management services was done in many services and libraries in Benin. Also, 50 delegates (public and private) of the corporation, 50 households from user associations and 10 resource persons were selected in the commune. The data collected were treated with empirical methods.

The results show that 298 and 9 Village Water Supply are delegated to public and private operators of the commune or out. But, concerning the Drilling Pump with Human Power, it made to private operators through the leasing contract. Those contractors must pay monthly 5,000 F CFA or 7.62 Euros. This activity generates a significant profit to the delegate.

The delegation of the water service is confronted with structural problems such as, the lack of intervention of the private sector in the field, the ignorance of the logical framework of intervention of the actors, the vagueness maintained in the granting of the market to the private one which no longer obliges the delegate to properly complete their specifications. A situation which explains the high cost of water to users. This way of managing the water service is an opportunity for its sustainability.

Keywords: *Bénin (West Africa), Dassa-Zoumé commune, water services, population drinkable water*

INTRODUCTION

Benin differs from other developing countries by the extreme decentralization of public drinking water and sanitation services, also leaving to the communities responsible for them the choice of management mode. Here again, public service delegation constitutes a successful form of management which allows the local authority to transfer the risks inherent in the management of the service while retaining its prerogatives as a public authority.

In the municipality of Dassa-Zoumé, the delegation of management of water supply networks characterized by the establishment of a contractual relationship between a delegating authority and a delegated manager in order to deliver a water service from these facilities.

Common in urban hydraulics, this approach was introduced in rural hydraulics in the early 2000s as an alternative to community management, the performance of which, after twenty years of practice, has generally not been up to the challenges [1]. Thus, the management delegation provided an appropriate framework for the participation of the private sector while addressing key issues that had not yet been addressed in rural areas such as the heritage status of installations, monitoring operator performance or even regulation [2].

DWS networks are playing an increasingly strategic role in water supply since they serve at least a quarter of the populations living in rural areas and in small centers. In this context, the delegation of management is part of a logic of alternative to the model of community management and opening up to the private sector in order to improve the sustainability of the water service. This research deals with "Governance and performance of public services delegated to drinking water in the municipality of Dassa-Zoumè".

MATERIALS AND METHODS

As part of this research, socioeconomic and regulatory data were used. They consider the delegation contract, the price of water transfer to subscribers, users' assessments regarding the delegation of the public water service. The business delegation contract was analyzed to highlight its strengths and weaknesses. These data were collected from the delegates, the Dassa-Zoumè Town Hall and from water users. The collection was made possible thanks to the documentary research carried out in the documentation centers of the Town Hall of Dassa-Zoumè, of the Service de l'Eau des Collines and the Ministry of Water, to the field surveys carried out with 80 delegates (public and private), 50 households from users and 10 resource persons. Of these resource persons, three gave telephone interviews, given their unavailability on the one hand and the health situation linked to the Corona virus (Covid-19) pandemic on the other. The questionnaire, the interview guide, the observation grid and a TECNO K7 brand laptop are the materials and tools that served as the basis for data collection.

Method for evaluating the performance of public drinking water services.

Today, the notion of performance has broadened to consider the "social responsibility" or social responsibility of the company vis-à-vis its stakeholders. With the emergence of sustainable development, the concept of global performance emerged in Europe, after having been the same in the United States and will soon reach Africa and Benin in particular. The figure 1 shows the method for evaluating the overall performance of the sustainability of public drinking water services.

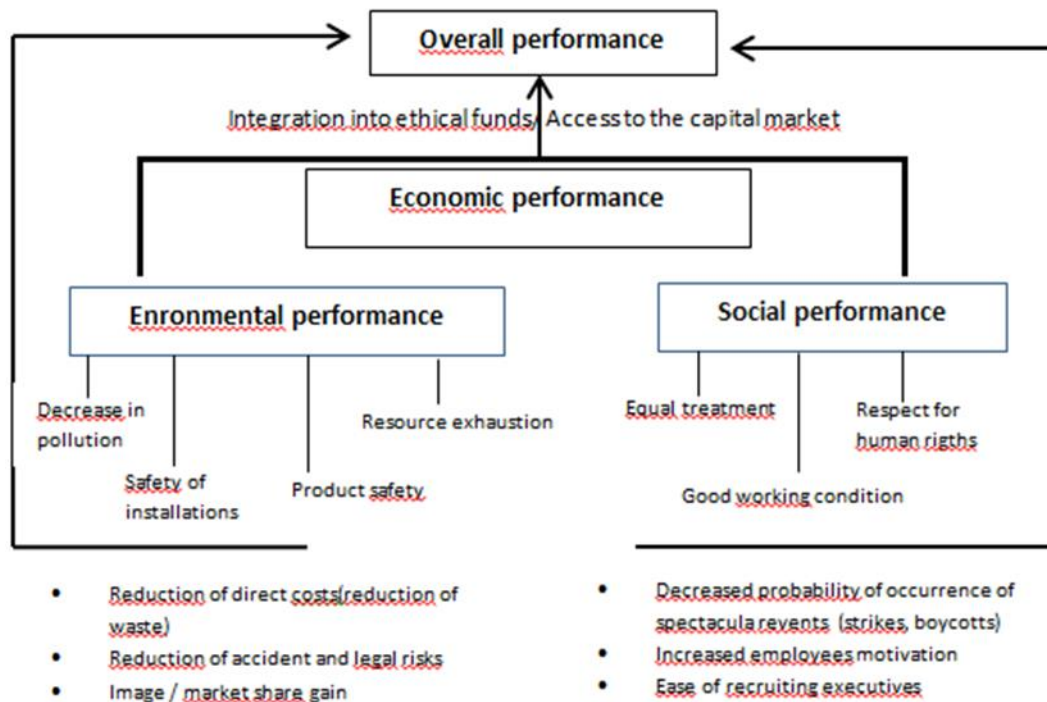


Figure 1: Method for assessing the performance of PFICs

Source : Adapted from [3]

The Sphinx 4.5 software made it possible to develop the database, to process the data collected. This treatment resulted in the demonstration of the chi2 test between the problems of delegation of drinking water services and the typology of water pumping services available in the municipality of Dassa-Zoume.

STATISTICAL ANALYSIS AND GRAPHICAL PRESENTATION

The town of Dassa-Zoumé, capital of the department of hills. It lies between 7 ° 29 'and 7 ° 57' North latitude and between 2 ° 9 'and 2 ° 13 "East longitude (Figure 2). It covers an area of 1,711 km² and has 112,122 inhabitants [4]. It is bounded to the north by the commune of Glazoué, to the south by the commune of Djidja, to the east by the communes of Savè and Kétou, and to the west by the commune of Savalou (figure 2). It is surrounded by hills to the east and receives less rainfall than the municipality of Savè. Thus, the average annual rainfall is around 1,100 mm [5].

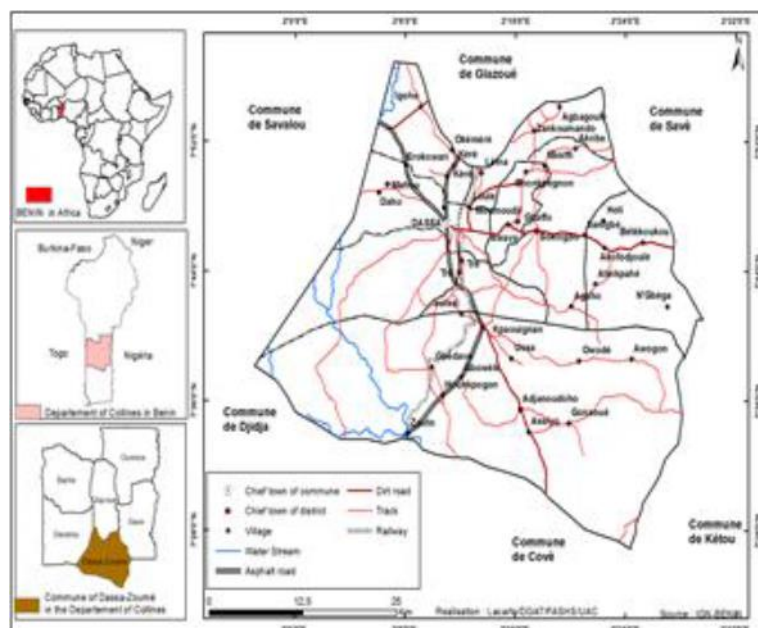


Figure 2 : Geographical situation of the commune of Dassa

It covers an area of 1711 km² and has 112,118 inhabitants in 2013 (INSAE, 2013). The average annual rainfall amounts in said commune around 1100 mm; temperatures vary between 20 °C and 37 °C and can sometimes rise to 38 °C.

RESULTS AND DISCUSSION

These results consider the analysis of the mode of governance by delegation of water services and the performance indicators achieved.

Governance by delegation of Public Drinking Water Services in the municipality of Dassa-Zoume
It considers the analysis of the institutional framework and the delegated mode of water services.

Institutional framework for governance of water services

The governance of water services in Benin in general and in the municipality of Dassa-Zoume in particular is reacted by an institutional framework undergoing reform. In fact, with the aim of improving universal access to drinking water for all by 2021, the government of Benin, through its Action Program, has carried out profound reforms of the institutional framework. Figure 3 presents the new institutional framework for the governance of public drinking water services.

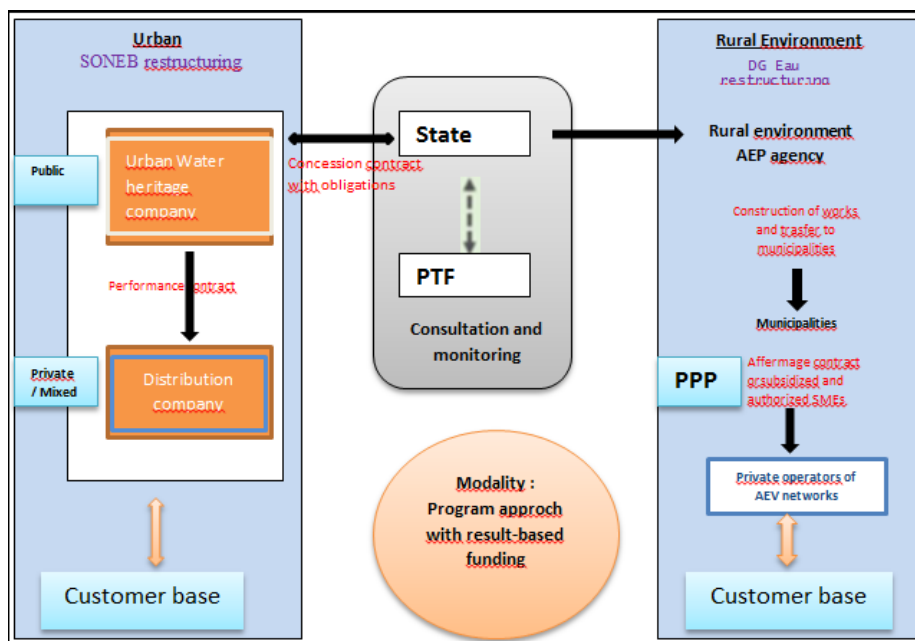


Figure 3: New institutional governance framework for DWS in rural and urban areas
Source: Field survey, June 2019

Figure 3 presents the new governance framework for Drinking Water Supply. Its analysis shows that the State and the TFPs play a role in the consultation and monitoring framework for a reorganization of the drinking water supply in urban and rural areas. We must describe the framework with the main components before the analysis!

Analysis of the delegated management of public drinking water services

- Management by delegation of simple structures

Delegation is a form of management in which the municipality signs a contract with a natural or legal person called a delegatee having a legal existence for the management of simple works. Figure 4 presents the logical framework of the actors in the delegation of water services.

Figure 4 presents the logical framework of the actors involved in the delegation of water points. Its analysis shows that there is a contractual relationship between a delegating authority that owns the facilities and the delegated manager responsible for providing the water service under the conditions defined by the delegation contract.

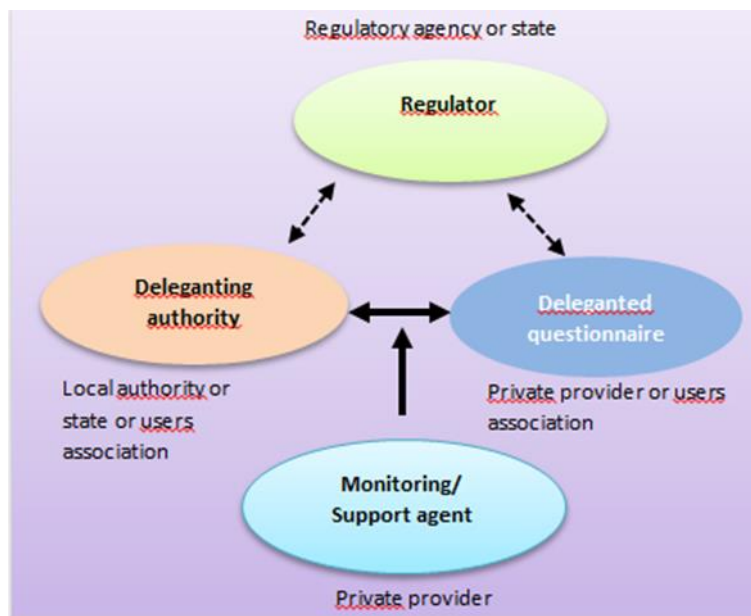


Figure 4: New institutional governance framework for DWS in rural and urban areas
Source: Field survey, June 2019

In the study sector, the delegatee gives a fee of 7.25 USD per month or 87 USD per year to the town hall. It is the town hall's head of the economic and market affairs department who is responsible for collecting funds from the delegates and who deposits them in the town hall's account in the water section. The delegatee has several roles, which are: to operate the works and sell water to consumers at a rate fixed by the contract; ensure the operation, routine servicing and maintenance of the system; pay a fee to the town hall per month or per year.

In this management mode, the costs related to breakdowns of less than 43.48 USD are the responsibility of the delegatee, but those greater than 43.48 USD are borne by the town hall. The repair craftsmen are recruited by the town hall and trained by the village water supply service. This management method is struggling to develop in the municipality of Dassa-Zoumé. Households are reluctant to put this mode into practice. They themselves prefer to agree to pay the royalties that the delegatee should pay to the town hall.

- Management method by delegation of complex water supply structures: case of Village Water Supply (AEV)

The complex water supply structures such as the Adductions d'Eau Villageoises (AEV) and the Autonomous Water Stations (PEA). The municipality of Dassa-Zoumé has 09 AEV (table) with 93 standpipes, 80 of which are functional. The table shows the AEVs and the delegated companies.

Table 1: AEV and delegated companies

N°	AEV	Delegated companies
1	Gbaffo	Concise
2	Kèrè	Ets Badjimou and son
3	KPAKPA AGBAGOULE	Management Committee
4	Minifi	AIR-Benin
5	Ouissi	Management Committee
6	Panouignan	COGEBA
7	Soclogbo	LIVE
8	Tré	Ets Flourishing
9	Vèdji	Management Committee

Source: Field survey, April 2020

Analysis of Table 1 shows that the municipality of Dassa-Zoumé has 09 AEV. Of its AEV, 06 are under leasing contract and managed by various delegates. On the other hand, the remaining three are managed by the management committees. These AEV have 93 standpipes, of which 13.98% are non-functional. The owner of the town hall of Dassa-Zoumé signs an affermage contract with the company that won the tender dossier previously launched. The delegated company, called the farmer, is responsible for the operation and maintenance of the equipment entrusted to it. A farmer can however take charge of part of the renewal of certain equipment. They are delegated to a farmer. Only in the face of resistance from the population of Ouissi, the village's EVA is managed by the community. Vêdji's AEV is in a trial period by a committee before launching DAO for the recruitment of a delegate. Regarding the AEV of Akpakpa-Agbagoulè, the delegatee resigned the contract with the contracting authority, the Town Hall. Apart from these 03 AEV, the others are put under the affermage contract.

PERFORMANCE OF DELEGATED PUBLIC DRINKING WATER SERVICES IN THE MUNICIPALITY OF DASSA-ZOUME

Economic and financial analysis / forecast operating account

The economic analysis was carried out on the basis of the cost of their implementation, production forecasts, various operating and renewal costs and the selling prices of water. The management of Village Water Adductions is based on the leasing of water points and management by committee. Table 2 shows the revenue from the sale of water at the point level.

Table 2 : Revenue en USD

AEV	2017	2018	2019
TRE	3048,83	3027,65	3318,34
MINIFI	2704,17	1141,12	1118,26
SCOLOGBO	1643,62	1762,20	2084,17
KERE	1992,29	1376,23	1662,55
GBAFFO AWAYA	105,32	708,60	472,12
KPAKPA	1546,07	1458,73	867,33
PANOUIGNAN	9110,11	8121,88	9673,95
KPINGNI	0,00	0,00	847,32
OUISSI	0,00	0,00	0,00
TOTAL (USD)	20150,41	17596,41	20044,04

Source: Field survey, April 2020

Analysis of Table 2 shows that the AEVs of the municipality of Dassa-Zoume record various annual economic performances depending on the operating mode in place. In fact, in 2017, revenues from the sale of water amounted to 20150,41 USD. They will drop to 17596,41 USD in 2018 before returning to 20044,04 USD in 2019. The operating and investment costs take into account the costs of supply (in generators, electrical energy, school panels), various repairs, payrolls (Figure 5).

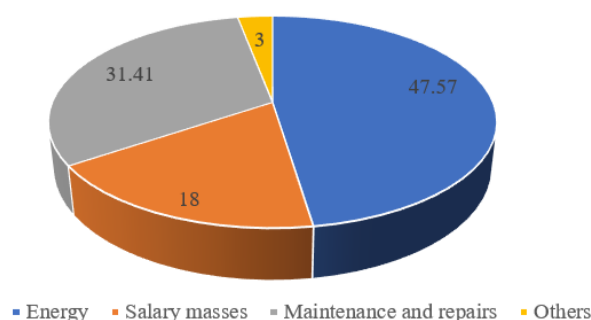


Figure 5: Percentage of "Drinking water" charges, year 2019

Source: Field survey, April 2020

The figure 5 shows the share of costs linked to the management of water services in the municipality of Dassa-Zoumé. It appears that the charges related to the management of services include energy charges (47.57 %), maintenance and repair costs (31.43 %), payrolls (18 %) and other charges which are of (3%). These different charges amount respectively to 5993.41 USD in 2017, 7065.76 USD in 2018 and 8707.81 USD in 2019. The figure 6 shows the difference between water revenue and the operating cost.

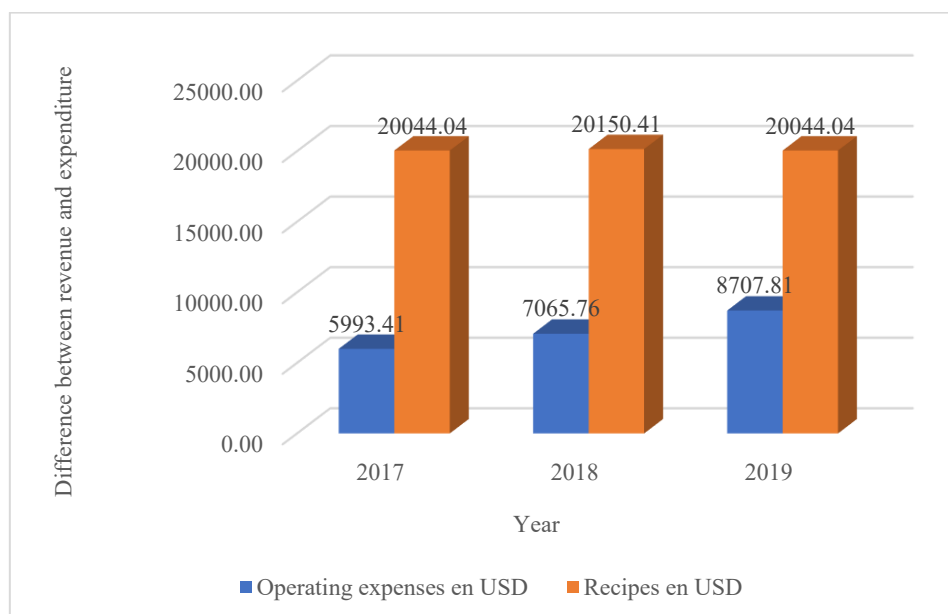


Figure 6: Difference between water revenue and operating cost
Source: Field survey, April 2020

The figure 6 shows the comparative evolution of invoiced water receipts and the operating cost of AEVs over the 2017-2019 period. Its analysis shows that the invoiced water revenues greatly exceed operating expenses. Indeed, operating expenses represent only 29.74 % in 2017; 40.15 % in 2018; and 43.44 % in 2019 of water bills sold. It therefore appears that the performance is more or less brilliant but does not preserve the sustainability of the service in view of the increase in expenses related to maintenance and operation of the service. The table below presents the performance indicators of the water service in the municipality of Dassa-Zoume.

Table 3: Performance indicators linked to public drinking water services

AEV performance indicators (PIs)	2019
Theoretical cost of the municipality's AEV	347826.08 USD
Water recipe	20044.03 USD
Operating and investment cost	5993,41 USD
Debt extinction period	17 Years

Table 3 presents the performance indicators related to the sustainability of the water service. It appears that the drinking water finances linked to the AEV are currently good, but investments for new boreholes are to be expected, which will greatly increase the duration of the debt extinction. The physical renewal of networks is less than the amortization period of around 40 years provided for in the accounts [6]. An increase in the renewal of drinking water networks therefore seems necessary since it would partially absorb the excessive losses of the network. The table presents the financial indicators to the delegation of boreholes equipped with human-powered pumps.

Table 4: Performance indicators related to water services

Performance indicators of delegated FPMH	2019
Theoretical cost of delegated FPMH	17391.31
Water price billed	86.95
Operating and investment cost	0
Debt extinction period	200 ans

The analysis of this table 4 shows that the finances of drinking water related to FPMH are currently good, but the annual price of water transfer is revised upwards, which would reduce the duration of the extinction of the debt that is 200 years old. The physical renewal of networks is less than the amortization period of around 40 years provided for in the accounts [6].

DISCUSSION

The governance of drinking water services in Benin has undergone profound institutional reforms since 2016. It is characterized by the creation of three institutions in urban areas: the State, the Heritage Company (SP) and the Exploitation Company (SE) and a National Drinking Water Supply Agency in Rural Areas (ANAEP -MR) which must manage the public drinking water services. In the same sense [7] in his thesis entitled “The sustainable management of water and sanitation services in Algeria”, it came to pass that the sustainability of water services implies, that existing institutional structures have the capacity to persist over time and continue to perform their duties over the long term. These structures would include all objectives related to stakeholder issues, transparency, citizen participation in the decision-making process, effectiveness and efficiency of measures taken. It highlights that the relevant governance of SEPAs implies the existence of city planning.

The management of public drinking water services in the municipality of Dassa-Zoumé still has to respond to three major challenges: the appropriation of the concept of management delegation by local actors, the securing of the continuity of service and the implementation effective regulation of water service in rural areas. Which are not the same with the research of [8]. Indeed, [8], by studying in their article the “Performance Evaluation of Water Supply Services in Developing Country: A Case Study of Ahmedabad City”, identify, long-term climate change, population growth, the aging of drinking water and sanitation networks, the unplanned and rapid growth of urban areas and economic development such as the challenges facing drinking water and sanitation services (SEPA). It is in this same logic that, [9] in their article entitled “Role of decentralized systems in the transition of urban water systems) have shown that population growth has led to increasing urbanization and pollution. and have contributed to ecological damage, urban flooding.

The economic performance indicators of drinking water services in the municipality of Dassa-Zoumé are characterized by an increase in the debt extinction rate which varies between 17 years for AEVs and 200 years for FPMH. These rates are much higher than those obtained by [10]. But, these authors presented a tool for assessing the sustainability of water and sanitation services in France. They propose a first original approach to assess the sustainability of a service by linking the method of Performance Indicators (PI) to that of 3Es (Environment, Ethics and Economy), thus they proposed a list of criteria. for the three dimensions of SD for the case of sustainable management of water services.

CONCLUSIONS AND RECOMMENDATIONS

At the end of this research, it emerges that the governance of delegated drinking water services faces several challenges in the municipality of Dassa-Zoumé. Who are responsible for the poor performance recorded in terms of indicators. The current evolution of its performance indicators does not call into question the sustainability of water services in the municipality of Dassa-Zoumé. To achieve this, the

water services sector must update existing legal and institutional reforms by including a three-fold requirement:

- the sustainability of the management of water resources;
- planning of hydraulic installations and concerted water management;
- the efficiency of the management of public water and sanitation services.

REFERENCES

- [1] ZODEKON Ayéman René, ODOULAMI Léocadie and COCKER Fèmi: Constraints and challenges of community management of boreholes equipped with human-powered pumps in rural areas in the town of Dassa-Zoumé in Benin, Published in *Hommage*; 2018. Vol 1 , 571-585 pp.
- [2] Water and Sanitation Program: Delegation of water service management in rural and semi-urban areas, Field Note on the Assessment of Seven African; 2010. Countries, 28 p.
- [3] GUERIN SCHNEIDER Laetitia: Introducing performance measurement in the regulation of water and sanitation services in France. Instrumentation and organization. Doctorate in Management - Water Science, ENGREF; 2001. 390 p.
- [4] INSAE: Fourth general population and housing census; 2013. Some results, 106 p.
- [5] ZODEKON Ayéman René: Management of water resources in the face of rainfall variability in the municipality of Dassa-Zoumé in Benin. DEA thesis, EDP / FLASH / UAC, 2016. 88 p.
- [6] Lejars Caroline and Guillem Canneva: Sustainability of water and sanitation services: evaluation method, case study and perspectives for a change of scale, Second Euro-Mediterranean public management dialogue, Portoroz, Slovenia; October 2009.
- [7] Boukhari Sofiane: The sustainable management of drinking water and sanitation services in Algeria, Doctorate in Management - Water Science, MOKTHAR ANNABA University; 2018. 241 p.
- [8] Yadav, S.M., Singh, N.P., Shah, K.A., & Gamit. J.H.: Performance Evaluation of Water Supply Services in Developing Country: A Case Study of Ahmedabad City. *KSCE Journal of Civil Engineering* 18 (7); 2014. 1984-1990pp.
- [9] Sharma, A., Burn, S., Gardner, T., & Gregory, A.: Role of decentralized systems in the transition of urban water systems. *Water Science and Technology*, 10 (4); 2010. 577-583pp.
- [10]. Lejars Caroline and Guillem Canneva: Sustainability of water and sanitation services: evaluation methodology, case study and perspective; 2008. 22 p.



VIII. International Symposium-2024

DEVELOPMENTAL, BEHAVIORAL AND BIOCHEMICAL EFFECTS OF ANTHRACENE AND Pb²⁺ TO ZEBRAFISH EMBRYOS

Abdelfettah GHERIB^{1,2}, Inês DOMINGUES³

¹Laboratory of Environmental Analysis, Biotechnology Research Centre (CRBt), 25000 Constantine, Algeria.

²Laboratory of Biology and Environment (LBE), Department of Biology and Plant Ecology, University of Brothers Mentouri Constantine 1, 25000 Constantine, Algeria.

^{3c}Department of Biology & Centro de Estudos do Ambiente e do Mar (CESAM), University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal.

ABSTRACT

This study aims to assess the toxicity of lead Pb+2 and anthracene to zebrafish (Danio rerio) eleutheroembryos survival, development, behavior and neurotoxicity. Fish embryo toxicity tests were conducted according to the OECD guideline TG 236. the video tracking system Zebrabox® was used to evaluate the effects of these chemicals on 120 hpf larvae behavior. Data showed that both chemicals have a moderate toxic effect on fish embryo survival: Pb+2 96h-LC50 value was 76.51 mg/L. Anthracene 96h-LC50 value was 133.35 mg/L. Regarding behavioral, anthracene decreased total swimming distance (TSD) and total swimming time (TST) at concentrations of 3.2, 6.4, 12.8 and 25.6 mg/L in light and dark periods suggesting hypoactivity. Although less pronounced, Pb+2 also affected locomotion by increasing distance travelled in rapid movements after 120 hpf exposure at 0.1, 1 and 10 mg/L suggesting hyperactivity. Besides, AChE was not responsive and sensitive to Pb+2 or anthracene after 120 hpf exposure.

KEYWORDS: PAHs, Behavior, FET, Lead, AChE and development.

Corresponding author: Abdelfettah GHERIB

Address: Centre de Recherche en Biotechnologie Ali Mendjli Nouvelle Ville UV 03 BP E73 Constantine, Algeria.

Phone: +213 (31) 77 50 37/+213 (31) 77 50 39, **Fax:** +213 (31) 77 50 44

E-mail: a.gherib@crbt.dz /gheribfettah@gmail.com

ORCID ID: <https://orcid.org/0000-0002-7354-8873>

INTRODUCTION

Aquatic contamination is becoming a huge threat to human populations and ecosystems. Aquatic systems are continuously exposed to domestic waste as well as industrial effluents overloaded with

various pollutants such as polycyclic aromatic hydrocarbons (PAHs) and heavy metals [1-2]. PAHs occur naturally in the environment but are also synthesized by humans reaching the aquatic environment through petroleum leaks and oil spills being ubiquitous pollutants [3,4-5]. In the environment, PAHs can elicit important effects on non-target organisms such as neurotoxicity [6-7], carcinogenicity, teratogenicity, cytotoxicity, mutagenicity [3, 8], cardiotoxicity, embryotoxicity [9-10], reproductive impairment [11] and mortality [4]. Among PAHs, anthracene showed acute toxicity to aquatic organisms (such as zooplankton, insect larvae and fish) [12], altering gene expression in the mummichog (*Fundulus heteroclitus*) [13], generating oxidative stress and liver dysfunction in *Labeo rohita* [14]. Their exposure also causes a disruption of cholinergic transmission by inhibition of AChE enzyme in the common goby (*Pomatoschistus microps*) and milkfish (*Chanos chanos*) [4, 15]. Heavy metals are common pollutants [3] and thus, their presence and/or bioaccumulation in biological systems is a public health concern. Many studies have been performed on zebrafish to assess heavy metal effects. According to [16], organisms exposed to Pb^{+2} showed deformations in the body vasculature, alterations in Rohon-Beard and dorsal root ganglion sensory neurons and increases in apoptotic clusters. Studies of Senger et al. [17] and Richetti et al. [18] indicated neurotransmission alterations after exposure to Pb^{+2} , Hg^{+2} and zinc chloride ($ZnCl_2$), cadmium acetate $Cd(CH_3COO)_2$, mercury chloride ($HgCl_2$) and lead acetate $Pb(CH_3COO)_2$. Rice et al. [19] and Dou and Zhang [20] revealed that Pb^{+2} exposures in zebrafish causes a variety of effects on neuronal function and neurodevelopment such as behavioral abnormalities, learning impairment, hearing loss and impaired cognitive functions. Heavy metals can also cause decreased fertility, cellular and tissue damage, cell death and dysfunction of a variety of organs [21]. The assessment of pollutants effects in aquatic ecosystems is critical to safeguarding human health and environment quality. Efficient and highly sensitive monitoring technologies should be developed which can directly reflect the toxic effects of pollutants on living organisms and human health [22]. Zebrafish (*D. rerio*) is a model vertebrate widely used in the field of developmental biology [23-24], with current expansion into all areas of biological research [24] such as molecular genetics, physiology and toxicology [17-18, 23]. Zebrafish has also been widely used to assess heavy metals and persistent organic pollutants effects such as endocrine disruption and neurotoxicity [17-18, 22]. So called *Drosophila* of vertebrates [25], this model raises many advantages [26] such as small size, low maintenance cost, easy and short breeding cycle and high fecundity [22, 24, 27]. It is considered also an excellent in vivo model organism because of their ex-utero fertilization, transparency of embryos and early larvae, allowing a microscopic observation during early developmental stages. These characteristics facilitate the follow-up of the chemicals kinetics to which these organisms are exposed to the environment and the evaluation of their effects at all embryonic stages [28].

Aquatic safety testing requires a cheap, fast and highly efficient platform for real-time evaluation of toxic pollutants [29]. The fish embryo toxicity (FET) test using zebrafish was standardized by OECD (guideline 236) contributing to the study of lethal and developmental effects of chemical compounds [26, 30]. Recently, biochemical and behavioral endpoints have been used by several authors as a complement to the test contributing for the characterization of effects at several levels of biological organization [31]. Particularly, behavior has been increasingly used in zebrafish (swimming behavior) as a marker of neuronal disruption. Measured parameters (swimming distance, path angles, velocity, swimming patterns) allow the identification of innate stereotyped behaviors (hyperactivity, hypoactivity, freezing, erratic swimming and thigmotaxis) interpreted as markers for anxiety and stress in fish. Besides the usefulness for the identification of neuroactive compounds, behavior is also considered an ecological relevant and sensitive endpoint given that disruption in behavior may imply impairments in key ecological functions such as feeding, reproduction and scaping from predators [21, 26, 32].

This study aims to assess the toxicity of Pb^{+2} (as lead nitrate ($Pb(NO_3)_2$) and anthracene ($C_{14}H_{10}$) individually on zebrafish (*D. rerio*) eleutheroembryos at several levels of biological organization to better understand the mode of action (MoA) of these chemicals:

- A fish embryo toxicity (FET) test was carried to assess the acute and sub-acute toxicity, following the OECD 236 guidelines for testing of chemicals, and determining lethal endpoints (coagulated eggs/dead eleutheroembryos, 96h-LC₅₀, lack of tail detachment, lack of heart beat, lack of somite formation) and developmental endpoints (lack of spontaneous movements, lack of pigmentation,

pericardial edema (PE), yolk sac edema (YSE), eyes deformities, teratogenicity and developmental delays).

- A second test was developed to evaluate the effects of both chemicals on larvae locomotor behaviour at 120 and 144 hpf of exposure using the video tracking system Zebrabox® (Viewpoint, France).
- Moreover, the activity of acetylcholinesterase (AChE E.C. 3.1.1.7), an important enzyme for the maintenance of normal nerve function, was determined in order to understand the mechanism of neurotoxicity of these chemicals.

MATERIALS AND METHODS

Fish husbandry and eggs production

Zebrafish (*D. rerio*) eggs were obtained from adult fish bred under standardized conditions, in the facility established at the Department of Biology, University of Aveiro (Portugal). Adult fish are kept in a circulating system with carbon-filtered water treated by an osmosis system at 26 ± 1 °C, conductivity of 750 ± 50 µS/cm, pH 7.5 ± 0.5 , total hardness of 100 mg CaCO₃/L and dissolved oxygen at 95% saturation. A photoperiod cycle of 14:10 h light/dark is used. Adult fish were fed with an artificial diet Gemma Micro 500 (Skretting®, Spain) once a day. Eggs were collected within 30 minutes after the natural mating of adults, rinsed with fish water system and examined and sorted using a stereomicroscope (Stereoscopic Zoom Microscope-SMZ 1500, Nikon Corporation). Unfertilized eggs, injured embryos and embryos with irregularities during cleavage were discarded as described with details by Domingues et al. [31] and Henriques et al. [32].

Fish Embryo Toxicity Assay (FET)

Chemicals solutions preparation

This experiment was carried out on a total of 180 organisms in the case of anthracene and 140 organisms in the case of Pb²⁺. Zebrafish (*D. rerio*) eleutheroembryos were exposed to the two different chemicals individually: i) Anthracene (C₁₄H₁₀), N°-CAS 120-12-7, purchased from sigma-Aldrich (Saint Louis, USA) and ii) Lead (Pb²⁺) (as lead nitrate (Pb (NO₃)₂), N°-CAS 10099-74-8, purchased from sigma-Aldrich (Saint Louis, USA).

Test solutions of the selected concentrations were prepared by dilution of a stock solution of Pb (NO₃)₂ (100 mg/L), by simply mixing or agitating in the fish water system. In the case of Anthracene (C₁₄H₁₀), the stock solution (25.6 mg/L) was prepared by dissolving the chemical in 0.1% methanol, following the procedure described in OECD Guidance Document No. 23, for handling of difficult substances (OECD, 2018) [33].

Fertilized eggs were exposed following the experimental plan recommended by the OECD TG 236 [34] for the FET test, at 26 ± 1 °C. In the case of anthracene, the exposure media was carefully replaced daily as described by McIntyre et al. [35], to avoid the degradation of this chemical with half-life of a few hours. A total of 24 organisms/concentration were exposed individually in 24-multiwell plates to the following concentrations:

- Anthracene: 0, 0.2, 0.4, 0.8, 1.6, 3.2, 6.4, 12.8 and 25.6 mg/L.
- Pb²⁺ (Pb (NO₃)₂): 0, 0.001, 0.01, 0.1, 1, 10 and 100 mg/L.

Toxicological endpoints : lethal endpoints (coagulated eggs/dead eleutheroembryos, lack of tail detachment, lack of heart beat and lack of somite formation), sublethal endpoints (lack of spontaneous movements, lack of pigmentation, pericardial edema (PE), yolk sac edema (YSE) and eyes deformities), teratogenic endpoints (tail deformities and length of tail) and finally hatching success were observed and reported daily for 96 hpf using a stereomicroscope (Stereoscopic Zoom Microscope SMZ 1500, Nikon Corporation), with magnification of 7× for eggs observations and 4× for larvae observations as described by Domingues et al. [31].

The distinction between normal and abnormal development was established using the zebrafish embryogenesis description published by Kimmel et al. [27].

For the following steps, embryos and pro-larvae were considered dead when no heartbeat was detected.

At the end of the experiment *D. rerio* eleutheroembryos were photographed (Power-Shot S50, Canon) to allow quantifying deformities endpoints. Based on the results of these assays, chemicals concentrations not inducing any abnormalities or mortality were selected for the behavioral assay test.

Behavioral assay

A behavioral assay was performed using anthracene and Pb^{+2} at concentrations that did not induced malformations in the previous experiment. A total of 24 replicates (1 embryo per replicate placed individually in each well of a 24 multi-well plate) were used per concentration and per chemical. Eleutheroembryos were exposed to 0, 0.2, 0.4, 0.8, 1.6, 3.2, 6.4, 12.8 and 25.6 mg/L of anthracene or 0, 0.001, 0.01, 0.1, 1 and 10 mg/L of Pb^{+2} . Behavior assessment was performed after 120-144 hpf of exposure directly on the 24 multi-well plates used for chemical exposure in order to reduce possible acclimation bias. Locomotor activity was measured by placing the plate into a Zebra Box (Viewpoint, Life sciences, Lyon, France). In brief, this system used for the monitoring of movement by automated video recording is equipped with internal LED lights that were used for stimulation/inhibition of the larvae, which tend to remain still in the light and move actively upon the sudden transition to dark. Movement of each larva was recorded during 6 minutes alternating periods of light and dark (3 minutes light, 3 minutes dark). The main ambulatory response includes swimming distance crossed, the observatory response includes swimming time to cross this distance. Inferential endpoints are a secondary behavioral response, calculated from the main ones, it concerns active swimming time and relative swimming time. The ratio between average time recorded moving and the total Integration time (120 s) was calculated to give the proportion of time spent moving. Therefore, behavioral parameters as: overall distance (mm) moved during a defined period (total swimming distance -TSD) and total time spent in movement (total swimming time -TST), slowly/inactivity movements, rapid movements and path angle were also measured as described by Ulhaq et al. [36]. Moreover, the reading area of the 24 multi-well plates, was split into two zones in the software, a central zone and a peripheric zone, to assess the swimming pattern as shown in Schnorr et al. [37]. Behavioral data was analyzed and mean distance and proportion of time spent moving in each zone during the light and dark period calculated as described by Domingues et al. [31] and Henriques et al. [32]. A transparent background mode with a detection threshold of 20 was used and a minimum distance of 0.5 cm was defined as record threshold of inactivity.

Biochemical assay

The experimental procedure for biomarkers assay followed the methodology described previously but used a higher number of embryos exposed in Petri dishes (405 eggs in the case of anthracene and 315 eggs in the case of Pb^{+2}), 45 eggs per concentration [Pb^{+2} : 0, 0.001, 0.01, 0.1, 1, 10 and 100 mg/L) and (anthracene: 0, 0.2, 0.4, 0.8, 1.6, 3.2, 6.4, 12.8 and 25.6 mg/L)] were maintained in petri dishes with 20 ml of the medium in triplicate with a rate of 15 eggs per dish per concentration. After 96 hpf of exposure, pools of 5 larvae were sampled in micro-tubes (Eppendorf, Hamburg, Germany) for the biochemical assay with 0.4mL of potassium phosphate buffer PBs (0.1 M, pH 7.2), snap-frozen, and stored at -80 °C until the day of analysis. On the day of biomarkers analysis, larvae samples were defrosted on ice and homogenized by ultrasound (Ystral GmbH D-7801, Dottingen, Germany) sonicator. The post-mitochondrial supernatant (PMS) obtained after the centrifugation of the homogenate at 4 °C, 3000 g and 4 min was recovered to serve as enzymatic extract for AChE activity determination following the method described by Domingues et al. [31].

• Acetylcholine Esterase Activity (AChE E.C. 3.1.1.7)

AChE enzymatic activity assay followed the protocol described in Domingues et al. (2010) which was based in the method described by Ellman et al. [38]. Briefly, AChE activity is measured using acetylthiocholine as substrate and measuring at 414 nm every 20 seconds for 5 minutes, the conjugation product between thiocoline (a product of the degradation of acetylthiocholine) and 5,5-dithiobis-2-nitrobenzoic acid (DTNB) (increase in absorbance) in the K-phosphate buffer (0.1 M, pH 7.2).

The determination of AChE activity was made using 0.05 ml of post-mitochondrial supernatant (PMS), 250 µl of reaction mixture (acetylthiocholine (75 mM) and DTNB (10 mM)) in the PBs (0.1 M, pH 7.2).

AChE activities were determined by spectrophotometric method in quadruplicate and expressed in nanomoles of hydrolyzed substrate per minute per mg of protein, via Labsystem Multiskan EX microplate for biochemical assay.

- **Total protein**

Total protein concentrations were determined in quadruplicate by spectrophotometric method according to Bradford et al. [39], at 595 nm, using γ -globulin as standard (BSA bovine albumin serum) as standard.

Statistical analysis

Statistical analysis of the obtained results was performed using the Sigma plot 12.5 (Systat Software, Inc. Sigma Plot for Windows, San Jose, California, USA). One-way ANOVA was used to detect differences between groups for normally distributed data sets. When data did not pass the Shapiro-Wilk normality test, a Kruskal-Wallis's test was used. Moreover, if significant results were found, Dunnett's or Dunn's test (for parametric or non-parametric tests, respectively) was used to detect significant differences between the tested concentrations and the control ($p < 0.05$). Also, a Mann-Whitney Rank Sum test ($p < 0.05$) was performed to test differences between movements in light and dark periods in behavioral assay. The lethal concentrations (LC_{10} and LC_{50}) were determined by recurring Probit analysis performed with Microsoft excel software according to the method of Finney [40], confidence limits, Slope and Chi-square values at 96 hpf exposure were established. Effects on hatching success and malformations were recorded as a binary absence or presence of an abnormal morphology for each endpoint and determined by recurring Chi-square test ($p < 0.05$) using Microsoft excel software (Microsoft Ink., version 2010).

RESULTS

- **Fish embryo toxicity (FET)**

The data from this study show a mortality rate of *D. rerio* eleutheroembryos always less than 10 % at 96 hpf in the control groups for both chemicals, as recommended in the OECD TG 236. The control groups presented a normal embryo development following the description of Kimmel et al. [27].

Anthracene: The observation of data showed a mortality rate of *D. rerio* eleutheroembryos between 20% and 40% after 96 h exposure. The anthracene 96h- LC_{10} value was 0.001 mg/L ($R^2=0.86$) and 96h- LC_{50} value was 133.35 mg/L ($R^2=0.86$). Regarding sublethal and teratogenic effects, statistical analysis performed via Chi-square test allowed revealing significant deformities of tail ($\chi^2_{TD}=22.86$, $p < 0.001$) after 96 h exposure of anthracene. However, no significant effect was recorded on other parameters.

Pb²⁺: Obtained data showed a mortality rate of *D. rerio* eleutheroembryos ranging between 5% and 90% after 96 h exposure of Pb²⁺. It was found that Pb²⁺ is toxic at concentrations superior to 10 mg/L, it shows a critical drop in embryo survival with a 96h- LC_{10} value of 10.01 mg/L ($R^2=0.51$) and a 96h- LC_{50} value of 76.51 mg/L ($R^2=0.86$). High concentration (100 mg/L) caused a mortality rate of *D. rerio* eleutheroembryos > 90%. Concerning sublethal and teratogenic effects, results of Chi-square test did not allow showing significant effects.

- **Hatching effects**

Table 3 synthesizes the results of the total hatched *D. rerio* eggs exposed to the anthracene and Pb²⁺. *D. rerio* embryos can hatch from the 48th hpf. The number of hatched larvae was recorded daily. A larva is considered hatched when all the body (from tail to head) is out of the chorion. The total hatched eggs in all groups (the control and treatment) reached approximately 100% at 120 hpf in the case of both chemicals. No hatching was observed for any of the chemicals before the 3rd day (72 hpf). Moreover, the Chi-square test did not show significant effect of these chemicals on hatching process in *D. rerio* eleutheroembryos ($\chi^2_{anthracene}=4.603$, $p=0.203$), ($\chi^2_{Pb+2}=3.24$, $p=0.778$).

- **Locomotory behavior**

The results of the locomotory behavior in *D. rerio* eleutheroembryos exposed to anthracene and Pb^{+2} after 120 h.

Zebrafish larvae exposed to anthracene showed higher activity during the dark periods than during the light (TST: Mann-Whitney U Statistic= 3056; $p<0.001$, TSD: Mann-Whitney U Statistic= 1394; $p<0.001$). Anthracene showed to significantly reduce the overall locomotor activity as TSD and TST at both periods [TSD: light ($H=32.92$; $p<0.001$); dark ($H=36.5$; $p<0.001$), TST: light ($H=33.35$; $p<0.001$); dark ($H=37.71$; $p<0.001$)] after 120 h exposure. Activity seemed to be reduced in a dose-dependent pattern with a Lowest Observed Effect Concentration (LOEC) of 3.2 mg/L. Anthracene seems to reduce “slowly/inactivity movements” distance ($H=32.73$; $p<0.001$) and duration ($H=30.67$; $p<0.001$), it decreases with increasing concentrations in a dose-response manner in both periods from 3.2 mg/L to 25.6 mg/L. In addition, a significant correlation was observed between TST and TSD in the light period ($R^2_{anth.}=0.86$), this result suggests that 120 h of exposure to anthracene can affect overall movement capacity by decreasing both the time and distance moved by zebrafish larvae especially in the light period.

Regarding Pb^{+2} , activities during the dark periods are higher than during the light periods (TST: Mann-Whitney U Statistic= 2623.5; $p<0.001$, TSD: Mann-Whitney U Statistic= 1350; $p<0.001$). Obtained results showed only a significant reduction of distance ($H=13.33$; $p<0.02$) and duration ($H=13.03$; $p<0.02$) travelled in rapid movements in the dark period at concentrations above 0.001mg/L. A significant correlation was observed between TST and TSD in the light period ($R^2_{Pb+2}=0.74$). This result suggests that 120 h of exposure to Pb^{+2} can also reduce overall movement capacity of zebrafish larvae by decreasing time and distance moved especially in the light period.

Concerning the path angle and swimming pattern of organisms, no significant differences were observed versus the control in both cycles regarding %Time moving out (%T out) and %D out) in different wells after 120 h exposure to both chemicals. However, significant differences were found among pairwise comparison: differences among concentrations were observed in the dark period (%D out: $H=13.65$; $p<0.023$) after 120 h exposure to anthracene. While differences among concentrations were observed in the light period (%T out: $H=2.66$; $p<0.026$, %D out: $H=13.65$; $p<0.023$) after 96 hpf exposure to Pb^{+2} .

- **Acetylcholine Esterase EC 3.1.1.8**

The results of Acetyl cholinesterase activity (nanomoles/ml/mg prot/min) in *D. rerio* can be observed which shown as the AChE activity in *D. rerio* larvae (mean values $\pm$ standard error) after 96 hpf exposure to anthracene and Pb^{+2} .

ChE activities measured ranged between 57.76 and 80.59 nanomoles/ml/mg prot/min recorded at 12.8 and 0.2 mg/L of anthracene respectively and between 54.78 and 90.93 nanomoles/ml/mg prot/min recorded at 100 and 1 mg/L of Pb^{+2} respectively. AChE levels did not change significantly after exposure to anthracene or Pb^{+2} [$P_{anthracene}=0.059$]; ($P_{Pb+2}=0.172$)].

DISCUSSION

- **Fish embryo toxicity (FET)**

According to Nagel [25], the *D. rerio* bioassay is a useful screening test to investigate chemicals action in fish early life stage. Regarding our data, no significant developmental effects (except tail deformities) were recorded in *D. rerio* eleutheroembryos exposed to anthracene for 96 h, in agreement with previous studies carried by Turcotte (2008) [41]and Lin et al. [42] which showed that all 123 PAHs (concentrations ranged between 0.1 and 50 μ M) tested except anthracene and chrysene were embryotoxic. According to Geier et al. [6], anthracene and dibenzo [a,i] pyrene were the only chemicals without observed morphology effects. Anthracene was not bioactive in any of the developmental toxicity assays performed on *D. rerio* eleutheroembryos. Most PAHs with severe effects are oxygenated, hydroxylated, or heterocyclic derivatives. On the contrary of our data, Bhagade [43] reported a bulging of abdomen and eyeballs after just 24 h of exposure to anthracene. Furthermore, while our data showed

an anthracene 96h-LC₅₀ value of 133.35 mg/L in *D. rerio* (table 1), Bhagade [43] showed a 96h-LC₅₀ value of 2 mg/L in *Puntius ticto* and Vasanth et al. [14] showed a 96h-LC₅₀ value of 10 mg/L in the fish *L. rohita* suggesting higher tolerance of zebrafish compared to other fish species.

In the case of Pb⁺², previous studies performed by Peterson et al. [44] and Thi-Thuong et al. [45] demonstrated that short term exposure (24-120 hpf and 24-168 hpf respectively) of *D. rerio* eleutheroembryos to Pb⁺² did not show significant developmental effect, which is consistent with our data. In the contrary, Li et al. [29] showed a strong inhibition of hatching success of zebrafish embryos after 72 h exposure to 1 mg/L Pb⁺². Roy et al. [16] reported a body curvature, decreased notochord staining, abnormal muscle staining and changes in somite length after 72 h exposure to 65 mg/L Pb⁺². According to Chen et al. [46], 96 h exposure of zebrafish larvae to Pb⁺² (as lead acetate PbAc) displays malformations in a dose-dependent manner. Deformities such as double tail spine, bent spine, pericardial edema and yolk sac edema have been observed with an EC₅₀ of 0.29 mg/L. Pb⁺² concentrations below 0.1 mg/L did not show apparent effect whereas concentrations of 0.5 mg/L resulted in 100% malformations in larvae. Our data showed lethal effects of Pb⁺² at concentrations superior to 10 mg/L showing a critical drop in embryo survival with 96h-LC₁₀ value of 10.1 mg/L and 96h-LC₅₀ value of 76.1 mg/L. Similar results were reported by Dou and Zhang [19]; Rice et al. [20] Peterson et al. [44] and Thi-Thuong et al. [45]. According to that, low concentrations of Pb²⁺ (up to 0.14 mg/L) [45] and up to 5 mg/L [44] did not affect zebrafish embryo survival and behavior. This can be attributed to the large subsistence of fish's body larvae on yolk-sac on the first day after hatching, thus Pb²⁺ could not penetrate it and generate toxic effects [47]. Furthermore, different values of Pb²⁺ 96h-LC₅₀ were reported in literature in different fish species: 32.70±2.23 mg/L, 22.38±3.24 mg/L and 47±4.44 mg/L in *L. rohita*, *Catla catla* and *Cirrhina mrigala* respectively [48], and 108 mg/L in *Rhamdia quelen* [49] which are of the same magnitude of the value found in the present study.

Locomotory behavior

Behavioral alterations in zebrafish have been studied as sensitive indicators of chemically induced stress in aquatic organisms [50], such as drug Gemfibrozil [32], heavy metals [2, 7, 31, 46], pharmaceuticals as oxytetracycline and amoxicillin [51], and PAHs [4-7]. Moreover, behavioral alterations like erratic swimming, restlessness and surfacing may be a reaction to toxic narcotic effects [50]. In our study anthracene caused hypoactivity in zebrafish eleutheroembryos (reduced TSD, TST and slow/inactivity movements at dark and light periods after 120 h exposure in a dose-response manner with increasing concentrations from 3.2 mg/L. This result agrees with published work of Wang et al. (2018) [7], which demonstrated that short term exposure to PAHs can reduce distance moved in fish larvae and juvenile and induce behavioral abnormalities via an impairment of brain neuron growth. According to Geier et al. [6], the LPR (larvae promotor response) assay revealed bioactivity for several PAHs that did not affect other end points, highlighting the value of behavioral end points in chemical toxicity assessments. A total of 97 PAHs induced a significant change in LPR in light or dark periods. 11 PAHs including anthracene were not associated with behavioral or morphological effects. This can be attributed to their low solubility in the aqueous medium, where the threshold for morphological or behavioral effects is higher than the concentrations tested. The primary effect of anthracene derivatives was on LPR behavior; every derivative except 2-nitroanthracene and 2-ethyl-anthraquinone affected LPR behavior [6]. According to Gravato et al. [52], behavioral alteration observed through swimming velocity decreases (LOEC: 128 mg/L, after 96 h exposure to anthracene in *palaemon serratus*) might be due to the allocation of energy to anaerobic pathway (less efficient in ATP production) to cope with anthracene induced oxidative damage in detriment of other energetic spending activities (e.g: swimming performance), suggesting that swimming impairments may be the consequent of oxidative stress where much of energy is reserved to anthracene detoxification.

Heavy metals are known by their anxiogenic and locomotory effects on zebrafish, they affect the purinergic system (ectonucleotidase activities) which regulate the concentration of ATP/ adenosine and P2/P1 receptor-mediated responses and modulate behavioral parameters. Regarding our data, significant behavioral effects were noticed. Pb⁺² seems to cause hyperactivity in zebrafish larvae, significantly increasing the rapids movements distance and duration in dark period at 0.1 mg/L, 1 mg/L and 10 mg/L. According to Roy et al. [16], 72 h exposure of zebrafish to lead can induce alteration of motor neurons

(Rohon-beards sensory neurons, dorsal root ganglion sensory neurons and ventrally extending motor neurons). This alteration could be correlated with behavioral defects (decreases in startle response) [19], escape reactions [20] speed and swimming pattern [19, 46]. Our results agree with many studies which showed locomotory behavior changes after exposure to Pb^{+2} in zebrafish such as: Rice et al. [19] showed alteration of startle behavior in response to tapping stimulation (<2-24 hpf, 0.025 mg/L or above of Pb^{+2} as (PbAc), Chen et al. [46] reported alteration of spontaneous movement (0.1 mg/L ($\approx 0.5 \mu M$)) or above, exposure period of ($\approx 6-8$ to 20-30 hpf), alteration of swimming activity in response to light stimulation (0.025 mg/L ($\approx 0.1 \mu M$)), exposure period of 6-96 hpf and alteration of swimming activity under light or dark condition after 6-120 hpf exposure to (0.025 mg/L ($\approx 0.1 \mu M$)). Dou and Zhang [20] reported altered spontaneous swimming activity in (65.05 mg/L, 0-144 hpf). Based on data obtained by Wang et al. [7], it was found that maternal and embryonic exposure to Pb^{+2} (10, 100 $\mu g/l$) could induce swimming activity alterations in larval and juvenile zebrafish. The angular velocity and turn angle decreased after treatment with Pb^{+2} (0.01, 0.1 mg/L) in 15 dpf larval zebrafish. Furthermore, Tu et al. [53] revealed swimming distance moved (mm/min), average velocity of activity (mm/s) and proportion of activity (%per minute) reduced from the concentration of 0.81mg/L to 3.252 mg/L in zebrafish after 120 hpf exposure to Pb^{+2} ($Pb(C_2H_3O_2)_2$).

• Acetylcholine Esterase

ChEs are a family of enzymes important for neurotransmission, being responsible for the degradation of the neurotransmitter acetylcholine in the cholinergic synapses [23]. In present study, neither anthracene nor Pb^{+2} at the tested concentrations changed AChE activities in *D. rerio* eleutheroembryos after 96 hpf of exposure, suggesting the absence of disruption in the nervous system via AChE activity inhibition. In the case of Pb^{+2} , obtained results are consistent with those obtained by Richetti et al. [18], which demonstrated a reduction of AChE level (18%, $p < 0.05$) after 24 h of exposure to high levels of Pb^{2+} (PbAc) followed by a progressive restoration to the control levels after 96 hpf and 30 days of exposure. It was found that low concentrations of the metal interfere with the acetylcholine hydrolysis depending on the time and level of exposure. The normalization of AChE levels can be attributed to compensatory response of the cell to the toxic effects induced by Pb^{+2} after short-term exposures. According to Tu et al. [53], we hypothesized that exposure to metals such Pb^{+2} (PbAc) may interfere with NEUREXIN2A (nrnx2a α and β - forms) genes expression, affecting central nervous system (CNS) and cause behavioral alterations in larvae. The Reelin (RELN) ortholog is in a subset of genes associated with neuronal function that was altered following exposure to 0.1 mg/L Pb^{+2} at 72 hpf [54]. As well, results of Wang et al. [7] showed impairment of the brain neurons growth and behavioral abnormalities in the larval and juvenile zebrafish after 15-30 days post fertilization exposure to (0.01 and 0.1 mg/L) PbAc, which indicate a chronic toxicity of Pb^{+2} rather than acute or sub-acute toxicity.

Regarding the effects of PAHs on AChE, in general, contradictory effects may be found in the literature with some studies reporting inhibition and others indicating no-effects Vieira et al. [15]. Several factors may account for these apparently contradictory effects, mainly the species and the compounds tested. Palanikumar et al. [4] and Vieira et al. [15] detected that both anthracene and benzo [a] pyrene inhibited *C. chanos* and *Pomatoschistus microps* AChE respectively, indicating that they have at least one mechanism of neurotoxicity in common: the disruption of cholinergic transmission by inhibition of AChE. A significant decrease of AChE activity was found at the highest tested concentration (LOEC=4 $\mu g/l$), corresponding to 52% of inhibition in *Pomatoschistus microps* (Teleostei, Gobiidae) [15]. However, according to Mathew et al. [55], because PAHs are known to be metabolized, we suggest that metabolism may be occurring in early life stage. Evidence suggests that metabolism commences with only a relatively short time-lapse from the initiation of exposure. These improvements in the data sets would help in understanding the toxicity of low-level exposures to PAHs and would shed more light on PAHs metabolism in fish early life stages as well as on the dependence of metabolism rates with physicochemical properties of PAHs. This last hypothesis can explain obtained data.

CONCLUSION

In conclusion, this study alarms that the presence of Pb^{+2} and anthracene in aquatic ecosystems can significantly affect aquatic species. Data showed lethal effects of concentrations with 96- LC_{50} values of 76.1 mg/L (Pb^{+2}) and 133.35 mg/L (anthracene). Moreover, Pb^{+2} and anthracene seem to cause swimming disturbance at concentrations equal or above 3.2 mg/L (anthracene) and 0.1 mg/L (Pb^{+2}). Data confirms the usefulness of early life stages of zebrafish for monitoring industrial effluents loaded with pollutants as Pb^{+2} and anthracene and the usefulness and sensitivity of behavioral assay for an accurate assessment of hazardous contaminant effects in natural ecosystems. AChE activity was not responsive and sensitive to 96 hpf exposures to Pb^{+2} and anthracene, suggesting that Pb^{+2} and anthracene neurotoxicity is not mediated via AChE disruption. For this reason, we suggest the study of other biomarkers (e.g. butyrylcholinesterase, energetic metabolism, genotoxic biomarkers, etc.) to understand the toxic MoA of Pb^{+2} and anthracene and select the most relevant and sensitive biomarkers for further studies. Obtained data can be useful for determining water quality guidelines for the protection of aquatic biota, for the deep understanding of the toxicity mechanisms. Therefore this acute study suggested that adequate care must be taken to avoid the release of HAPs and heavy metals to the aquatic environment. Further work should investigate other targets at the central nervous system as well as the chronic neurotoxicity of these chemicals, which is ecologically more relevant.

Acknowledgments

This work was supported by the General Directorate of Scientific Research and Technological Development of Algeria (DGRSDT), we acknowledge Dr. Amar Azioune, Director of the Biotechnology Research Centre (CRBt) of Constantine for the funding of this work. Thanks are due to FCT/MCTES for the financial support to (UIDP/50017/2020+UIDB/50017/2020), through national funds. Authors would like also to thank all the colleagues: Ana Rita Almeida, Niedja Santos, Pedro Manuel and Miguel Oliveira for their help, support and hospitality at CESAM, University of Aveiro, Portugal.

Disclosure statement

No potential conflict of interest was reported by the authors.

REFERENCES

- [1] Rhodes, S. The effects of dimethylated and alkylated Polycyclic Aromatic Hydrocarbons on the embryonic development of the Japanese medaka. . *Ecotox Environ Safe*. **2005**, 60, S247-S258.
- [2] Nisha, J.C.; Jeya, S.R.R.; Chandran, R. Acute effect of chromium toxicity on the behavioral response of zebrafish. *Int. J. Pl. An. Env. Sc*. **2016**, 2, 6-15.
- [3] Ribeiro, A.B.; Mateus, E.P.; Ottosen, L.M.; Bech-Nielsen, G. Electrodialytic removal of Cu, Cr, and As from chromated copper arsenate-treated timber waste. *Environ. Sci. Technol*. **2000**, 34, 784-788.
- [4] Palanikumar, L.; Kumaraguru, A.K.; Ramakritinan, C.M.; Anand, M. Ecotoxicology and environmental safety biochemical response of anthracene and benzo [a] pyrene in milkfish (Chanos Chanos). *Ecotox. Environ. Safe*. **2012**, 75, 187-97.
- [5] Perrichon, P.; Le Menach, K.; Akcha, F.; Cachot, J.; Budzinski, H.; Bustamante, P. Toxicity Assessment of water-accommodated fractions from two different oils using a zebrafish (Danio Rerio) embryo-larval bioassay with a multilevel approach. *Sci.Total Environ*. **2016**, 568, 952-66.
- [6] Geier, M.C.; Chlebowski, A.C.; Truong, L.; Masseyimonich, S.L.; Anderson, K.A.; Tanguay, R.L. Comparative developmental toxicity of a comprehensive suite of polycyclic aromatic hydrocarbons. *Arch. Toxicol*. **2017**. 92 (2), 571-586.

- [7] Wang, Y.; Shen, C.; Wang, C.; Zhou, Y.; Gao, D.; Zuo, Z. Maternal and embryonic exposure to the water soluble fraction of crude oil or lead induces behavioral abnormalities in zebrafish (*Danio rerio*), and the mechanisms involved. *Chemosphere*. **2018**, 7-16.
- [8] Verma, N.; Pink, M.; Rettenmeier, A.W.; Schmitz-Spanke, S. Review on proteomic analyses of benzo[a]pyrene toxicity. *Proteomics*. **2012**, 12, 1731-1755.
- [9] Hodson, P.V. (2017). The toxicity to fish embryos of PAH in crude and refined oils. *Arch. Environ. Contam. Toxicol.* 73(1), 12-18.
- [10] Jung, J.H.; Lee, E.H.; Choi, K.M.; Yim, U.H.; Ha, S.Y.; An, J.G.; Kim, M. Developmental toxicity in flounder embryos exposed to crude oils derived from different geographical regions. [Comp. Biochem. Physiol., C: Comp. Pharmacol. Toxicol.](#) **2017**, 196, 19-26.
- [11] Hall, T.; Otis J. T. Anthracene reduces reproductive potential and is maternally transferred during long term exposure in fathead minnows. *Aquat Toxicol.* **1991**, 19, 249-264.
- [12] Oris, J.T.; Giesy, J.P.; Allred, P.M. Photoinduced toxicity of anthracene in aquatic organisms: an environmental perspective. *The Biosphere: Problems and Solutions*. **1984**, 939-958.
- [13] Peterson S.K.; Bain L.J. Differential gene expression in anthracene-exposed mummichogs (*Fundulus heteroclitus*). *Aquatic Toxicology*. **2004**, 66, 345-55.
- [14] Vasanth, S.; Ganesh, A.; Siva Vijayakumar, T.; Karthikeyeni, S.; Manimegalai, M.; Subramanian, P. Assessment of anthracene on hepatic and antioxidant enzyme activities in *Labeo rohita* (Hamilton, 1822). *Int. J. Pharm. Life. Sci.* **2012**, 3(5), 1696-1704.
- [15] Vieira, L.R.; Sousa, A.; Frasco, M.F.; Lima, I.; Morgado, F.; Guilhermino, L. Acute effects of Benzo[a]pyrene, anthracene and a fuel oil on biomarkers of the common goby *Pomatoschistus microps* (Teleostei, Gobiidae). *Sci. Total Environ.* **2008**, 395, 87-100.
- [16] Roy, N.M.; DeWolf, S.; Carneiro, B.. Evaluation of the developmental toxicity of lead in the *Danio rerio* body. *Aquat Toxicol.* **2015**, 158, 138-148.
- [17] Senger, M.R.; Rico, E.P.; Arizi B. M.; Frazzon, A.P.; Dias, R.D.; Bogó, M.R.; Bonan, C.D. Exposure to Hg^{2+} and Pb^{2+} changes NTPDase and ecto-5'-nucleotidase activities in central nervous system of zebrafish (*Danio rerio*). *Toxicology*. **2006**, 226, 229-237.
- [18] Richetti, S.K.; Rosemberg, D.B.; Ventura-Lima, J.; Monserrat, J.M. Bogob, M.R. , Bonan, C.D. Neurotoxicology acetylcholinesterase activity and antioxidant capacity of zebrafish brain is altered by heavy metal exposure. *Neurotoxicology*. **2011**, 32(1), 116-22.
- [19] Rice, C.; G.J.K.; Zalewski, K.; Weber, D. N. Developmental lead exposure causes startle response deficits in zebrafish, *Aquat Toxicol.* **2011**, 105(3-4), 600-608.
- [20] Dou, C.; Zhang, J. Effects of lead on neurogenesis during zebrafish embryonic brain development. *J. Hazard. Mater.* 2011, 194, 277-82.
- [21] Fraysse, B.; Mons, R.; Garric, J. Development of a zebrafish 4-day embryo-larval bioassay to assess toxicity of chemicals. *Ecotox. Environ. Safe.* **2006**, 63, 253-267.
- [22] Dai, Y.J.; Jia, Y.F.; Chen, N.; Bian, W.P.; Li, Q.K.; Ma, Y.B.; Chen, Y.L.; Pei, D.S. Zebrafish as a model system to study toxicology. *Environ. Toxicol. Chem.* **2014**, 33(1), 11-17.
- [23] Oliveira, R.; McDonough, S.; Ladewig, J.C.L.; Soares, A.M.V.M.; Nogueira, A.J.A.; Domingues, I. Effects of Oxytetracycline and Amoxicillin on Development and biomarkers activities of zebrafish (*Danio rerio*). *Environ. Toxicol. Pharmacol.* **2013**, 36(3), 903-12.
- [24] Lee, J.; Freeman, J.L. Zebrafish as a model for developmental neurotoxicity assessment: the application of the zebrafish in defining the effects of arsenic, methylmercury, or lead on early neurodevelopment. *Toxics*. **2014**, 464-95.
- [25] Nagel, R. DarT: The embryo test with the zebrafish *Danio rerio*-a general model in ecotoxicology and toxicology. *Altex-Alternativen Zu Tierexperimenten*. **2002**, 19, 38-48.
- [26] Cristiano, W.; Lacchettia, I.; Mancinia, L.; Cortia M.; Di Domenicco K.; Di Paolob, C.; Hollertb H.; Carerea, M. Promoting Zebrafish embryo tool to identify the effects of chemicals in the context of water framework directive monitoring and assessment. *Microchem. J.* **2019**, 149, 1-12.
- [27] Kimmel, C.B.; Ballard, W.W.; Kimmel, S.R.; Ullmann, B.; Schilling, T.F. Stages of embryonic development of the zebrafish. *Dev. Dyn.* **1995**, 203, 253-310.

- [28] Zhang, J.; Peterson, S.M.; Weber, G.J.; Zhu, X.; Zheng, W.; Freeman, J.L. Decreased axonal density and altered expression profiles of axonal guidance genes underlying lead (Pb) neurodevelopmental toxicity at early embryonic stages in the zebrafish. *Neurotoxicol. Teratol.* **2011**, *33*, 715-720.
- [29] Li, Y.; Yang, X.; Chen, Z.; Zhang, B.; Pan, J.; Li, X.; Yang, F.; Sun, D. Comparative toxicity of lead (Pb²⁺), copper (Cu²⁺), and mixtures of lead and copper to zebrafish embryos on a microfluidic chip. *Biomicrofluidics*. **2015**, *9*, 1-10.
- [30] Ansari, S.; Ansari, B.A. Effects of heavy metals on the embryo and larvae of zebrafish *Danio rerio* (Cyprinidae). *Scholars Acad. J. Biosci.* **2015**, *3*, 52-56.
- [31] Domingues, I.; Oliveira, R.; Lourenço, J.; Grisolia, C.K.; Mendo, S.; Soares, A.M.V.M. Biomarkers as a tool to assess effects of chromium (VI): Comparison of responses in zebrafish early life stages and adults. *Comp. Biochem. Physiol., C: Comp. Pharmacol. Toxicol.*, Part C. **2010**, *152*(3), 338-45.
- [32] Henriques, J.F.; Almeida, A.R.; Andrade, T.; Koba, O.; Golovko, O.; Soares, A.M.V.M.; Oliveira, M.; Domingues, I. Effects of the lipid regulator drug Gemfibrozil: A toxicological and behavioral perspective. *Aquat Toxicol.* **2016**, *170*, 355-364.
- [33] McIntyre, J.K.; Davis, J.W.; Incardona, J.P.; Stark, J.D.; Anulacion, B.F.; Scholz, N.L.. Zebra fish and clean water technology : Assessing soil bioretention as a protective treatment for toxic urban runoff. *Science of the Total Environment*. **2014**, 173-180.
- [34] OECD. Fish, Acute Toxicity Test, OECD guideline for testing of chemicals, Draft revised version, 11th Version. **2018**.
- [35] OECD. Fish Embryo Acute Toxicity (FET) Test. Test 236. OECD Guideline for the Testing of Chemicals, Section 2, OECD Publishing, Paris, France. **2013**.
- [36] Ulhaq, M.; Orn, S.; Carlsson, G.; Morrison, D.A.; Norrgren, L. Locomotor behavior in zebrafish (*Danio rerio*) larvae exposed to perfluoroalkyl acids. *Aquat Toxicol.* **2013**, 332-340.
- [37] Schnorr, S.J.; Steenbergen, P.J.; Richardsen, M.K.; Champagne, D.L. Measuring thigmotaxis in larval zebrafish. *Behav Brain Res.* **2012**, *228*, 367-374.
- [38] Ellman, G.L.; Courtney, K.D.; Featherstone, R.M. A new and rapid colorimetric determination of acetylcholinesterase activity. *Biochem. Pharmacol.* **1961**, *7*, 88-95.
- [39] Bradford, M.M. A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein-dye binding. *Anal. Biochem.* **1976**, *72*, 248-254.
- [40] Finney, D.J. Probit analysis. 3rd edition, Cambridge University Press, London. **1971**, 333.
- [41] Turcotte, D. The toxicity of alkyl PAH to early life stages of fish. Ph.D. Dissertation, Queen's University, Kingston, ON. **2008**.
- [42] Lin, H.; Morandi, G.D.; Brown, R.S.; Snieckus, V.; Rantanen, T.; Jørgensen, K.B.; Hodson, P.V. Quantitative structure- activity relationships for chronic toxicity of alkyl-chrysenes and alkyl-benz[a]anthracenes to Japanese medaka embryos (*Oryzias latipes*). *Aquat Toxicol.* **2015**, *159*, 109-118.
- [43] Bhagade, A. Acute Toxicity of Anthracene on a local fresh water fish- *Puntius ticto* (Ham.). *Int J. Res Biosci, Agri and Tech.* **2017**, *2*(5), 912-916.
- [44] Peterson, S.M., Zhang, J., Weber, G., Freeman, J.L. Global gene expression analysis reveals dynamic and developmental stage-dependent enrichment of lead-induced neurological gene alterations. *Environ. Health Perspect.* **2011**, *119*, 615-621.
- [45] Thi Thuong, H.N.; Thai, Q.K.; Thi Tuong, V.L.; Van, T.T.; Thi Phuong, D.T. Examining the effects of lead on the life of larval zebrafish (1-7 days old). *Series Physiology.* **2014**, *1*(2), 11-20.
- [46] Chen, L.; Huang, C.; Hu, C.; Yu, K.; Yang, L.; Zhou, B. Developmental lead acetate exposure induces embryonic toxicity and memory deficit in adult zebrafish. *Neurotoxicol. Teratol.* **2012**, *34*, 581-586.
- [47] Lawrence, C. The husbandry of zebrafish (*Danio rerio*): A review, *Aquaculture.* **2007**, *269*, 1-20.
- [48] Javid, A.; Javed, M.; Abdullah, A.; Ali, Z. Bio-accumulation of Lead in the Bodies of Major Carps (*Catla catla*, *Labeo rohita* and *Cirrhina mrigala*) during 96-h LC exposures. *Int. J. Agri. Biol.* **2007**, *9*(6), 909-912.
- [49] Muñoz, L.; Weber, P.; Dressler, V.; Baldisserotto, B.; Vigliano, F. A. Histopathological biomarkers

- in juvenile silver catfish (*Rhamdia quelen*) exposed to a sublethal lead concentration. *Ecotox. Environ. Safe.* 2015, 241-247.
- [50] Kaushal, B.T.; Mishra, A. Investigation of acute toxicity cadmium on snakehead fish *Channa punctatus*. A comparative toxicity analysis on median lethal concentration. *Int. J. Adv. Biol. Res.* 2013, 3, 289-294.
- [51] Oliveira, R., McDonough, S., Ladewig, J.C.L., Soares, A.M.V.M., Nogueira, A.J.A., Domingues, I., Effects of Oxytetracycline and Amoxicillin on Development and biomarkers activities of zebrafish (*Danio rerio*). *Environ. Toxicol. Pharmacol.* 2013, 36(3), 903-12.
- [52] Gravato, C.; Almeida, J.R.; Silva, C.; Oliveira, C.; Soares, A.M.V.M. Using a multi-biomarker approach and behavioural responses to assess the effects of anthracene in *Palaemon serratus*. *Aquat Toxicol.* 2014, 149, 94-102.
- [53] Tu, H., Fan, C., Chen, X., Liu, J., Wang, B., Huang, Z., Zhang, Y., Meng, X., Zou, F. Effects of cadmium, manganese, and lead on locomotor activity and neurexin 2a expression in zebrafish. *Environ. Toxicol. Chem.* 2016, 36(8), 2147-2154.
- [54] Peterson, S.M., Zhang, J., Freeman, J.L. Developmental reelin expression and time point-specific alterations from lead exposure in zebrafish. *Neurotoxicol Teratol.* 2013, 38, 53-60.
- [55] Mathew, R. McGrath, R.J., Di Toro, D.M. Modeling polycyclic aromatic hydrocarbon bioaccumulation and metabolism in time-variable early life-stage exposures. *Environ. Toxicol. Chem.* 2008, 27(7), 1515-1525.



VIII. International Symposium-2024

LEBANESE AGRO INDUSTRIES' KNOWLEDGE IN FOOD LOSS IS AN INITIAL STEP TOWARD THE SUSTAINABLE DEVELOPMENT GOAL 12.3

Nathalie Pano¹, Nada Nehme², Jalal Halwani³, Kostas Karantininis⁴, Najah Taleb²

¹ Doctoral School of Science and Technology, Lebanese University, Hadath, Lebanon, Nathalie Pano*, Nathaliepano@gmail.com

² Lebanese University, Faculty of Agricultural Engineering and Veterinary Medicine, Dekwene, Lebanon, Nada Nehme, nada.nehme@ul.edu.lb, Najah Taleb, najahtaleb94@gmail.com,

³ Lebanese University, Water & Environment Science Lab, Tripoli, Lebanon, Jalal Halwani, jhalwani@ul.edu.lb

⁴ Swedish University of Agricultural Sciences, Alnarp, Sweden, Kostas Karantininis, karantininis.konstantinos@slu.se

Abstract:

The drive to diminish food waste is embedded within the 2015 Sustainable Development Goals (SDG), particularly under Goal 12, which aims to foster sustainable consumption and production practices. Specifically, SDG 12.3 sets the target of cutting per capita global food waste in half at both the retail and consumer levels, while also curbing food losses across production and supply chains by 2030. Consequently, mitigating food loss and waste (FLW) stands out as a crucial step toward transforming our food systems. The understanding and knowledge of value chain actors regarding this issue is vital for kick-starting initiatives and implementing processes aimed at measuring, preventing, and reducing FLW. What is the level of knowledge of the Lebanese food industries toward FLW?

Based on literature review, a survey was designed to collect the relevant data from various agro-industries in Lebanon. 30 agro industries participated in the 16 questions' survey. The data collected were statistically analyzed. The results show that there is a significant gap in the public awareness and understanding of food waste, which may hinder the efforts to reduce food waste and achieve a sustainable food system. 20.69 % have no knowledge at all, 31.03% misunderstand the issue, 27.59% have partial knowledge and only 20.69% have extensive knowledge. Finally, awareness and knowledge about food waste are essential in addressing this global challenge. With informed individuals and organizations, effective strategies can be implemented to reduce losses along the entire value chain, and work towards sustainable food systems that ensure reaching the SDG 12.3.

Keywords: Awareness, Food waste and loss, Food-industry, Knowledge, Lebanon, SDG 12

INTRODUCTION

The Sustainable Development Goals (SDGs) established by the United Nations in 2015 stimulate action until 2030 in areas of critical importance for humanity and the planet: People, Plant, Prosperity, Peace,

Partnership.¹ SDG 12 aims to promote the responsible utilization of resources, enhance energy efficiency, establish sustainable infrastructure, guarantee access to essential services, foster the creation of environmentally friendly and fair employment opportunities, and ultimately improve the standard of living for everyone.² This goal relates to the relationships between production activities and urban environments, emphasizing the necessity to meet the needs of a rapidly growing population through the use of natural resources, their transformation, logistics management, transportation, consumption habits, and final disposal techniques. Each of these interconnected elements plays a role in the creation of waste and pollutants that are discharged into the environment, thus requiring the formulation of strategies focused on a significant change in the life cycle and distribution logistics of products designed for human use.³ One of the particularly alarming issues is food loss and waste (FLW).

Food loss and food waste have become a prevalent issue on a global scale in recent times and are commonly recognized as a significant obstacle to worldwide sustainability.⁴ Thus, the reduction of FLW has emerged as a fundamental priority on the sustainability agenda at the global, regional, and national levels. The Sustainable Development Goal 12.3 ‘By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses’⁵ addresses the significant issue of FLW globally^{6,7}. Research emphasizes the necessity of reducing FLW, highlighting the socio-environmental impacts and the barriers and drivers hindering its minimization and its treatment.

It is a serious and well-known fact that a large amount of food is wasted every year. This amounts to more than 1.3 billion tons, or 1/3 of the globally produced food.⁸ FLW have significant economic, environmental, and social impacts globally. To address FLW, interdisciplinary approaches and sustainable supply chain frameworks are crucial.⁹ Studies highlight the importance of a holistic supply chain approach to tackle FLW, emphasizing stakeholder collaboration, circular economy principles, and regulatory changes for effective waste reduction strategies.¹⁰ In general, agro-industries are increasingly focusing on reducing food waste through various strategies. Research indicates a shift towards circular agricultural production, emphasizing waste reduction, reuse, and recycling, viewing agricultural residues as valuable raw materials for diverse industries.¹¹

Lebanon, a country facing currently multiple challenges among them the economic crisis, political instability, and refugee influx, affecting the food system and contribute to food loss and waste.

¹ United Nations (2023). Sustainable consumption and production. United Nations Sustain. Develop. Available online at: <https://www.un.org/sustainabledevelopment/sustainable-consumption-production/> (accessed January 16, 2023).

² “Ensure sustainable consumption and production patterns” Published online at OurWorldInData.org. Retrieved from: ‘<https://ourworldindata.org/sdgs/responsible-consumption-production>’ [Online Resource]

³ Wang, Y. (2019). The challenges and strategies of food security under rapid urbanization in China. *Sustainability* 11, 542. Doi: 10.3390/su11020542

⁴ Xue, L., Liu, G., Parfitt, J., Liu, X., Van Herpen, E., Stenmarck, A., et al., 2017. Missing food, missing data? A critical review of global food losses and food waste data. *Environ Sci Technol* (51) 12, 6618-6633.

⁵ Transforming Our World: The 2030 Agenda for Sustainable Development | Department of Economic and Social Affairs,” n.d.

⁶ Mills, Briar, Miranda Miroso, Ray O’Brien, and Sheila Skeaff. 2023. “Reaching for Sustainable Development Goal 12.3 in Aotearoa’s Tertiary Institutes.” In *NSNZ 2022*, 4. MDPI. <https://doi.org/10.3390/msf2023018004>.

⁷ Jacob-John, Jubin, Clare D’Souza, Timothy Marjoribanks, and Stephen Singaraju. 2023. “Sustainable Development Goals: A Review of SDG 12.3 in Food Supply Chain Literature.” *Benchmarking: An International Journal* 30 (9): 3465–81. <https://doi.org/10.1108/BIJ-12-2021-0736>.

⁸ Pleissner, D. (2018). Recycling and reuse of food waste. *Current Opinion in Green and Sustainable Chemistry*, 13, 39–43. <https://doi.org/10.1016/j.cogsc.2018.03.014>

⁹ Baysal, S. Su, and M. Ali Ülkü. 2022. “Food Loss and Waste: A Sustainable Supply Chain Perspective.” In *Advances in Environmental Engineering and Green Technologies*, edited by Ulas Akkucuk, 90–108. IGI Global. <https://doi.org/10.4018/978-1-7998-8900-7.ch006>.

¹⁰ Sánchez-Teba, Eva M., Germán Gemar, and Ismael Pablo Soler. 2021. “From Quantifying to Managing Food Loss in the Agri-Food Industry Supply Chain.” *Foods* 10 (9): 2163. <https://doi.org/10.3390/foods10092163>.

¹¹ Chikezie Ogbu, Cosmas, and Stephen Nnaemeka Okey. 2023. “Agro-Industrial Waste Management: The Circular and Bioeconomic Perspective.” In *Agricultural Waste – New Insights*, edited by Fiaz Ahmad and Muhammad Sultan. IntechOpen. <https://doi.org/10.5772/intechopen.109181>.

According to some estimates, Lebanon wastes about 1.3 million tons of food every year.^{12,13} Food loss and waste in Lebanon is poorly managed and regulated. With the lack of national legislation, policies, interventions, and initiatives to address food waste, most of the food waste ends up in landfills or open dumps.¹⁴ FLW in Lebanon presents opportunities for improvement and innovation. There is a potential for reducing and recovering food waste through various strategies, such as awareness campaigns, education programs, donation schemes, composting systems, biogas production, or animal feed.¹⁵ The agrifood industries an important driver in the Lebanese economy. The purpose of this paper is to advance the existing understanding and practices surrounding FLW management within the context of Lebanon. By synthesizing current knowledge and exploring practical applications, this study seeks to offer valuable insights and recommendations to enhance strategies for mitigating food waste in Lebanon. Through comprehensive analysis and innovative approaches, this research aims to contribute to the ongoing efforts to address this pressing issue, fostering sustainable practices and promoting efficient utilization of food resources in the country.

MATERIALS AND METHODS

While undertaking research into food system transformation in Lebanon (methodology framework in fig.1), collection of data was conducted at agro-industries level to identify process food losses related causes, quantities, and practices to prevent it and discard it. The methodology started with a literature review and carried out a survey of agro-industries to collect information on process food loss.

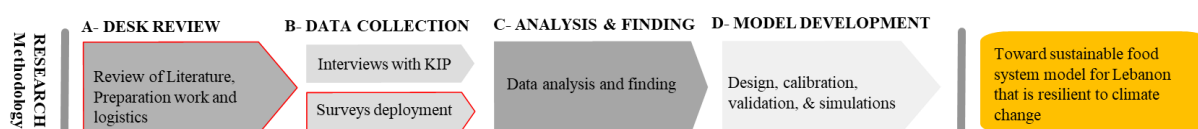


Figure 11: Methodology framework

Questionnaire development

The questionnaire, comprising 16 questions, originally developed in English, and translated later into Arabic. The participants had the option to choose the language they want to answer. It aimed to determine the factors influencing process food loss generation in Lebanese Agro-industries. The questionnaire also included questions enable to categorizing the level of knowledge and their point of view toward food waste. The survey was conducted in person and took an average of 10 to 15 minutes to complete. The questionnaire covered three key sections:

- Characteristic analysis of participants,
- Amount of agricultural waste, reasons, and motives leading to food waste
- Approaches employed by the Agro-industry in dealing with food waste.

Participants were informed about the purpose of the study at the beginning of the survey. They were informed that their participation is voluntary and there would be no risks associated with the study and all data would be kept confidential and anonymous.

Thirty (30) agro-industries from different food production sectors participated in the survey. They are situated across diverse regions of Lebanon. The research was carried out over the period extending from

¹² Abiad, M. G., & Meho, L. I. (2018). Food loss and food waste research in the Arab world: A systematic review. *Food Security*, 10(2), 311–322. <https://doi.org/10.1007/s12571-018-0782-7>

¹³ Chalak, A., Abiad, M. G., Diab, M., & Nasreddine, L. (2019). The Determinants of Household Food Waste Generation and its Associated Caloric and Nutrient Losses: The Case of Lebanon. *PLOS ONE*, 14(12), e0225789. <https://doi.org/10.1371/journal.pone.0225789>.

¹⁴ Charbel, L., Capone, R., Grizi, L., Debs, P., Khalife, D., Bilali, H. E., & Bottalico, F. (2016). Preliminary Insights on Household Food Wastage in Lebanon. *Journal of Food Security*, 4(6), Article 6.

¹⁵ Zeineddine, M., Kharroubi, S., Chalak, A., Hassan, H., & Abiad, M. G. (2021). Post-Consumer food waste generation while dining out: A close-up.

June until November 2023. The persons who answered the survey were the factory owners, usually also managing in the industry.

Data collection was facilitated using the Kobo Toolbox program (Kobo Toolbox), ensuring a streamlined and efficient process. Participant's responses were recorded and managed in real-time through this platform. Additionally, to maintain data integrity and accessibility, the collected information was meticulously translated in an Excel spreadsheet. Based on the purpose of this paper, data were coded and analyzed using the Statistical Package for Social Sciences (SPSS v 26).

STATISTICAL ANALYSIS AND GRAPHICAL PRESENTATION

Importance to address FLW issue in the Lebanese agro-industries

A multiple-choice question is related to the importance of addressing the FLW issue and improve resource efficiency. The agro industrialists chose one out of four options: Very important, moderately important, slightly important, and not important.

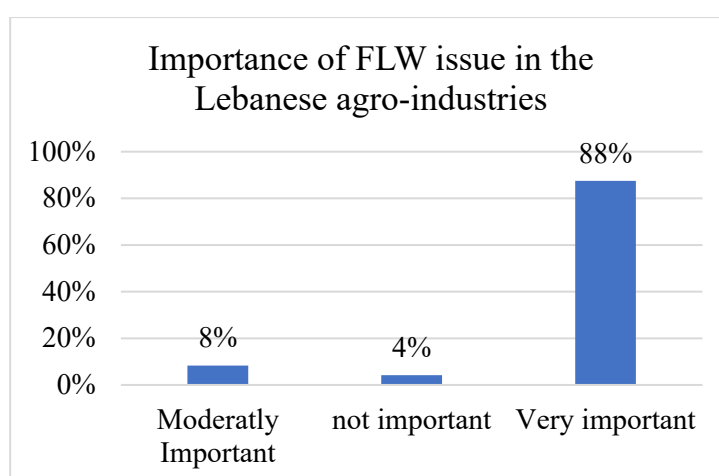


Figure 12: The Importance of the FLW issue in the Lebanese agro-industries

The Fig 2 shows the 4% of the agro industrialists consider the FLW issue not important, 0% slightly important, 8% moderately important and the majority 88% consider that it is very important to address FLW and improving resource efficiency.

Understanding Food Waste

An open-ended question was asked to let agro-industrialists define food loss and waste in their own words. In Arabic we asked about **هدر الغذاء** that can define both food loss and waste to prevent confusion in the analysis. The answers varied widely containing correct and incorrect definitions, quantities, causes, treatment methods, and answers like we don't know, or answers focusing on the stage where food loss happen.

To be able to statistically analyze this, the answers were categorized into 4 categories:

- Extensive Knowledge: Answers and statements that correctly define food loss and waste.
- Partial Knowledge: Answers and statements that don't correctly define food loss and waste but state correct information regarding this issue.
- No Knowledge: Answers like we don't know,
- Misunderstanding: Answers and statements that incorrectly define food loss and waste and neither state correct information.

The results presented in Fig. 3 show that majority of participants (31.03%) have a misunderstanding about food waste, meaning that they gave incorrect or incomplete definitions, only (20.69%) of

participants have extensive knowledge about food waste, meaning that they gave accurate and comprehensive definitions, the remaining participants (27.59%) have partial knowledge about food waste, meaning that they gave partially correct or vague definitions, Another 20.69% of participants have no knowledge about food waste, meaning that they gave irrelevant answers.

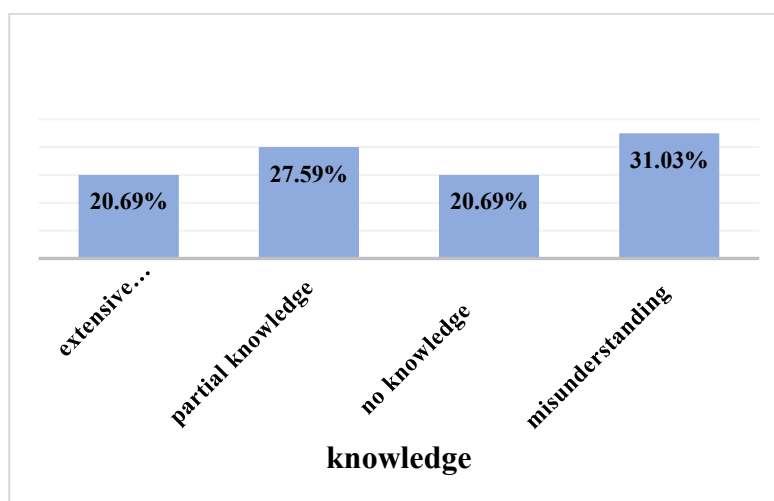


Figure 13 Bar charts representing the distribution of the knowledge defining food waste among Agro-industries.

Lebanese agro-industries' FLW' records

A yes/no questions was asked to the agro industries to collect information if they keep record on FLW generated in their industry.

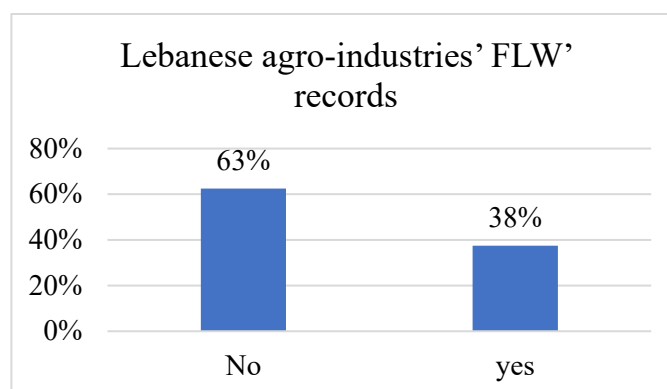


Figure 14 Lebanese agro-industries' FLW' records

The fig 4 shows that 63% of the respondents don't record the food waste generated in the industry, while 38% do.

Need for Awareness and educational support.

Another open-ended question tackled measures to reduce or prevent food loss and waste. The responses varied widely, but some common themes emerged. The most frequently mentioned measures were:

- Customized production based on customer demand and market conditions.
- Quality control and daily supervision of the production process.
- Proper planning and optimization of raw materials, purchasing, warehousing, and sales.
- Improvement of storage, transportation, and loading conditions.
- Use of by-products or residues as alternative sources of income.
- ***Training of employees and awareness-raising of members.***
- Pursuit of the highest quality manufacturing and after-sales service.

- **Learning from mistakes and fixing them.**
- Securing a generator to prevent damage to the product.
- Changing the quality of raw materials.

RESULTS AND DISCUSSION

Most of the Lebanese agro-industries consider addressing the FLW issue and improving resource efficiency very important. Thus, those are aware of the significance and urgency of the issue and are likely to adopt measures to reduce FLW. However, when asked about their definition of FLW, the fig 3 shows a significant gap in the knowledge and understanding of FLW, which may hinder the efforts to reduce losses. Documenting records related to FLW, their quantities, causes and others, lacks in 63% of the Lebanese food industries.

Despite considering addressing FLW very important, thus significant, the Lebanese agro-industries lack adequate knowledge about the issue. The non adequate knowledge often leads to inaction to prevent FLW, reduce the generated quantities or adequately discard them. In practice, most of them don't even record any information about the FLW generated. Many respondents are not aware of food loss and thus underestimate the weight of this issue.

When talking about the efficient actions to prevent FLW, training of employees, awareness raising and learning are mentioned. This confirms that the raising knowledge is crucial and efficient to reach the SDG 12.3

CONCLUSIONS AND RECOMMENDATIONS

Several barriers hinder the agro-industries to prevent and reduce their FLW generation. It is important to address these barriers and encourage the agro-industries to prevent and reduce FLW and achieve a sustainable food system. This study shows that despite the importance of the FLW issue among the Lebanese agro-industries, there is a significant gap in their FLW' knowledge, that hinder the actions to prevent FLW. The agro-industries consider raising awareness and knowledge as one of the efficient measures to conduct to reduce food waste. Based on the findings the following few important recommendations are proposed as follow:

- The agro-industries and their staffs should actively participate in FLW relevant training sessions and knowledge groups and networks. It is advised that best practices and lessons learned are shared across among the industrialists.
- The agro-industries should adequately record and monitor the FLW generated, and its causes. Thus, enabling an efficient analysis and design of adequate systems to reduce waste.
- Awareness campaigns should be launched on national level in general but also specifically to the food chain actors.
- The public sector should provide adequate guidelines to support food chain actors in their goal to reduce FLW. It should make available standardized methodologies and tools to record FLW.

REFERENCES

- [1] United Nations (2023). Sustainable consumption and production. United Nations Sustain. Develop. Available online at: <https://www.un.org/sustainabledevelopment/sustainable-consumption-production/> (accessed January 16, 2023).
- [2] "Ensure sustainable consumption and production patterns" Published online at OurWorldInData.org. Retrieved from: '<https://ourworldindata.org/sdgs/responsible-consumption-production>' [Online Resource]
- [3] Wang, Y. (2019). The challenges and strategies of food security under rapid urbanization in China. Sustainability 11, 542. Doi: 10.3390/su11020542

- [4] Xue, L., Liu, G., Parfitt, J., Liu, X., Van Herpen, E., Stenmarck, A., et al., 2017. Missing food, missing data? A critical review of global food losses and food waste data. *Environ Sci Technol* (51) 12, 6618-6633.
- [5] Transforming Our World: The 2030 Agenda for Sustainable Development | Department of Economic and Social Affairs,” n.d.
- [6] Mills, Briar, Miranda Miroso, Ray O’Brien, and Sheila Skeaff. 2023. “Reaching for Sustainable Development Goal 12.3 in Aotearoa’s Tertiary Institutes.” In *NSNZ 2022*, 4. MDPI. <https://doi.org/10.3390/msf2023018004>.
- [7] Jacob-John, Jubin, Clare D’Souza, Timothy Marjoribanks, and Stephen Singaraju. 2023. “Sustainable Development Goals: A Review of SDG 12.3 in Food Supply Chain Literature.” *Benchmarking: An International Journal* 30 (9): 3465–81. <https://doi.org/10.1108/BIJ-12-2021-0736>.
- [8] Pleissner, D. (2018). Recycling and reuse of food waste. *Current Opinion in Green and Sustainable Chemistry*, 13, 39–43. <https://doi.org/10.1016/j.cogsc.2018.03.014>
- [9] Baysal, S. Su, and M. Ali Ülkü. 2022. “Food Loss and Waste: A Sustainable Supply Chain Perspective.” In *Advances in Environmental Engineering and Green Technologies*, edited by Ulas Akkucuk, 90–108. IGI Global. <https://doi.org/10.4018/978-1-7998-8900-7.ch006>.
- [10] Sánchez-Teba, Eva M., Germán Gemar, and Ismael Pablo Soler. 2021. “From Quantifying to Managing Food Loss in the Agri-Food Industry Supply Chain.” *Foods* 10 (9): 2163. <https://doi.org/10.3390/foods10092163>.
- [11] Chikezie Ogbu, Cosmas, and Stephen Nnaemeka Okey. 2023. “Agro-Industrial Waste Management: The Circular and Bioeconomic Perspective.” In *Agricultural Waste – New Insights*, edited by Fiaz Ahmad and Muhammad Sultan. IntechOpen. <https://doi.org/10.5772/intechopen.109181>.
- [12] Abiad, M. G., & Meho, L. I. (2018). Food loss and food waste research in the Arab world: A systematic review. *Food Security*, 10(2), 311–322. <https://doi.org/10.1007/s12571-018-0782-7>
- [13] Chalak, A., Abiad, M. G., Diab, M., & Nasreddine, L. (2019). The Determinants of Household Food Waste Generation and its Associated Caloric and Nutrient Losses: The Case of Lebanon. *PLOS ONE*, 14(12), e0225789. <https://doi.org/10.1371/journal.pone.0225789>.
- [14] Charbel, L., Capone, R., Grizi, L., Debs, P., Khalife, D., Bilali, H. E., & Bottalico, F. (2016). Preliminary Insights on Household Food Wastage in Lebanon. *Journal of Food Security*, 4(6), Article 6.
- [16] Zeineddine, M., Kharroubi, S., Chalak, A., Hassan, H., & Abiad, M. G. (2021). Post-Consumer food waste generation while dining out: A close-up.



VIII. International Symposium-2024

CHANNEL SELECTION ENHANCEMENT IN COGNITIVE RADIO NETWORKS BASED ON FUZZY APPROACH

Akeel BDRANY¹, Sattar B. Sadkhan²

¹Department of field crops, College of Agriculture, University of Diyala, Iraq,
akeelbdrany@uodiyala.edu.iq

²College of Information Technology, University of Babylon, Al-Mustaqbal University,
Babylon, Iraq, drengsattar@ieee.org

Abstract

The great increase in devices (laptops, smartphones, etc.) during the last decade that uses wireless communication as communication technology has increased the need for different spectral frequencies, for their use by these devices, this demand has led to a phenomenon called spectrum scarcity. Statistics issued by the Federal Communications Commission (FCC) have shown inefficiency in allocating fixed spectrum. To solve this problem (spectrum scarcity) the concept of cognitive radio is proposed. One of the promising responses to using the available (unused) spectrum is the so-called cognitive radio (CR), which was developed to enable secondary users (SUs) to exploit the spectrum holes in authorized channels. Secondary users should quickly clear the channel and change to another available channel if access to the primary user is sensed. One of the most important measures of the efficiency of spectrum use by secondary users is the continuous reduction of channel exchange. In this paper, it is proposed to use artificial intelligence algorithms to improve the selection of the best available channels. The metrics to evaluate the artificial intelligence algorithms are channel switching, throughput, and delay time.

The simulations were done using MATLAB Simulator. Neural network algorithms have shown promising results compared to some FIS (TSK, Mamdani). Also, the ANFIS algorithm showed superiority compared to the FIS algorithms in the throughput of data.

Keywords: Cognitive Radio, Channel Selection, FIS, ANFIS.

INTRODUCTION

The massive expansion of devices that use spectral frequencies in communication during the past two decades, this leads to a decrease in the available spectral frequencies (spectrum scarcity). Radio frequencies are used in many fields such as radio and television broadcasting, cellular communications, and satellite communications. Where it is considered one of the most requested resources in the field of wireless communications.

To ensure the quality level of licensed and unlicensed services, planning and spectrum assignment tools are used. Mobile phone networks have consumed a lot of resources because of their development and expansion.

Interweave paradigm :The fundamental tenet of the interweave model is opportunistic access. There are spectrum holes, which are temporary space-time-frequency voids that are unoccupied by authorized or Future wireless systems need to face the problem of finding suitable bands for the receiving services, as the spectrum bands are almost completely allocated to the various services.

Measurements of the spectral frequency occupancy efficiency prove that large parts of the frequency bands are partially occupied.

Therefore, spectrum management policies can be used to provide many advantages in frequency bands that are not being used inefficiently.

The future services that must be provided need new and more flexible algorithms to deal with wireless networks.

Cognitive radio technology is one of the ways to better use the frequency spectrum, this technology was developed for wireless networks.

In the cognitive radio network, there are authorized users (primary users) and unauthorized users (secondary users).

Cognitive radio has a lot of capabilities, as well as there are many challenges due to the presence of free channels in addition to the spectral frequencies in which the channels are available.[1]

Spectrum bands can be exploited by secondary users in a collaborative manner. Spectrum-sharing techniques (such as interweave, overlay and underlay) can be used to share the spectrum between authorized and unauthorized users without disturbing the primary users.

Cognitive Radio Networks

The cognitive radio network includes several operations, such as sensing the spectrum, sharing the spectrum, the decision about the spectrum, and the mobility of the spectrum. As shown in figure 1.

The spectrum sharing techniques that show in figure.2 describes the underlay, overlay, and interweave [2]:

A. **Interweave paradigm** :The fundamental tenet of the interweave model is opportunistic access. There are spectrum holes, which are temporary space-time-frequency voids that are unoccupied by authorized or unauthorized users. These gaps change over time and space. Information on the activity of spectrum users is needed for the interweave approach. This system periodically scans the spectrum, uses intelligence to determine when different parts of the system are occupied, and then opportunistically transmits via the vacant spectrum with minimal interference.

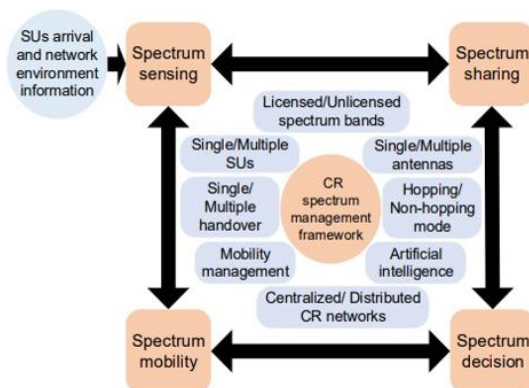


Fig. 1. Spectrum management framework [14]

- B. The Underlay paradigm is aware of the noise that every user creates. It mandates that primary and secondary systems can only be transmitted simultaneously if interference from the SU at the PU is below an acceptable threshold.
- C. The SU in overlay systems is aware of the PU's codebooks and communications [3]. The PUs broadcast at any power, thus relaying the PUs message can reduce interference to the PUs.

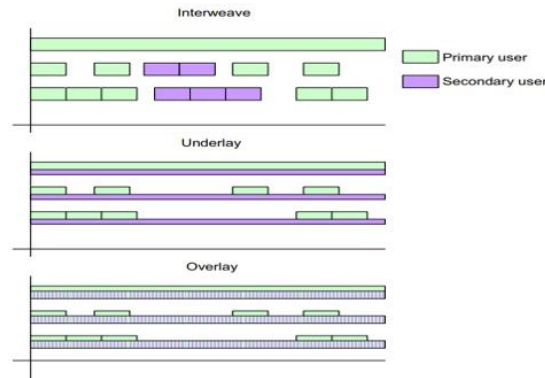


Figure 2: Different types of cognitive radio schemes: interweaved, underlay, overlay.

DECISION-MAKING ALGORITHMS

Fuzzy Inference systems

An important part of fuzzy logic is represented by fuzzy inference systems and is used in many different applications. The fuzzy inference systems create a clear non-linear map. Where logical knowledge or fuzzy rules encoding experts are identified about the problem.

An adaptive neuro-fuzzy inference system

The Takagi-Sugeno fuzzy inference system serves as the foundation for an artificial neural network called an adaptive neuro-fuzzy inference system (ANFIS), also referred to as an adaptive network-based fuzzy inference system. In the early 1990s, the technique was developed. Because it incorporates both into a single framework, it can benefit from both fuzzy logic and neural network concepts. A set of fuzzy IF-THEN rules with the ability to learn and approximate nonlinear functions serve as its representation of an inference system. ANFIS is therefore viewed as a global estimator. The ANFIS can be employed more effectively and optimally by using the best parameters discovered by a genetic algorithm. It can be used in energy management systems that are intelligent and situationally aware.

LITERATURE REVIEW

In the literature, many researchers have proposed the topic of interweaving channel assignment schemes, such as Asifuddola et al., An algorithm of Vacate on Demand (VD) has been proposed in cognitive radio networks. To allocate channels for secondary users, a Hopping algorithm was used by building the ranking Table in the least amount of time. Each CR user has its secure navigation sequence which is used during data communication between other CR users. Therefore, when PUs reach their spectrum, the CRs must be scanned and a new spectrum location will be immediately assigned to them to a channel [4].

Researchers in [5], as a possible solution to make predictions about which channel can provide low latency and high throughput at any given time, have implemented a Multi-layered Feedforward Neural Network (MFNN). Two scenarios were implemented: the first involving interference and the second non-interference due to other sensors and Wi-Fi, the results showed promising solutions.

In the article [6], the authors propose a scheme for selecting the spectral channel, under the IEEE 802.22 standard, which takes into account previous transmissions and also the list of backup channels. To select the best channel, it uses a fuzzy logic controller, where channels are categorized into working, reserved, filtered, guaranteed, and shared, as well as unclassified to allocate them to unauthorized users without prejudice to the transmission of the authorized users.

In paper [7], three contributions made by this paper are the utilization of real data, the adoption of a cooperative decision-making approach, and the measurement of information volume through the frequency of unsuccessful handoffs. The decision-making approach employs the Simple Additive Weighting and feedback fuzzy analytical Process as two multi-criteria techniques.

The authors in [8], proposed a hybrid optimization algorithm, in which the optimal clustering and relay selection technique is taken into account. The goal of the model is a unified assessment of network isolation and some minor differences. Also, to calculate the continuity of decision-making by implementing the relay selection technique.

In [9] S. Jang et al., proposed a system for the optimal band and also select a channel by using Q- the learning dynamic, this system takes into consideration the wireless environment to increase transmission time and capacity in time.

In [10], J.Ma et al., the Proposed algorithm of machine learning that uses Tug of War dynamic for IOT communication by using cognitive select the channels.

In [11], R. Saifan et al., proposed a protocol for CRNs called (PDPS) the probabilistic and deterministic path detection Protocol. This protocol increases the probability to find the best path between the destination and the source.

In [12], V. Zuniga et al., propose a system to predict the future occupation bands and permit to adapt dynamically the best channel by changing the specifications of radio frequency and the analog. For doing this, the system uses Long Short-Term Memory networks.

In [13], A. Ali et al., the fuzzy logic system built on the decision support system was proposed in this article by researchers, this system reduces switching between channels, and makes channels more adaptable, by jointly dealing with the selection and switching of channels and common channels of CRN networks. The suggested FLB-DSS method is a strong contender for system units when making informed choices in a CR environment as the results of simulation are encouraging in terms of handoffs number and throughput of data.

SYSTEM MODEL AND PARAMETERS

The proposed cognitive radio approach was designed and developed to enhance channel selection by adding more helpful parameters (attributes) than four parameters rather than depending on one or two parameters only.

The approach consists of several stages; each stage works to improve the approach for providing the best approach to cognitive radio.

In the first stage, the cognitive radio environment is initializing, where the setting of the base stations, primary users, and secondary users are in the simulation area.

In the second stage, the parameters (attributes) are selected (extraction) from channel state information (CSI), this will be done manually and it can be developed into the dynamic in future work.

These parameters represent the characteristics of the input data, and its (parameters) are used to select the best channels through the use of fuzzy logic algorithms and neural network algorithms.

In the third stage, decision-making algorithms are applied based on the inputs, and the output is an evaluation of each available channel, and then choose the best of these channels based on the best output value (highest value).

In the four stages, simulated the cognitive user in a wireless network until the simulation time runs out.

Within the simulation process, the secondary user will continuously sense the surrounding radio channels, exploit the spectral holes if needed, and leave (evacuate the channel) upon sensing the presence of the primary user.

-making.

A. The strategy of Decision-Making for the Proposed Approach

Cognitive radio technology depends on many steps, which start from sensing the surrounding environment, analyzing the sensor data, and then applying the techniques of choosing the appropriate frequency available (free channel) to use in transmission operations.

Figure 3 shows the detailed steps of the proposed strategy for cognitive radio. The strategy shown in Figure (3) can be illustrated by the following **steps**:

1. Initialization step: In this step, the work environment is created where base stations, primary users, and secondary users are created.
 2. The extraction features step: In this step, the characteristics that will be used to make the decision are selected (normally, four characteristics are chosen).
 3. Dataset step: In this step, simulation data or training data for neural network algorithms are generated.
 4. Data Check Step :In this step, when the secondary user needs to find an available radio channel.
 5. Research step: This step includes searching the spectral band for all available channels, and choosing the best one by using one of the decision-making techniques.
 6. Transmission step: This step involves the secondary user modifying their settings to perform the transmission and reception process on the selected radio channel.
 7. Verification step: This step involves the secondary user verifying the presence of the primary user or the secondary user. Complete the data transmission process. In the first case, the secondary user will stop broadcasting and vacate the channel and return to the search step to choose a new channel. In the second case, the user will secondary evacuates the channel and returns to the waiting state.
- B. Parameters of simulation
- **RSSI**: the degree to which a network or access point can reliably pick up a signal from your device. You can use this number to determine whether you have a strong enough signal to establish a wireless connection. The client device's Wi-Fi card provides an RSSI value, thus it should be noted that it is different from the transmitting power from a router or AP (thus, "received" signal strength). The values of RSSI that represent the signal strength indicator in the 4G (LTE) network range between (-65 .. -100).
 - **Distance from BS**: This parameter is used to measure the distance between the secondary user and the communication base station, and this scale plays an important role in measuring the quality of communication. The distance has values ranging from (1..1000 Meters).
 - **Bandwidth**: The capacity at which a network can transfer data is specifically referred to as bandwidth. For instance, if a network's capacity is 40 Mbps, it means that under no circumstances can the network transfer data at a rate greater than 40 Mbps. The values of bandwidth used in this dissertation (3, 5, 10, 15, 20 MHz).
 -
 - **CQI**: A measure of the quality of the network connection, this is for a scale that is composed of 15 codes in a 4G (LTE) network. It has values ranging from (1.15).

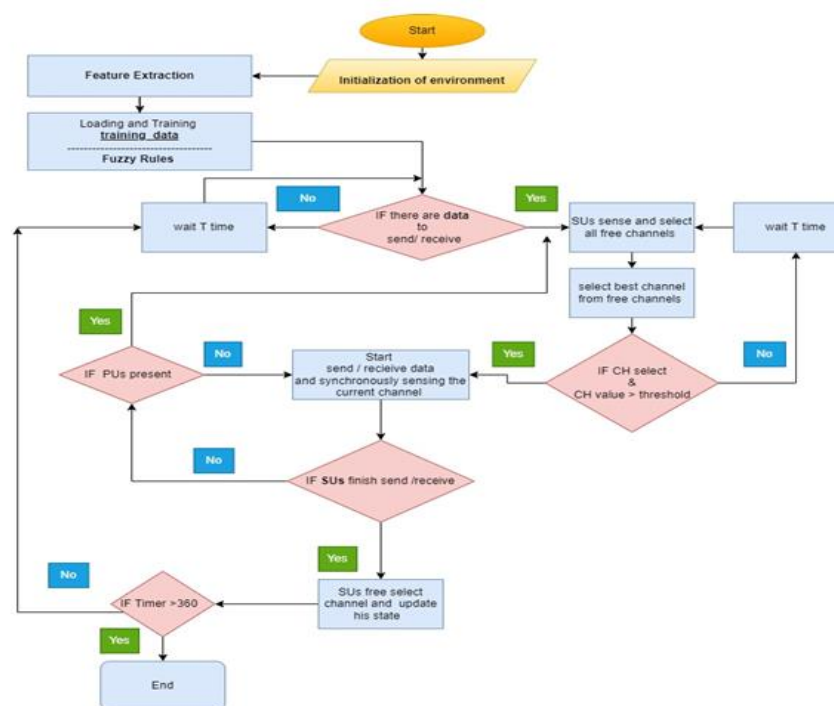


Figure 3: Cognitive Radio Strategy Flowchart Diagram

C. Fuzzy Inference Rules

Fuzzy inference systems use a set of rules that are prepared by experts or prior knowledge, in the proposed system, there is one set of parameters.

Table 1 Represents the ranges of Fuzzy Logic , Table (2) represent the rules of the fuzzy inference system for four parameters, where there are eighty-one fuzzy rules.

TABLE 1: Represents the ranges of Fuzzy Logic for RSSI.

Fuzzy Logic	Range
Low	-100..-90
Moderate	-89..-80
High	-79..-65

TABLE 2: Represents the ranges of Fuzzy Logic for CQI.

Fuzzy Logic	Range
Low	0-5
Moderate	6-10
High	11-15

Table 3: Represents the ranges of Fuzzy Logic for Bandwidth (MHz).

Fuzzy Logic	Range
Low	3 - 5
Moderate	10 - 15
High	18 - 20

Table 4: Represents the ranges of Fuzzy Logic for Distance.

Fuzzy Logic	Range
Low	700-1000
Moderate	400-699
High	0-399

TABLE (partial Table) 5: Represents Dependence of Channel probability on (Signal strength, channel quality, bandwidth and distance)

RSSI	CQI	Bandwidth	Distance	Probability
Low	Low	Low	Low	Low
Low	Low	Low	Moderate	Low
Low	Low	Low	High	Low
Low	Low	Moderate	Low	Low
Low	Low	Moderate	Moderate	Low
Low	Low	Moderate	High	Low
Low	Low	High	Low	Moderate
Low	Low	High	Moderate	Moderate

TABLE (partial Table) 5: Represents Dependence of Channel probability on (Signal strength, channel quality, bandwidth and distance)

D. Training Dataset

The neural network algorithms need a dataset for the training process, this dataset will allow the neural networks to find the best patterns that can be extracted from the dataset under training.

The training dataset was generated through the MATLAB code, where two types of the dataset were randomly generated, the first type is the training dataset with four parameters: RSSI, Distance, Bandwidth, and CQI, and the second type is the training dataset, which consists of four parameters: SNR, RSSI, Idle time, and Bandwidth.

The training dataset was generated in a simulation of 4G LTE networks. 4G LTE Networks was chosen, because it supports cognitive radio networks, and it is also characterized by high speed and the ability to transfer large amounts of data due to its large bandwidth.

The size of the training dataset that is generated consists of 1000 records, and each record represents individual channel state information (CSI) with four parameters that we mentioned above.

The neural network algorithms we use are supervised algorithms. So we need to preprocess the training dataset by finding the target dataset.

The target datasets (probability of selection) are generated by a proposed method, see the description of this method in section (3.6). The training dataset was divided into 70% for training, 15% for testing, and 15% for validation, see Table (3.5) and Table (3.6) represent examples of dataset training.

The output in this process call the probability of selection, this target (the probability of selection) is a percentage consisting of the sum of the different or equal weights of the parameters extracted from the channel state information (CSI), and calculate we will use the following equation:

$$\text{Prob}_{sel} = W_{par1} + W_{par2} + W_{par3} + W_{par4}. \quad (1)$$

The W represents the weight of the parameter.

SIMULATION AND RESULTS

Evaluation Metrics

To evaluate the cognitive network scenarios, several measures are used (throughput of SUs, Handoff, Delay time, and complexity).

Throughput of SU's

Throughput per SUs, it counts the amount of data that transmitter by SU devices that measure by bits per second. Throughput is a metric for the effectiveness of the channel and the volume of data sent to the target location. It provides us with a rough idea of the channel's speed and quality.

To calculate the throughput of the secondary user, we will use the following equation:

$$\text{Throughput}_{SU} = \sum_{ch}^{n_{ch}} F_N(t)_{ch} * (\text{frame size} * Ch_{\text{efficiency}}) \quad (2)$$

Where **frame size** (*bit*) is TTI size in bit multiplied by 10, **Ch_{efficiency}** represents the channel efficiency, which is a percentage, obtained from the parameter (CQI), which is one of the dataset parameters (*If the value of the CQI is higher, then the percentage is better and vice versa*). **ch** is no. of the actual channel, **n_{ch}** sum of channels in the cognitive radio network, **F_N(t)_{ch}** represents a number of the frames for channel **ch** in **t** time (transmission time for an actual channel * the number of frames per second, note: *the number of frames is fixed, 100 frames per second to all channels and in all case of quality, (frame=10 ms)*).

Handoffs

The process that an active call or data session is transferred from one cell in a cellular network to another, or from one channel in a cell to another, which is called a handoff. For a caller or user of a data session to have uninterrupted service, a handoff must be properly executed.

The handoff process in the cognitive radio network will be calculated as The number of times the secondary user

switches from one radio channel to another during the transmission period.

Delay time

The delay time represents the time needed by the secondary user in the process of searching and selecting one of the available channels, as well as the waiting time. The formula for this is:

$$\text{Delay}_{time} = \frac{D_{search} + D_{selecti}}{n} + D_{wait} \quad (3)$$

Where **D_{search}** is the delay in discovering an available channel, **D_{selection}** is the time spent to select one channel from the available channel, and **D_{wait}** is the time spent waiting. **n** is the total number of SU in a network and is used to calculate the average delay.

THE RESULTS AND ANALYSIS

Throughputs of SUs

Table 6 offers information on the numerical comparison between the five different techniques in the environment of simulation with (2, 3, 4, 5) channels and during 360 seconds for every simulation process. The comparison process is done according to the effect of the number of channels and decision-making technique on the network throughput.

Table 6 and figure 4 Notes network throughput with ANFIS technique in the CR network is the best method among others.

By comparing the results from this Table 6, the ANFIS technique is better than other fuzzy inference systems techniques in throughput network metrics. An ANFIS technique achieved 2556 Mbit during 360 seconds in a 1000 M *1000 M area.

Table 6: Comparison of throughput among different techniques

Decision-making Algorithm	membership function	Number of Channels	Throughput of data (Mbps)
Mamdani	GaussMF	2	1679
		3	1752
		4	1825
		5	1898
TSK	GaussMF	2	1704
		3	1856
		4	1956
		5	1932
ANFIS		2	1830
		3	2058
		4	2341
		5	2556

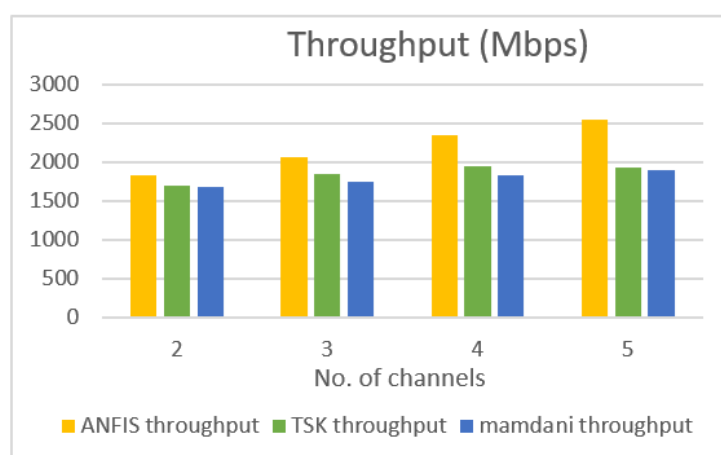


Figure 4: Throughput Metric to Different Techniques

Handoffs

Table 7 offers information on the numerical comparison between the five different techniques in the environment of simulation with (2, 3, 4, 5) channels and during 360 seconds for every simulation process. The comparison process is done according to the effect of the number of channels and decision-making technique on several switching (Handoffs).

Table 7 and figure 5 Note Handoffs with Neural network method (ANFIS) in CR network is the best method among others. By comparing the results from this Table, the ANFIS technique is marginally better than other neural network and fuzzy inference systems techniques in the handoff metric. An ANFIS technique achieved 25 handoffs during 360 seconds and 5 channels.

Table (7): Comparison of Handoffs among different techniques

Decision-making Algorithm	Membership function	Number of Channel	Number of Handoffs
Mamdani	GaussMF	2	41
		3	38
		4	37
		5	36
TSK	GaussMF	2	35
		3	33
		4	32
		5	29
ANFIS	GaussMF	2	33
		3	31
		4	28
		5	25

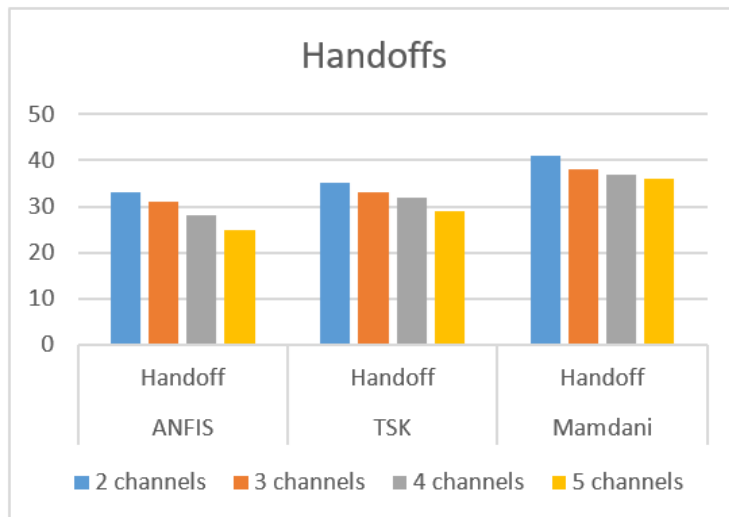


Figure 5: Handoff Metric to Different Techniques

Delay Time

Table 8 offers information on the numerical comparison between the five different techniques in the environment of simulation with (2, 3, 4, 5) channels and during 360 seconds for every simulation process. The comparison process is done according to the effect of the number of channels and decision-making technique on the network delay time.

Table 8 and figure 6 notes network delay time with the ANFIS technique in the CR network is the best method among others. By comparing the results from this Table, the ANFIS technique is better than other neural network and fuzzy inference systems techniques in delay time metric for the network. An ANFIS technique achieved the best delay time.

Table (8): Comparison of delay time among different techniques

Decision-making Algorithm	membership function	Number of Channel	Average of Delay time (sec.)
Mamdani	GaussMF	5	1.79
		4	2.13
		3	2.45
		2	2.56
TSK	GaussMF	5	1.29
		4	1.53
		3	1.76
		2	1.89
ANFIS		5	1.14
		4	1.46
		3	1.57
		2	1.64

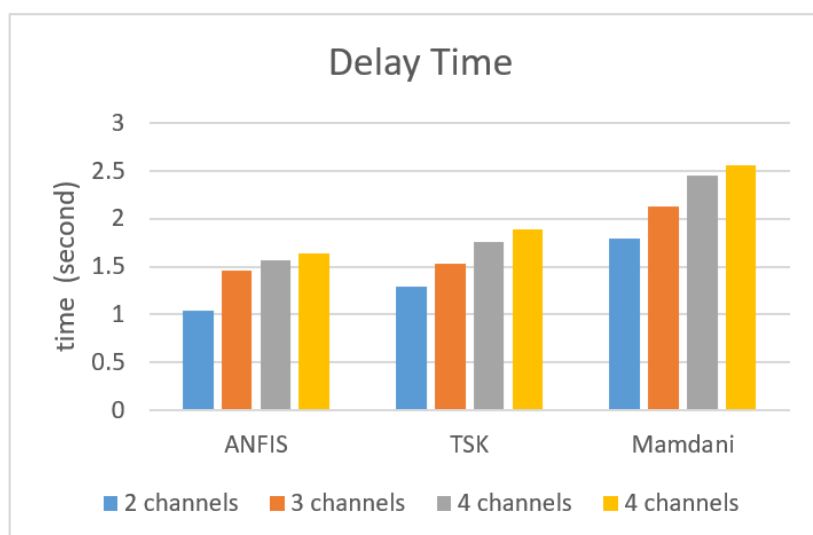


Figure 6: Delay Time to Different Techniques

CONCLUSION

This article proposes to use three algorithms from the fuzzy logic system (Mamdani, TSK) and one algorithm from neural networks (ANFIS) to improve the decision-making process in choosing the best available channels in the radio network. To achieve this, the system was tested by using non-cooperative parameters for secondary users.

After all, simulations were performed, three metrics were used for evaluation, including network throughput of data, handoffs (switching), and delay time. Where a comparison and analysis of the simulation results were carried out, the ANFIS algorithm showed an advantage over the FIS algorithms (TSK, Mamdani).

REFERENCES

- [1] L. Kung, "Channel Selection for Cognitive Radio Terminals," pp. 1–5, 2019.
- [2] L. Giupponi and C. Ibars, "Cooperative Cognitive Systems," *Cogn. Radio Syst.*, 2009, doi: 10.5772/7841.
- [3] W. Wang, "Spectrum Sensing for Cognitive Radio," pp. 10–12, 2009, doi: 10.1109/IITAW.2009.49.
- [4] M. Asifuddola, S. Ram, G. R. Begh, and G. M. Rather, "Vacate on demand algorithm in cognitive radio networks," *2013 IEEE Int. Conf. Signal Process. Comput. Control. ISPCC 2013*, pp. 1–5, 2013, doi: 10.1109/ISPCC.2013.6663430.
- [5] M. Chincoli, P. Den Boef, and A. Liotta, "Cognitive channel selection for Wireless Sensor communications," in *Proceedings of the 2017 IEEE 14th International Conference on Networking, Sensing and Control, ICNSC 2017*, 2017, pp. 795–800, doi: 10.1109/ICNSC.2017.8000192.
- [6] N. The, "Toward Spectrum Sharing : Opportunities and Technical Enablers," no. July, pp. 26–33, 2015.
- [7] D. Giral and C. Hern, "Spectrum Decision-Making in Collaborative Cognitive Radio Networks," 2020.
- [8] Y. Teekaraman, H. Manoharan, A. R. Basha, and A. Manoharan, "Hybrid Optimization Algorithms for Resource Allocation in Heterogeneous Cognitive Radio Networks," *Neural Process. Lett.*, 2020, doi: 10.1007/s11063-020-10255-2.
- [9] S. Jang, C. Han, K. Lee, and S. Yoo, "Reinforcement learning-based dynamic band and channel selection in cognitive radio ad-hoc networks," pp. 1–25, 2019.
- [10] J. Ma, T. Nagatsuma, S. Kim, and M. Hasegawa, "A Machine-Learning-Based Channel Assignment Algorithm for IoT," *2019 Int. Conf. Artif. Intell. Inf. Commun.*, pp. 1–6, 2019.
- [11] R. Saifan, A. M. Msaeed, and K. A. Darabkh, "Probabilistic and deterministic path selection in cognitive radio network," *IET Commun.*, vol. 13, no. 17, pp. 2767–2777, 2019, doi: 10.1049/iet-com.2019.0748.
- [12] V. Zuniga, L. Camunas-Mesa, B. Linares-Barranco, T. Serrano-Gotarredona, and J. M. De La Rosa, "Using neural networks for optimum band selection in cognitive-radio systems," *ICECS 2020 - 27th IEEE Int. Conf. Electron. Circuits Syst. Proc.*, pp. 0–3, 2020, doi: 10.1109/ICECS49266.2020.9294894.
- [13] A. Ali *et al.*, "Hybrid Fuzzy Logic Scheme for Efficient Channel Utilization in Cognitive Radio Networks," *IEEE Access*, vol. 7, pp. 24463–24476, 2019, doi: 10.1109/ACCESS.2019.2900233.
- [14] M. S. Gupta and K. Kumar, "Progression on spectrum sensing for cognitive radio networks: A survey, classification, challenges and future research issues," *J. Netw. Comput. Appl.*, vol. 143, no. January, pp. 47–76, 2019, doi: 10.1016/j.jnca.2019.06.005.



VIII. International Symposium-2024

DESIGN OF NOVEL COAXIAL MAGNETIC GEAR FOR HIGH POWER DENSITY APPLICATIONS

Amberbir Wondimu^{*1}, Yang Chaojun², Guo Yafei³, Abankwa Ebenezer Omari⁴

^{1*} School of Mechanical Engineering, Jiangsu University, Zhenjiang, China,
ambirewondimu@gmail.com

² School of Mechanical Engineering, Jiangsu University, Zhenjiang, China,
yangchaojun@ujs.edu.cn

³ School of Mechanical Engineering, Jiangsu University, Zhenjiang, China,
aguoyafei@163.com

⁴ School of Mechanical Engineering, Jiangsu University, Zhenjiang, China,
5103220313@stmail.ujs.edu.cn

Abstract

It is clear that energy presents a significant challenge for the world in the near future. To overcome energy challenges, it is crucial to develop new energy sources or enhance the performance of existing energy generation devices. Investigation of a new coaxial magnetic gear (CMG) for high-power density applications held promising features to meet the increasing demand for sustainable energy sources. Wind turbines play a crucial role in utilizing wind energy and are highly valued by all countries. The objective of this research was to enhance the power density and torque performance of wind turbines by introducing new modulator and outer rotor designs to the conventional CMG. Analytical and simulation studies were conducted to characterize the torque and magnetic flux density plots of the new CMG. The results showed a significant reduction in volume (2.2%) and weight (1.3%) in the new modulator design, whereas there was a more than 60% reduction in both volume and weight of the outer rotor and permanent magnet, which showed the new CMG design was more economical compared to the conventional design. Furthermore, a significant amount of torque (1.0%) and power density were improved, reducing losses below 5%. The new CMG design ultimately improved the energy generation capacity. These inventions had the potential to revolutionize the field of green energy technology, leading to the development of more sustainable and environmentally friendly energy solutions.

Keywords: Coaxial magnetic gear, power density, sustainable energy, torque, wind turbine.

INTRODUCTION

The transition from fossil fuels to renewable energy sources is gradually seen as a global imperative. The main drivers behind this shift are the negative environmental impacts, particularly climate change

and resource scarcity. Consequently, renewable energy sources such as solar, wind, and wave power are gaining attention on a global scale. In 2020, renewable energy consumption showed a 3% increase, mainly due to the declining demand for traditional fuels. Research studies show that wind and solar energy have a significant contribution to sustainable energy development, making up two-thirds of the overall growth. Since 2021, China has led the global renewable energy expansion, with the United States, the European Union, and India following closely behind (refer to Figure 1). Among various technological advances in renewable energy, wind energy stands out as a cost-effective and efficient option, as illustrated in Figures 1a and b. The gearbox serves as a critical component in the wind turbine drive train, facilitating the conversion of energy by adjusting the speed from the rotor blades to align with the rotational speed necessary for the electric generator, as depicted in Figure 1b. While mechanical gears are widely utilized in wind turbine drive trains due to their relatively lower investment costs, they come with inherent drawbacks including continuous lubrication needs, increased noise levels, bulkier size, and heavier weights, as noted in various sources [1]–[4]. Mechanical gears are also identified as the component with the highest failure rate among all drive train elements. Failures in mechanical gears lead to production interruptions, elevated operational costs, and a reduced lifespan for wind turbine drive trains. As the demand for sustainable energy sources continues to grow, there is a pressing demand for innovative solutions that can substitute current power transfer methods while reducing energy losses, as highlighted in multiple studies [5]–[7]. The development of a novel coaxial magnetic gear for high-power density applications represents a significant breakthrough in wind energy generation, as documented in references [8], [9]. Coaxial magnetic gears offer numerous advantages, including reduced maintenance requirements, enhanced reliability, non-contact transmission, minimal friction, elimination of the need for lubricants, tolerance to misalignment, and decreased noise levels, as supported by various investigations [10]–[12].

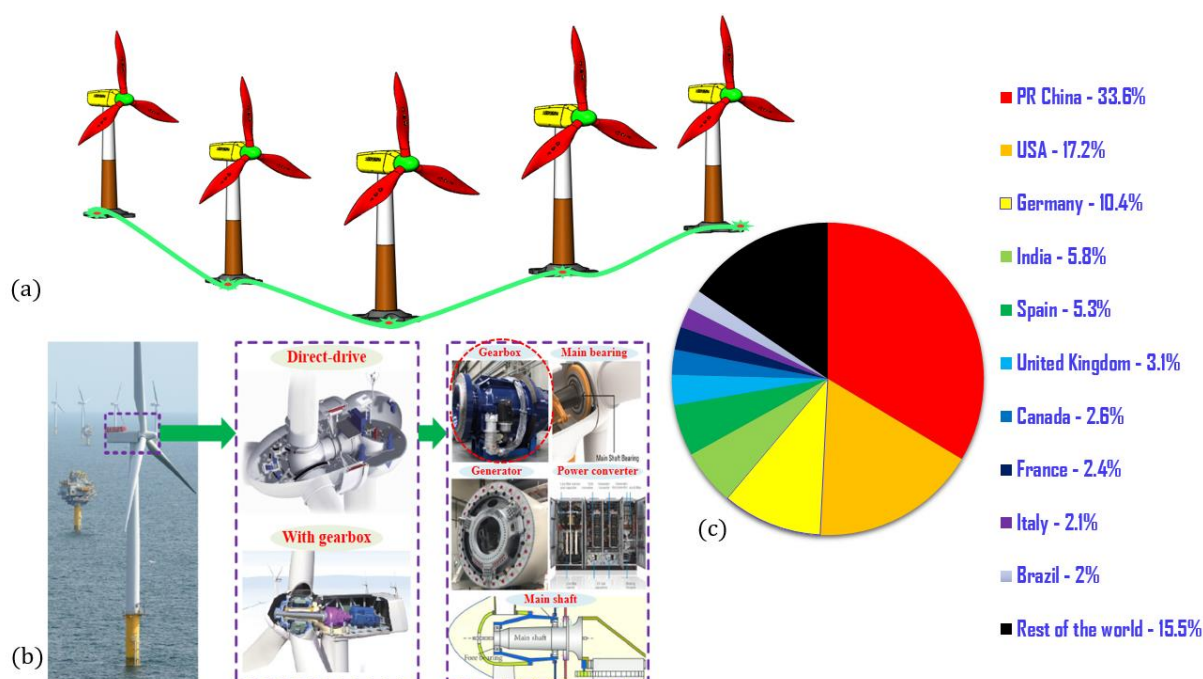


Figure 1: (a) Onshore and (b) Offshore wind turbines [2], (c) Recent global wind power capacity [10]

Several studies were undertaken to investigate various design features of magnetic gear in order to improve its performance. Some essential areas of investigation include permanent magnet materials, structure, installation methods, and modulator ring profiles [12–14]. Studies have demonstrated that rare earth PM materials have better performance than non-rare earth materials. Furthermore, CMG research has focused on the effect of permanent magnet thickness on torque capacity, as well as the effect of the distance between the inner rotor and the surrounding air gap on torque capacity [15].

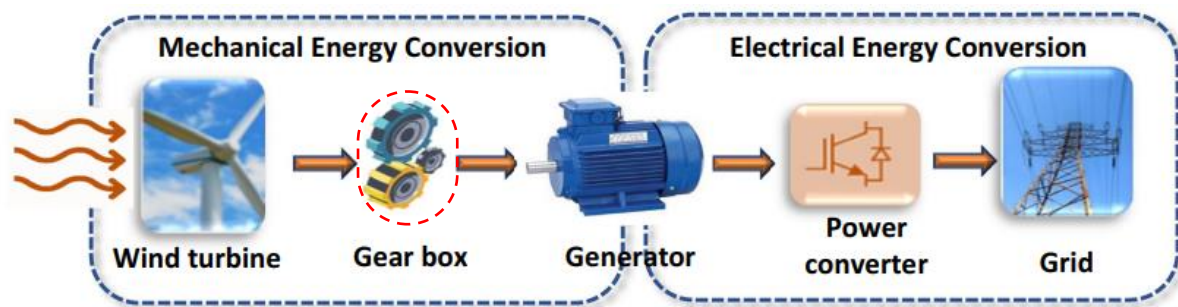


Figure 2: Energy conversion stages in a modern wind energy generation [10].

Figure 2 depicts wind turbine energy conversion levels and how gearboxes transfer input power (low speed and high torque) from a rotor to a generator (high speed and low torque). Moreover, CMGs might be placed in a tight space of nacelles, and their failure requires expensive and time-consuming repairs. The design of a driving train influences not only the performance of the wind turbine but also its service life. Continuous attention must be paid to the progress of enabling technologies and research related to wind turbine energy generation for the wind power sector to remain competitive overall. Therefore, the following design limitations are identified for the existing CMG design of wind turbines: high volume and weight, costly consumption of permanent magnets, and inability to resist harsh environmental conditions such as corrosion.

This research mainly focuses on the numerical and analytical investigation of a new CMG design to enhance wind turbine power density by overcoming the limitations of the conventional design of CMG for more efficient and reliable renewable energy solutions. The paper organized as follows: Section II covers the material and method of the study, which includes part design, working principles, and governing equations for calculating torque and magnetic flux density. Section III, results, and discussion compare the magnetic flux density and torque analysis to the results of the analytic investigation. Lastly, research concludes that the increased torque achieved from the new CMG design fits the high-power density criteria for wind turbine energy generation.

MATERIALS AND METHOD

In this paper, the COMSOL multiphysics version 6.2 computational software tool is used to model and analyze the torque and magnetic flux density of coaxial magnetic gear. The CMG, shown in Figures 3a and b, are made up of an inner rotor, an outer rotor, and a magnetic modulator ring in between the two. The permanent magnet in the inner and outer rotors is made of NdFeB, which is attached to the rotor yoke. The PM is magnetized in the radial direction and magnetically coupled through the magnetic modulator ring. For the new CMG design (Figures 3 b and c), the outer PM and outer rotor are segmented and coated with an electrical steel sheet as an insulating layer, which greatly prevents energy loss.

System Design

The CMG consists of three rings: a high-speed inner rotor ring with a certain number of PMs pole pairs (P_{in}), a low-speed rotor ring with a specific number of PMs pole pairs (P_{out}), and a fixed modulator (N_p) positioned between the two rotors ($P_{in} = 4$, $P_{out} = 17$, $N_p = 21$), which are made based on the design parameters in Table 1. The new CMG has two air-filled regions: the inner air gap between the inner rotor and the magnetic modulation ring, and the outer air gap between the outer rotor and the magnetic modulation ring. The modulation ring plays a crucial role in regulating the magnetic field produced by the PMs on both the inner and outer rotors within the air gaps. Through synchronization, the magnetic fields align to enhance torque transmission. The inclusion of the magnetic modulation ring allows for adjustment of the magnetic fields in the inner and outer air gaps, resulting in the generation of a variety of harmonic components.

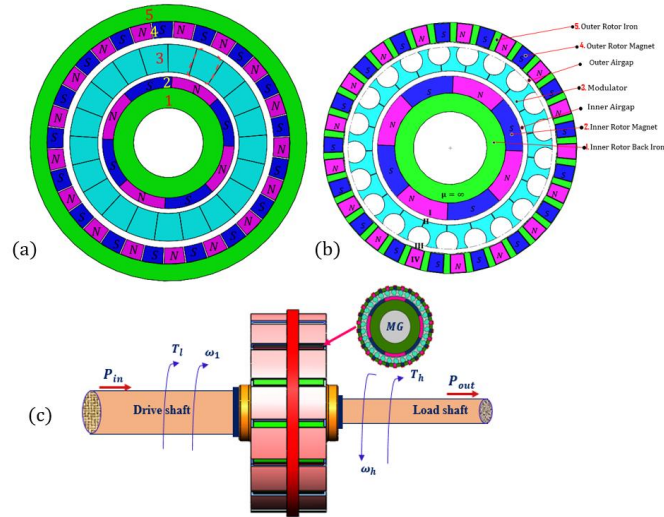


Figure 3: Coaxial magnetic gear models, (a) Conventional, (b) New, and (c) 3D model

Table 1: Design parameters of CMG, OR (outer rotor), IR (inner rotor), Q (modulator)

Design Parameters			
IR inner radius (mm)	15	IR pole pairs	4
IR outer radius (mm)	20	OR poles pairs	17
Inner radius of Q (mm)	49	Q (Number)	21
Outer radius of Q (mm)	64	Axial length (mm)	60
Inner radius of OR (mm)	65	PM thickness (mm)	5
Outer radius of OR (mm)	70	Remanence of PMs (T)	1.2
Air gap inner/outer (mm)	1	PMs material	NdFeB
Density of ferromagnetic steel	7800 kg/m ³	Density of PMs	7500 kg/m ³

The accuracy of the finite element analysis relies on the shape and number of elements used in meshing the CMG structure; see Figures 4 a and b. To minimize errors from mesh inconsistencies between the models, the mesh shapes and numbers of nodes and elements were kept consistent at 172,371 and 217,384.

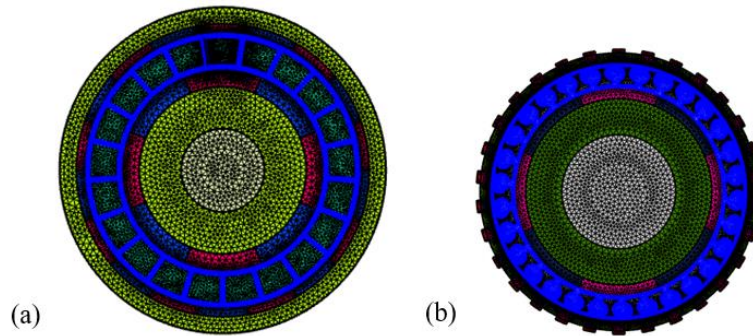


Figure 4: Mesh generation for (a) Existing, and (b) New coaxial magnetic gear model

Operating Principle

In coaxial magnetic gears, the relation between the number of modulators and the number of pole pairs of permanent magnets in the rotors given is as follows:

$$P_i \omega_i + P_o \omega_o = N_p \omega_p \quad (1)$$

where, ω_{in} (rpm) is the speed of inner rotor, ω_{out} (rpm) is the speed of the outer rotor and (rpm) is the speed of the modulator ($\omega_p = 0$).

$$N_p = P_i + P_o \quad (1)$$

P_i and P_o are the pairs of PM poles attached on the inner and outer rotors respectively; N_p is the number of modulators. When the model is running, the modulator remains stationary ($\omega_p = 0$) and the inner and outer rotors rotate in opposite directions, and the gear ratio becomes

$$G_r = -\frac{P_o}{P_i} \quad (2)$$

As shown on Figure 5, the flux density due to the PMs the outer rotor, modulated magnetic flux can be expressed as follows

$$\lambda_o(t, \theta) = A \cos[P_o * (\omega_o t - \theta)] * \cos[nP_o * (\omega_o t - \theta)] \quad (4)$$

In Eq. (1-9), the subscript ‘o’ shows outer rotor and ‘i’ is for inner rotor, λ_o & λ_i the flux density, A & B are the ultimate amplitude of the flux density, P_o & P_i are the number of pole pairs, ω_o & ω_i are the rotational or angular velocity, and θ the angular position with respect to a stationary frame of reference, n is defined as a modulation factor, and α (a constant) is the angle showing the angular separation between the inner and outer rotor magnetic fields at $t = 0$. The quantity n is a real number and not necessarily an integer. Similarly, for the inner rotor, the magnetic flux can be expressed as:

$$\lambda_i(t, \theta) = B \cos[P_i * (\omega_i t - \theta - \alpha)] \quad (5)$$

According to trigonometric formulation, Eq. (4) can be written and simplified as:

$$\lambda_o(t, \theta) = \frac{A}{2} \{ \cos[P_o * (\omega_o t - \theta)] + [nP_o * (\omega_o t - \theta)] + \cos[P_o * (\omega_o t - \theta)] - [nP_o * (\omega_o t - \theta)] \} \quad (6)$$

$$\lambda_o(t, \theta) = \frac{A}{2} [\{\lambda_{o1}(t, \theta)\} + \{\lambda_{o2}(t, \theta)\}] \quad (7)$$

But

$$\begin{aligned} \lambda_{o1}(t, \theta) &= \cos[\{(1+n)P_o * (\omega_o t)\} - \{(1+n)P_o * \theta\}] \\ \lambda_{o2}(t, \theta) &= \cos[\{(1-n)P_o * (\omega_o t)\} - \{(1-n)P_o * \theta\}] \end{aligned} \quad (3)$$

To obtain torque equation, the two magnetic fields $\lambda_{o1}(t, \theta)$ and $\lambda_{o2}(t, \theta)$ need to create interactions and multiplied by $\sin(\alpha)$. Using trigonometric formulation, the resulting torque due the interaction created among two magnetic fields can be given as:

$$\begin{aligned} T &= \frac{A}{2} \{\lambda_{o1}(t, \theta) * \lambda_i(t, \theta)\} \\ &= \frac{AB}{2} \{\cos[(1+n)P_o * (\omega_o t)] - [(1+n)P_o * \theta]\} * \cos[P_i * (\omega_i t - \theta - \alpha)] \} \end{aligned} \quad (4)$$

RESULTS AND DISCUSSION

The working parameters of the coaxial magnetic gear were determined using a finite element and analytical method. COMSOL Multiphysics 2D was utilized for rotating electromagnetic machinery to ascertain the magnetic flux density and torque characteristics under transient conditions of the inner rotor, modulator, and outer rotor. Figure 5 (a and b) depicted the finite element results of the magnetic flux density plot for both conventional and novel CMG, respectively. This novel design of the CMG allowed for a reduction in the thickness of the outer yoke and reduced the continuous consumption of permanent magnets, resulting in a smaller volume of CMG. Additionally, the electrical steel lamination of the outer rotor enabled it to function effectively in harsh environmental conditions, such as corrosive

environments. Given that most wind turbines have been offshore recently, this feature was advantageous in preventing the impact of corrosion on the proper function of CMG.

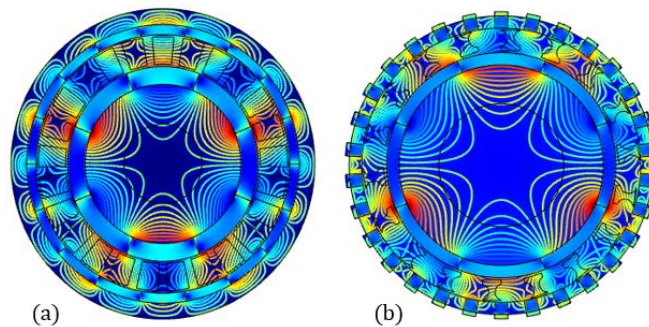
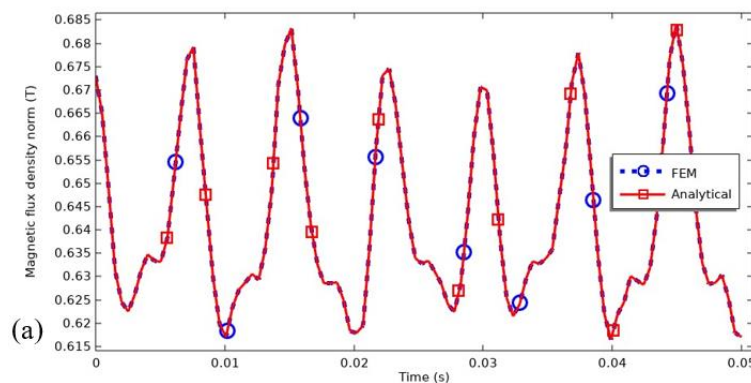


Figure 5: Magnetic flux contour plot for (a) Existing CMG, and (b) New CMG model

Figure 6 (a-c) demonstrated the magnetic flux density on the transient bases of the inner rotor, modulator, and outer rotor, respectively. The result comparison plot for both analytical and FEM showed a 2% deviation, confirming that the findings were consistent. Figures 6(a and c) showed that the inner and outer rotors of a coaxial magnetic gear were designed to have strong magnetic fields that interacted with each other to transmit torque without physical contact. This high flux density in the rotors allowed for efficient power transmission and torque generation. On the other hand, the modulator in the CMG served to control the interaction between the inner and outer rotors, adjusting the gear ratio and torque transfer capabilities. Figure 6b depicted that the magnetic flux density in the modulator was usually lower compared to the rotors, as its primary function was to modulate the magnetic field rather than directly transmit power. Overall, the distribution of magnetic flux density in the inner and outer rotors compared to the modulator was a key design consideration in optimizing the performance and efficiency of CMG.



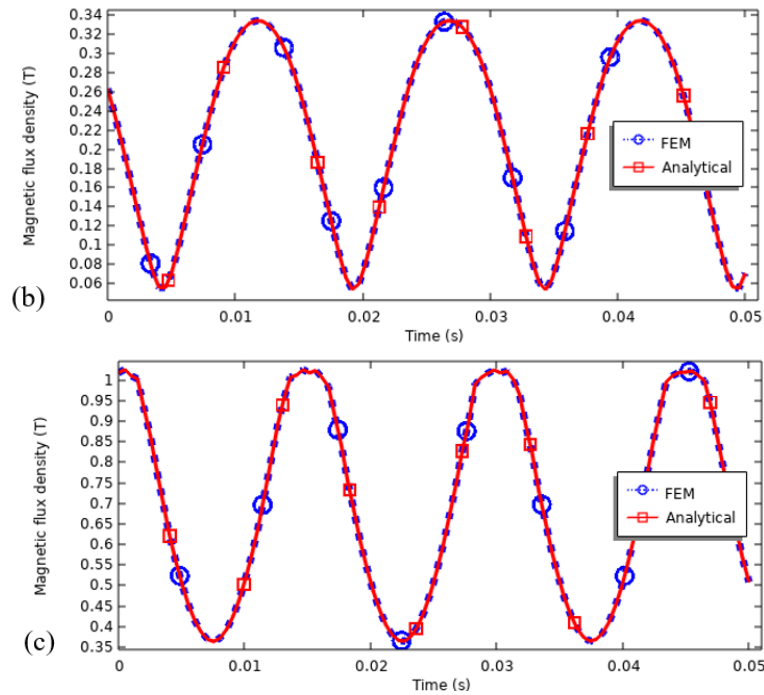


Figure 6: Magnetic flux density plot of (a) Inner rotor (b) Modulator, and (c) Outer rotor

Figure 7 (a and b) demonstrated the electromagnetic torque on the transient bases of the inner rotor and the outer rotor, respectively. Notably, the peak values of the torques for both the inner and outer rotors showed significant improvements of 1.5% and 1.4%, respectively, as compared to the existing model. This improvement was due to the new design of the modulator, outer rotor PM segmentation, and electrical steel lamination of the outer rotor.

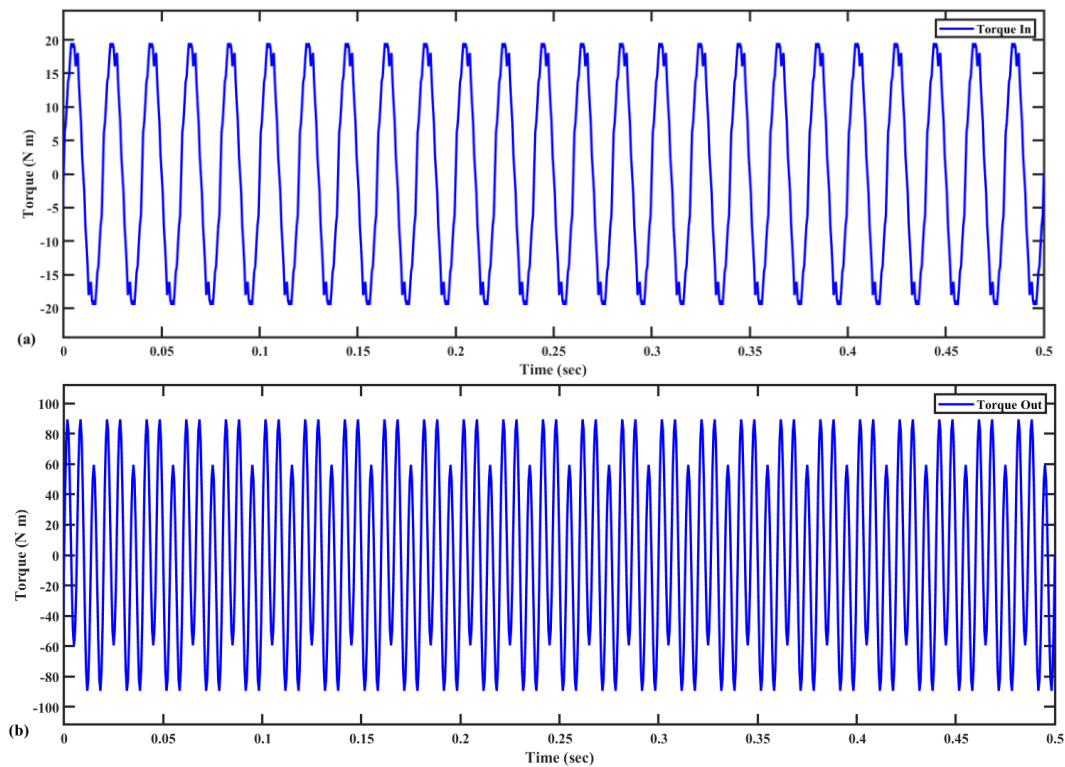


Figure 7: Transient electromagnetic torque plot of (a) Inner and (b) Outer rotor

Furthermore, the comparison between the conventional and new coaxial magnetic gear in a wind turbine drive showed that the newer design had a significant effect on reducing the volume and weight of the modulator, whereas it had a huge impact on the outer rotor permanent magnets and outer rotor of the CMG. This implied that even in terms of cost reduction, this much weight and volume had a great impact on the related costs of materials, particularly costly magnetic materials. In general, this novel CMG design had a significant contribution to reducing the overall weight of the magnetic gear by 5.7% and the total volume by 4.2% compared to the existing model in wind energy, as shown in Table 2.

Table 2: Comparison of the two models of coaxial magnetic gears

Components	Parameters	Conventional Model	New -Model	Change (%)
1	Inner rotor			
	Mass(Kg)	20.046	20.046	-
	Volume (m ³)	2.570*10 ⁻³	2.570*10 ⁻³	-
2	Inner rotor			
	Weight(N)	196.450	196.450	-
	PM			
3	Modulator			
	Mass(Kg)	0.775	0.775	-
	Volume (m ³)	1.020*10 ⁻⁴	1.020*10 ⁻⁴	-
4	Ring			
	Weight(N)	7.605	7.605	-
	Mass(Kg)	6.799	6.675	1.841
5	Outer rotor			
	Volume (m ³)	8.902*10 ⁻⁴	8.707*10 ⁻⁴	2.210
	Weight(N)	67.679	66.750	1.382
6	PM			
	Mass(Kg)	0.965	0.483	66.574
	Volume (m ³)	1.272*10 ⁻⁴	6.36*10 ⁻⁵	67
7	Outer rotor			
	Weight(N)	9.650	4.826	66.648
	Mass(Kg)	1.065	0.495	73.077
8	Outer rotor			
	Volume (m ³)	1.367*10 ⁻⁴	6.36*10 ⁻⁵	72.990
	Weight(N)	10.654	4.953	73.057
Total volume (m ³)		3.826*10 ⁻³	3.669*10 ⁻³	4.189
Total weight (N)		292.038	275.758	5.734
Torque (N m)		77.9	79.5	1.0
Power density (kW)		26.3	27.9	3.006

CONCLUSION AND RECOMMENDATIONS

In conclusion, the design of a new CMG for high-power density applications shows great potential in terms of improving power density and performance in wind energy applications. The innovative approach of utilizing coaxial magnetic gear offers a compact and efficient solution for transmitting power with minimal losses. Using both analytical and finite element analysis, it is demonstrated that the new CMG design can significantly enhance maximum torque by 1.00% and power density by 3.006%.

Based on the findings of this new design, it is recommended to further optimize the design parameters of the coaxial magnetic gear to maximize its performance in high-power density applications. Additionally, conducting more extensive experimental validation and service life testing helps validate the reliability and longevity of the new coaxial magnetic gear drive. Collaborating with industry partners to implement this technology in real-world applications also provides valuable insights for further improvements and commercialization. Lastly, the findings of this research have the potential to revolutionize the field of green energy technology, paving the way for more sustainable and environmentally friendly energy solutions.

REFERENCES

- [1] Qingkai Han; Jing Wei; Qingpeng Han; Hao Zhang, "Dynamics and vibration analyses of gearbox in wind turbine," Springer, <https://doi.org/10.1007/978-981-10-2747-5>, 2017.

- [2] Amir R. Nejad; et al, "Wind turbine drivetrains state-of-the-art technologies and future development trends," Wind energy science, <https://doi.org/10.5194/wes-2021-63> , 2021.
- [3] Xiao-Peng Ji; Zhao Liu; Weiwei Liu; Xinyu Zhang "Collaborative control of integrated generation and storage for offshore wind turbines," IEEE innovative smart grid technologies Asia (ISGT Asia), Chengdu, China, DOI: [10.1109/ISGT-Asia.2019.8881353](https://doi.org/10.1109/ISGT-Asia.2019.8881353), 2019.
- [4] Zhengming Xiao; Yanli Cheng; Zaiyu Xiang; Xin Wang "Dynamic simulation and scale model experimental analysis of planetary gears train of semi-direct drive wind turbine," IEEE International conference on information and automation, DOI: [10.1109/ICInfA.2015.7279621](https://doi.org/10.1109/ICInfA.2015.7279621), 2015.
- [5] Meiyang Lou; Ligang Yao, "Mathematic modelling and numerical analysis for a novel inner-type nutation magnetic drive," Energies, vol. 13, pp. 1-14, DOI: <https://doi.org/10.3390/en13061346>, 2020.
- [6] Zheng-Ming Xiao; Li-Rong Huan, "Dynamic analysis of planetary gears with gear crack of semi-direct drive wind turbine," Sapporo, Japan., DOI: [10.1109/ICASI.2017.7988388](https://doi.org/10.1109/ICASI.2017.7988388), 2017.
- [7] Ruiz-Ponce, G.; Arjona, M.; Hernandez, C.; Escarela-Perez, "A Review of magnetic gear technologies used in mechanical power transmission," Energies, vol. 16, pp. 1721, <https://doi.org/10.3390/en16041721>, 2023.
- [8] Xiaocun Huang; Yuxiu Guo; and Libing Jing, "Comparative analysis of electromagnetic performance of magnetic gear," Progress in electromagnetics research letters, vol. 97, pp. 69-76, [doi:10.2528/PIERL21031501](https://doi.org/10.2528/PIERL21031501), 2021.
- [9] L.Jiang; et al, "Analysis of wind turbine gearbox's environmental impact considering its reliability," Journal of cleaner production, vol. 180, pp. 846–857, <https://doi.org/10.1016/j.jclepro.2018.01.078>, 2019.
- [10] Desalegn B; Gebeyehu D; Tamrat B and Tadiwose T, "Wind energy-harvesting technologies and recent research progresses in wind farm control models," Frontiers in energy Research, <https://doi.org/10.3389/fenrg.2023.1124203>, 2023.
- [11] Eui-Jong Park ; Sang-Yong Jung; Yong-Jae Kim, "Structure and electromagnetic characteristics of pole-piece support materials in magnetic gear," IEEE transactions on applied superconductivity, vol. 30(4), pp. 1-4, <https://doi.org/10.1109/TASC.2019.2963297>, 2019.
- [12] Jeong-In Lee; Kyung-Hun Shin, "Design and analysis of the coaxial magnetic gear considering the electromagnetic performance and mechanical stress," IEEE transactions on applied superconductivity, vol. 30(4), pp. 1-5, DOI: [10.1109/TASC.2020.2968267](https://doi.org/10.1109/TASC.2020.2968267) , 2020.
- [13] Mu Chen; K. T. Chau; Wenlong Li; Chunhua Liu, "Cost-effectiveness comparison of coaxial magnetic gears with different magnet materials," IEEE transactions on magnetics, vol. 50(2), pp. 821–824, DOI: [10.1109/TMAG.2013.2281988](https://doi.org/10.1109/TMAG.2013.2281988), 2014.
- [14] Xiaoxu Zhang. et al, "Analysis and design optimization of a coaxial surface-mounted permanent-magnet magnetic gear," Energies, vol. 7(12), pp. 8535–8553, DOI: [10.3390/en7128535](https://doi.org/10.3390/en7128535), 2014.
- [15] Ahmet Cansiz; Emre Akyerden, "The use of high temperature superconductor bulk in a co-axial magnetic gear," Cryogenics, vol.98, pp. 80-86, <https://doi.org/10.1016/j.cryogenics.2019.01.008>, 2019.



VIII. International Symposium-2024

ENERGY CRISIS IN SOUTH AFRICA: ASSESSMENT OF THE EFFECT OF LOAD SHEDDING ON THE LOGISTICS CONTEXT.

Mathapelo Kgolomela MOTIMELE

Department of Logistics and Forwarding, Széchenyi Istvan University, Győr, Hungary, Mathapelo Kgolomela Motimele, kgolo.motimele@gmail.com

Abstract

This research aims to investigate the energy crisis and its impacts on logistics in South Africa. With its severity having increased since it first began in 2007, the year 2023 has been recorded as being the worst year ever with up to 10 hours of blackouts per day, the logistics operations will inevitably be affected. A study is done over three main key areas that can offer a better understanding of the issue at hand, the history of the energy crisis, the economic impacts of logistics operations in South Africa, and the current load shedding status and its impacts. Through an extensive literature review, an understanding of the above-mentioned topics can be had. The research employed a mixed methods approach through the usage of both primary and secondary data. An in-depth literature review from African journals will give insight into the Energy crisis as well as possible alternatives that have been introduced to cater to the energy needs of South Africans. To explore the extent to which the damage has been done a survey is design ned and will target drivers from Coca-Cola Beverage South Africa Pretoria (CCBSA) Pretoria, South Africa. The widespread availability of social media will also be taken advantage of by posting the survey on several “truck drivers in South Africa” pages to cover a wide range of participants. This paper contributes to the ongoing discourse around Load shedding and how it is changing as well as challenging the South African Landscape as we know it.

Keywords: Energy, Eskom, “Load Shedding”, Logistics, “South Africa”, Traffic

INTRODUCTION

South Africa has been experiencing an energy crisis for over 16 years due to its inability to meet its growing electrical consumption. In 1998, the minister of Energy and minerals released an energy white paper stating (Whitepaper FuE-Themen, 2015) that 30% of the country's electricity generation could potentially come from other producers, but no legislation was passed (Akpeji et al., 2020). The energy sector significantly impacts the sustainability of economies, generating jobs, resource efficiency, and protecting the environment (Ndlovu & Inglesi-Lotz, 2020). The industrial sector, the primary source of economic growth for South Africa's GDP (Ateba et al., 2019)., is directly linked to a decline in power sustainability. The root cause of the energy crisis is complex, including historical, technological, and economic factors. Eskom (1998), South Africa's largest electricity supplier, has been experiencing

frequent breakdowns in older generation plants due to inadequate maintenance and operations. The construction of Medupi and Kusile power stations in 2008 and 2017 synchronized to the national grid has brought hope for a resolution, but the new generators are less dependable due to poor construction. The following questions arose while conducting research:

- How has the current energy crisis impacted the contribution made by the logistics industry to South Africa's GDP?
- What are the outcomes of Load shedding that impact the logistics industry?

This paper reviews relevant literature on the economic contributions of the logistics industry in South Africa using databases like Scopus, Google Scholar, and Sabinet. The focus is on three areas: economic contributions, logistics, and South Africa. The research uses VosViewer software to map the relationships between recurring keywords.

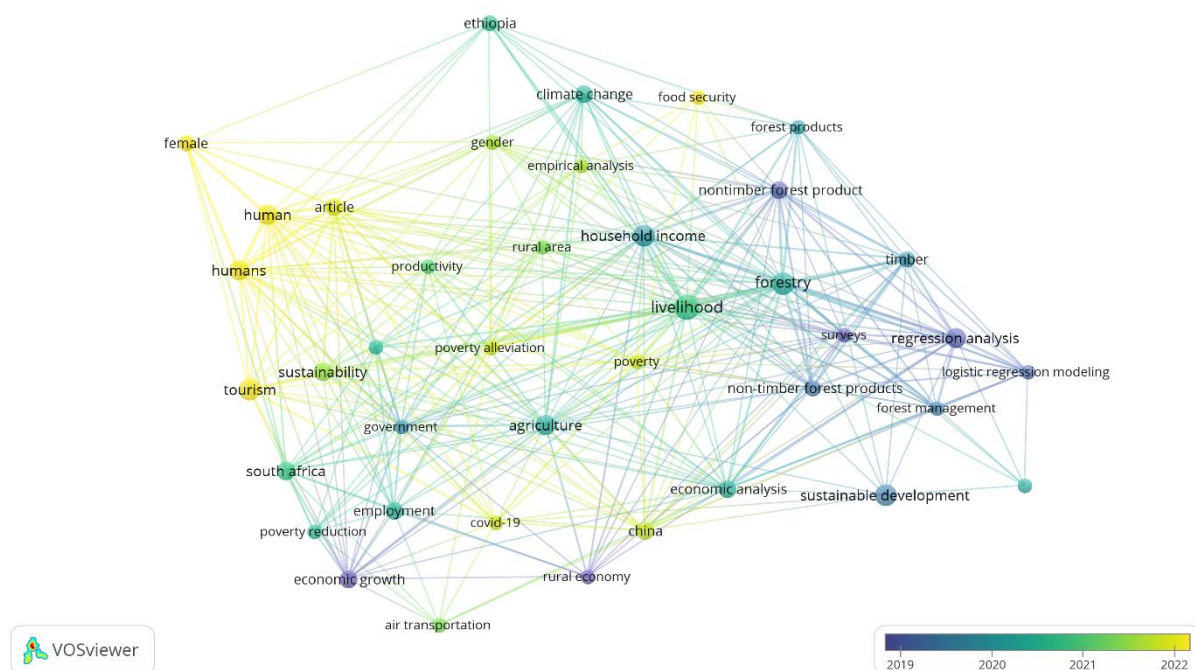


Figure 1. Overlay Visualization by VOSViewer from the research results of Scopus on the 22nd of March 2024. Keywords: “economic contributions” AND logistics AND “South Africa”

It was narrowed down the Scopus database for the Keywords: “economic contributions” AND logistics AND “South Africa”, I got 119 publications, which I visualized in Figure 1. As you can see in the figure, in 2019 "Sustainable development" was still emphasized, in 2020-21 "Climate Change" and "Sustainability" appeared, and in 2022 it was already "Human" and "Food Security". In other words, this is shown by the fact that researchers examine the economic contribution from the perspective of people.

The paper aims to provide a comprehensive understanding of the logistics industry's economic contributions in South Africa (Peixoto et al. 2008). South Africa's logistics industry contributed 5% of the country's GDP and 2.5% of employment in 2016. Road freight is the largest subsector, accounting for over 70% of land freight revenue and payload (Havenga, 2010). Over 90% of land transport revenue is generated by road freight, with passenger travel accounting for the remaining 3% (Havenga, 2010). Road freight is preferred over rail freight in South Africa due to reliability, cost, accessibility, long run times, and under-capacity. The country's energy crisis has been a topic of interest for over three thousand articles, books, and journals from 2020-2023.

Energy blackouts have been a reality in African countries since 2008, with South Africa's Department of Minerals and Energy predicting that by 2007, electricity demand would exceed supply if no more power was added to the national grid. Despite this, the government refused to allow Eskom (Flash, 2023)

to start construction of new power stations, leading to the first units of Medupi and Kusile being synchronized to the national grid in 2015, with energy demand outweighing their output. The last power plant was constructed in 1983 (Akpeji et al., 2020).

Load shedding is a strategy used to prevent systemic power outages or collapse of the power system due to supply-demand chain instability (Folly, 2021). It aims to reduce demand and free up more capacity by reducing power usage from primary sources or providing a backup power supply. Electricity supply interruptions can be sporadic or chronic, with sporadic interruptions occurring in the Global North and chronic interruptions in underdeveloped nations with less reliable infrastructure. Factors contributing to load shedding include a large gap between power supply and demand, power stations with inadequate generation capacity, unreliable main sources of energy, equipment malfunctions, restrictions, and outdated or inadequate infrastructure. The study was primarily sourced from the Sabinet database, an African journal site.

MATERIALS AND METHODS

For this paper, both primary and secondary data were gathered. Primary data was gathered by the author through a survey that was designed and shared with the targeted audience online and at the Coca-Cola South Africa Pretoria plant. Secondary data was collected using a department report, and various literature sources from the literature review.

A questionnaire can be categorized as a quantitative or qualitative method depending on the questions it asks; it is used in this research to collect additional information from freight drivers. Questions having multiple-choice answer choices that are closed-ended, or constrained, are evaluated using quantitative methods. The study findings in this case can be displayed using percentages, bar charts, pie charts, and tables.

The following benefits come from using questionnaires as the main technique of data collection:

1. Standardization: The same questions are posed to each respondent
2. The potential to get the primary data more quickly.
3. Online questionnaires could be used to contact people who live far away.
4. The researcher's bias should be as little as possible during the data collection process.
5. Economic viability.
6. Generally, respondents have more time than during interviews to consider their answers before responding.

The initial approach to gathering data for this paper was to post a questionnaire in multiple South African logistics-related groups on Facebook. The target was truck drivers in South Africa as well as personnel involved in Logistics who use such platforms to share information.

To get access to such groups, access must be granted by the group administrators. To safeguard against misuse of the group and irrelevant content that could potentially be posted in the group, a few questions have been answered by anyone seeking to become a member of the group. The objective of this is to establish the purpose of seeking membership and whether it aligns with group rules.

Table 1: Facebook groups used for Questionnaire (9th of October 2023)

Group Name	Number of Members	Average posts per day
Logistics in South Africa	67.3k	10+
Transport and Logistics South Africa	34k	2+
Trucking contracts and logistics, South Africa	42k	10+
Imperial Logistics Trucks	24k	10+

Although the above groups have a high number of members, the questionnaire’s success rate was zero as no feedback was received. Potential reasons for the failure included the target audience, visibility, length, user interface, and lack of incentive. The questionnaire was over three pages long, which could be discouraging for some, and the external link was not user-friendly. The lack of an incentive may have discouraged participation. After not receiving feedback from the Facebook groups, Coca-Cola South Africa Pretoria (CCBSA) approached the company to share the questionnaire with their truck drivers. The company agreed to share the results with their truck workers, but the link had to be shared with the company's IT department to prevent potential cyber-attacks or phishing attempts.

The designed questionnaire seeks to understand how frequently the workers experience load shedding whilst on duty and what challenges they face as a result. “In South Africa, more investment and jobs are created when goods are transported to markets efficiently. The pricing, availability, and timing of the items we purchase are all impacted by the efficiency of freight transportation (Sós et al. 2023). Lower goods costs and more availability are anticipated because of improved freight efficiency.” (Western Cape Government For you, 2023). The current results of the questionnaire will be shared in this paper however it is important to note they are primary as the questionnaire is still live and ongoing. Results from research conducted previously will also be shared to give a better understanding of the impacts load shedding has had on logistics. Focus will be given to businesses in Johannesburg as the city is known as Africa’s economic hub. The other focus will be on Durban, which is where South Africa’s busiest port is located.

STATISTICAL ANALYSIS AND GRAPHICAL PRESENTATION

The Port Operations

In April 2023, Eskom announced that most of the country would be returning to Load shedding stage six and the absence of power harmed the Durban port operations.

Table 2: April Forecasted Durban Container Port weekly flow. Source: (Transnet, 2023)

Weekly Forecasted Container flow in April without load shedding		
	No. Containers to import	No. containers to export
Terminal tier 1	5,204	5,483
Terminal tier 2	12,546	14,966
Total	17,748	20,499

The table above shows the projected averages of the Durban port during April with the eThekweni municipality under stage 2 load shedding. Due to the flooding that had happened in the area a few months prior, Eskom had not enforced higher stages of load shedding. The projections were based on the demonstrated capacity of the port and the berthing vessel schedules, and they show that with the availability of power, port operations run more productively. These projections are also within the boundaries of the 2010s targets which were met.

Table 3: April Actual Durban Container Port weekly flow. Source: (Transnet, 2023)

Weekly Forecasted Container flow in April with load shedding		
	No. Containers to import	No. containers to export
Terminal pier 1	2,999	4,977
Terminal pier 2	7,247	12,564
Total	10,246	17,541

Upon the reintroduction of load shedding stage 6 in eThekweni municipality, the container port flow at the Durban port saw a drop of 26% for import and 7% for export container flow. The port throughput efficiency drop signifies the cargo ships experiencing major delays due to the persistent issue of port congestion; offloading periods were extended by up to three weeks or more. As a result, leading shipping

companies have implemented additional fees known as "congestion surcharges" (Khumalo, 2023) because of the circumstances. The shipping companies are imposing additional fees, almost R8,000(€390) per container, claiming that the delays in South Africa are the reason for the interruptions to their international schedules.

RESULTS AND DISCUSSION

In 2016, a study in the City of Johannesburg (CoJ) focused on local power disruptions, analyzing data on planned and unplanned power outages announced on social media by City Power, the city's electricity supplier. The study found 300 recorded power outages in 174 locations during March and April, with most concentrated in the western and northwest regions. On average, eleven outages were reported daily, with at least twenty districts losing power on specific days. Some outages took over 72 hours to fix, impacting smaller businesses, particularly those dealing with spoilage products. City Power confirmed two medium voltage failures per week and five low voltage issues per day (Schoeman, 2018). The study found that 44.4% of businesses reported no discernible difference in customer numbers during power outages compared to an average day, while 38.9% reported fewer customers during such outages. Many businesses used private backup systems. Shopping centers in Trinity Village, Bryan Park, and Douglasdale Village experienced heavy traffic congestion due to power outages, resulting in a decline in patronage (Schoeman, 2018).

Power outages led to a 16.7% increase in customers for restaurants, with at least 30% more patrons frequenting three establishments than usual. This shift in clientele affected revenue levels. Additionally, equipment damage from power outages and power surges negatively affected enterprises, with 37% of companies experiencing damage. 14 out of 20 companies sustained at least R5,000 worth of damage, while some businesses, like a photography shop, suffered R50,000 in damages. Out of the 100 participants with whom the survey was shared through Coca-Cola South Africa, 44 have responded. This section will outline the responses received and analyze what they represent about this paper’s topic. The location of the plant where this questionnaire was posted is in Pretoria, so it is not surprising that most of them responded with it being a place they have traveled to for work. Although the Gauteng-Durban corridor is one of the busiest in the country, it is not surprising that only 1% of the respondents have traveled there for work as there is another CCBSA in Durban.

Provinces worked, 44 responses.

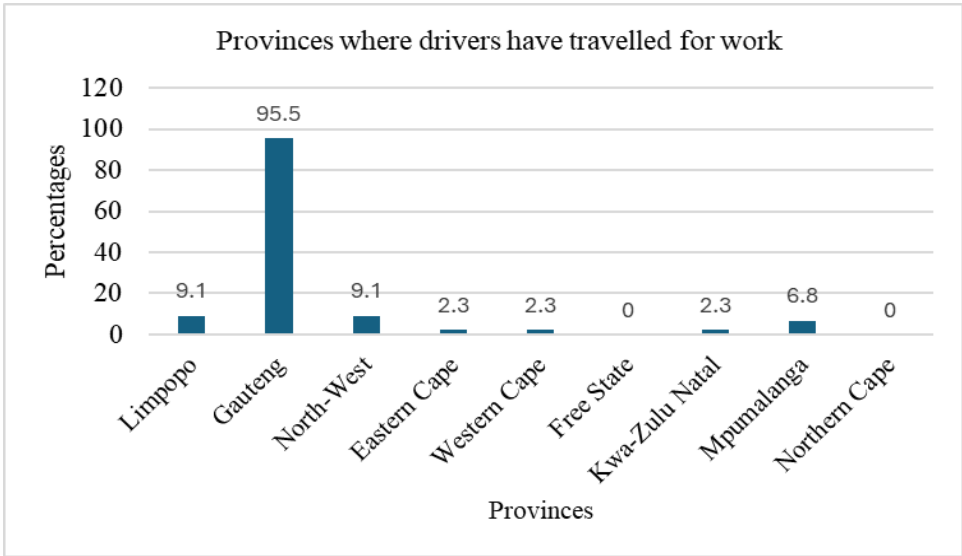


Figure 2: Survey on Challenges faced by Drivers and Operators due to Load shedding (Own editing).

Figure 2 shows 95.5% of the respondent's work required them to travel around the Gauteng province. This number refers only to the workers at the Midrand plant where this survey was posted. The percentages for Free State and Northern Cape are 0% as the company has facilities in these provinces as well.

Load shedding experience whilst driving, 44 responders.

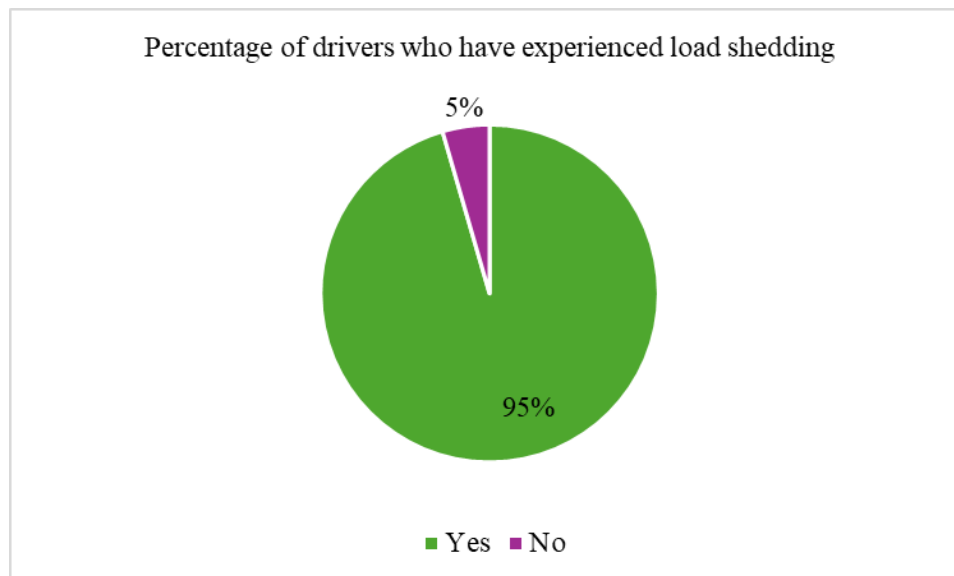


Figure 3: Survey on Challenges faced by Drivers and Operators due to Load shedding (Own editing).

A total of 42 respondents have confirmed experiencing Load shedding whilst driving. This means within the Johannesburg area where these freight drivers were required to make deliveries, the area was under load shedding. Only 4.5% of the Coca-Cola drivers have not experienced load shedding whilst on duty. This is not to say the same can be said for their experience outside working hours.

Stages of load shedding experienced whilst driving, 44 responders

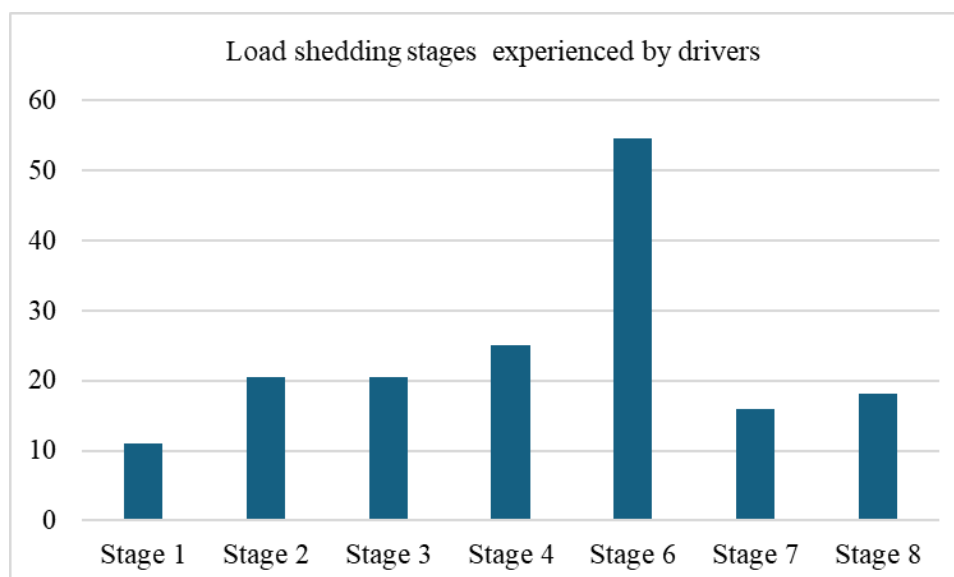


Figure 4: Survey on Challenges faced by Drivers and Operators due to Load shedding (Own editing).

Figure 4 identifies stage 6 as loss of power over 36 hours/ 96 hours. The longest bout of uninterrupted load shedding began on September 8, 2022, is at more than 441 hours and counting, including record high levels of Stage 6 load shedding (Montsho, 2022) and this has been experienced by 54.5% of drivers as shown.

Impacts of load shedding on drivers, 44 responders

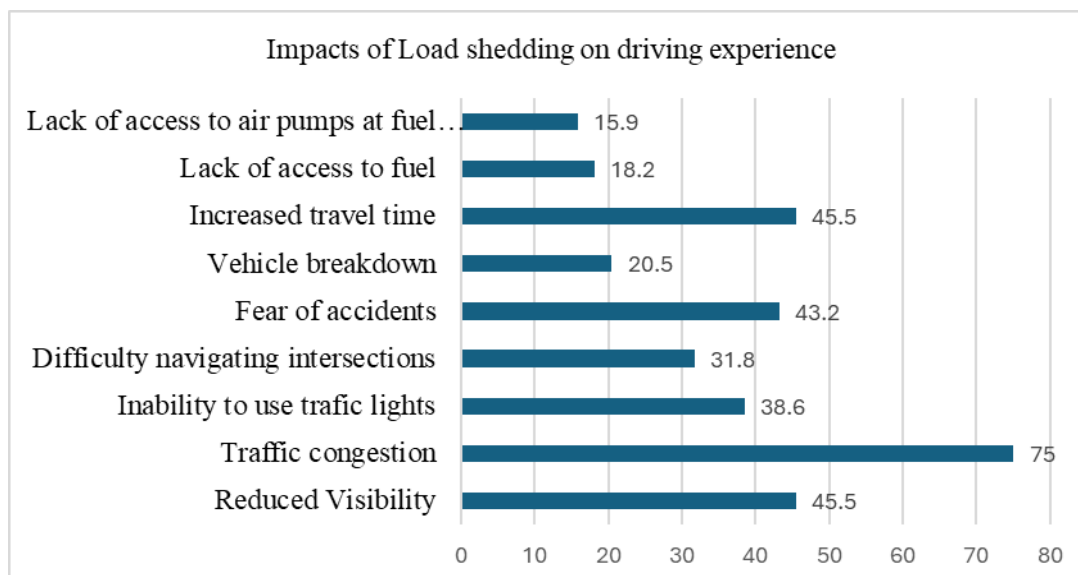


Figure 4: Survey on Challenges faced by Drivers and Operators due to Load shedding (Own editing).

The biggest consequence of load shedding for most drivers, 75% experienced traffic congestion. This is not surprising as the unavailability of traffic lights which are connected to the national grid in South Africa led to slower and more chaotic movement of cars. If the workers are driving at night, it may be harder to see as reported by 45.5% of the responders because the streetlights will be off. Both traffic congestion and lack of visibility have the ripple effect of increasing the time drivers spend on the road, which appears to be the case for 45.5%.

Average working schedule affected by load shedding, 44 responders.

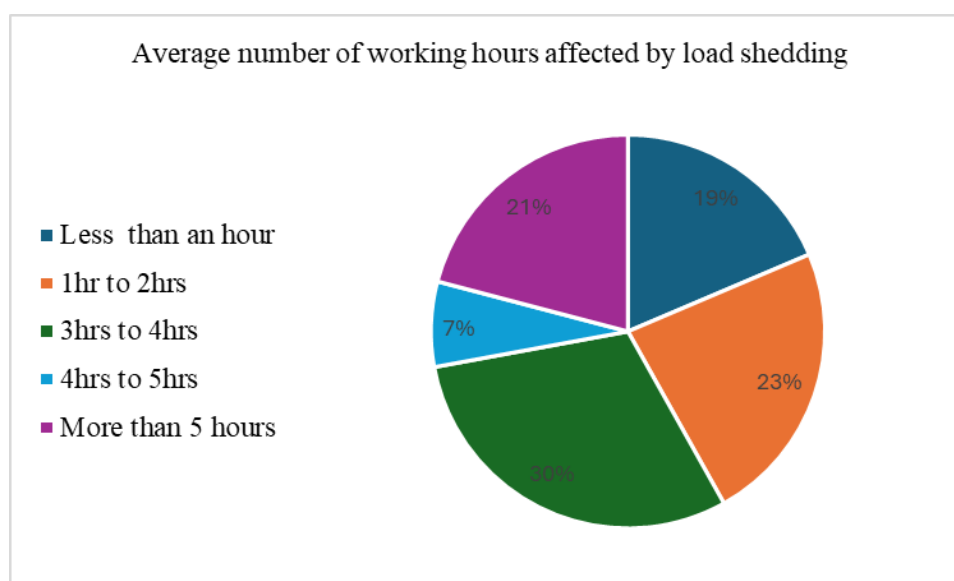


Figure 5: Survey on Challenges faced by Drivers and Operators due to Load shedding (Own editing).

Figure 5 shows that all respondents have had their working schedules affected by load shedding by a few hours. The highest percentage of 30.2% interruptions of 4 to 5 hours. This is equivalent to 66% to 83% of Stage 1 hours. Whilst the 6 hours of stage 1 load shedding would be distributed over 4 days, for drivers these interruptions are experienced in one go. About 20.9% of drivers have had their schedules interrupted by 5 hours. South Africa has endorsed a driving time of 15 hours for truck drivers in 24 hours. A delay of 5 hours or more would cause inconveniences to the drivers’ delivery time.

Inconveniences due to load shedding, 44 responders

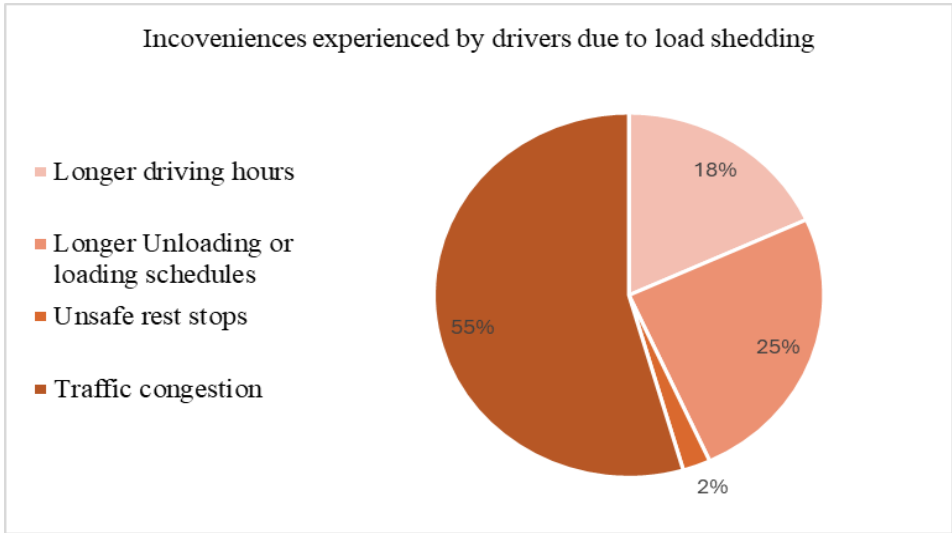


Figure 6: Survey on Challenges faced by Drivers and Operators due to Load shedding (Own editing).

Freight drivers are not immune to the inconvenience brought about by load shedding. Figure 6 shows that 54.5% of drivers experience traffic congestion during downtime hours. This goes back to there not being any way to regulate traffic during this time. Four-way intersections help alleviate traffic however they are not available at all intersections so naturally traffic will back up where traffic lights are supposed to be operating. This also leads to longer time on the road as pointed out by 18.2%. 2.3% of respondents point out the safety element of not having electricity at rest stops, given South Africa’s high crime rate drivers are faced with the challenge of finding rest stops that have backup generators.

Results of schedule interruptions, 44 responders

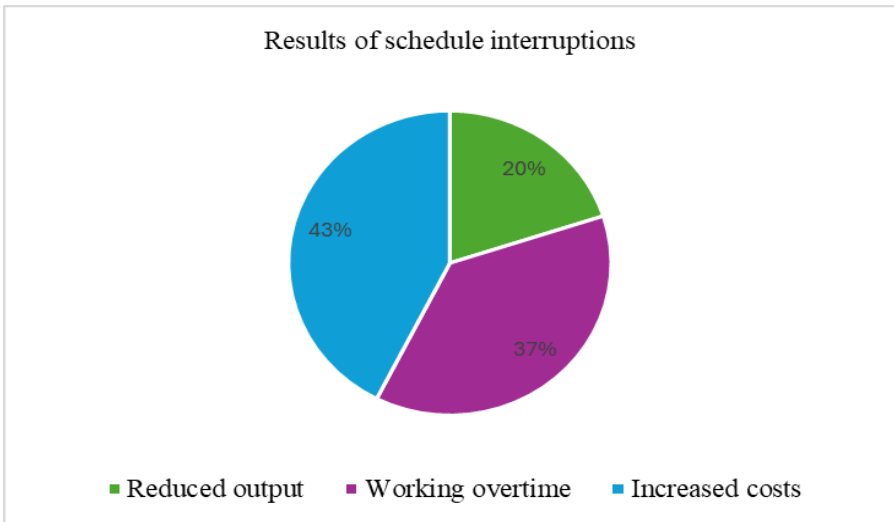


Figure 7: Survey on Challenges faced by Drivers and Operators due to Load shedding (Own editing).

As a result of having their loading and unloading schedules interrupted by load shedding, figure 15 shows that 37.5% of respondents end up having to work overtime. This may also affect the number of shipments that end up being moved as 20% of respondents say they have noticed a reduction in output. Any interruptions in work activities have a cost associated with them.

Willingness to drive, 44 responders

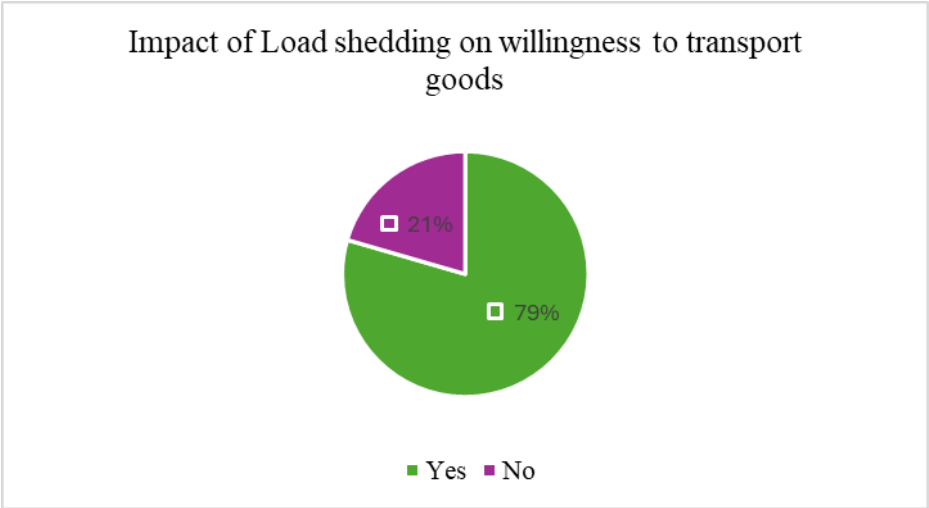


Figure 8: Survey on Challenges faced by Drivers and Operators due to Load shedding (Own editing).

In the Africa Economic Outlook report for 2022, PwC South Africa projects that by 2030, the nation's unemployment rate will soar to 40% (Montsho, 2022). This is reflected in Figure 8 as 79.5% of the survey responders are experiencing low employee morale due to the impacts of load shedding on their ability to carry out their responsibilities uninterrupted.

CONCLUSIONS AND RECOMMENDATIONS

Logistics plays a crucial role (Sós & Földesi, 2023) in economic growth by distributing resources and products efficiently. In South Africa, land transportation is the primary means of transferring people Merven et al. (2019), products, and services, contributing 2.5% of employment and almost 5% of GDP in 2016. Over 70% of land freight income and payload is generated by the road freight subsector, making it the largest subsector within the transportation industry. Road freight is preferred over rail freight in all sectors (Sós & Nagy, 2020), except mining, due to under capacity, long run times, accessibility, affordability, and reliability.

South Africa's energy business is still impacted by the country's history of apartheid and subsequent political, social, and economic forces. Load shedding can be attributed to factors such as greater demand than supply for energy, insufficient capacity for energy generation, unreliable sources of energy, and equipment or infrastructure failures and malfunctions. The port of Durban, where Johannesburg imports and exports most of its goods, has a higher percentage of heavy vehicles and is a busy route with significant traffic volumes. Higher stages of load shedding can cause a decline in port throughput efficiency, leading to substantial delays and prolonged offloading times.

The logistics sector in South Africa is consistently crumbling due to load shedding, and the recommended alternatives in this paper aim to help the industry return to optimal operations and meet the targeted Total Economic Units (TEUs) by 2050.

Port operational efficiency and energy efficiency are positively correlated, with improving energy efficiency increasing resource efficiency. South African ports could benchmark renewable energy sources from the German maritime sector, such as geothermal, solar, and wind energy. Hamburg Port has thirty wind turbines and seven more planned for 2017. Other renewable energy sources include geothermal, wave, and tidal power generation. Smart energy management systems Shrouf (2015), such as microgrids and smart grids, enable enhanced communication between energy suppliers and port energy consumers, monitoring, controlling, analyzing, and optimizing electricity. These systems consist of four primary components: energy supply management, battery-powered energy storage capacity, control of energy demand, and effective management and communication of all available resources. Smart grid ports can use onshore power supply, quay cranes, electrified yard equipment, buildings, warehouses, and reefer areas to reduce energy consumption and improve efficiency.

REFERENCES

- [1] Manuscripts Akpeji, K. O., Olasoji, A. O., Gaunt, C., Oyedokun, D. T., Awodele, K. O., & Folly, K. A. (2020). Economic impact of electricity supply. *SOUTH AFRICAN INSTITUTE OF ELECTRICAL ENGINEERS*.
- [2] Ateba, B. B., Prinsloo, J. J., & Gawlik, R. (2019). The significance of electricity supply sustainability to industrial growth in South Africa. *Energy Reports*, 1324-1338.
- [3] Baker, L., Newell, P., & Phillips, J. (2014). The political economy of energy transitions: The case of South Africa. *New Political Economy*.
- [4] ESKOM. (1998). 1998-Annual-Report. Johannesburg: Eskom Corporate Communication. <https://www.eskom.co.za/heritage/wp-content/uploads/2021/10/1998-Annual-Report.pdf>
- [5] Flash, N. Folly, K. A. (2021). *Local Electricity Markets*. Cape Town: Academic Press.
- [6] Havenga, J. (2010). Logistics costs in South Africa - The case for macroeconomic measurement. *South African Journal of Economics*, 460-476.
- [7] McKune, A. (2016). *The Indirect Impact of Road Freight Transport Case Study: N3 Johannesburg to Durban Road Freight Corridor*. Cape Town: University of Cape Town.
- [8] Merven, B., Hartley, F., & Ahjum, F. (2019). *Road freight and energy in South Africa*. South Africa - Towards Inclusive Economic Development.
- [9] Montsho, M. (2022). *SA experiencing the longest load-shedding streak – here’s what needs to happen*. Gauteng: IOL.
- [10] Ndlovu, V., & Inglesi-Lotz, R. (202). The causal relationship between energy and economic growth through research and development (R&D): The case of BRICS and lessons for South Africa. *Energy*, 1.
- [11] Peixoto Neto, A., Galves, M., & Lima Júnior, O. (2008). Challenges of urban transport problems and city logistics: Sao Paulo city center case. *WIT Transactions on The Built Environment*, 133-141.
- [12] Schoeman, T. (2018). The impact of power outages on small businesses in the City of Johannesburg. *10th Int'l Conference on Education, Business, Humanities and Social Sciences Studies (EBHSSS-18)*, (pp. 329-332). Cape Town.
- [13] Shrouf, F., & Miragliotta, G. (2015). Energy management based on Internet of Things: practices and framework for adoption in production management. *Journal of Cleaner Production*, 100, 235-246.
- [14] Sós, E. & Földesi, P. (2023) Application of the QFD Technique Method in Logistics Strategy. *Acta Polytechnica Hungarica. Vol. 20. No. 2*, pp. 145–164.
- [15] Sós, E., Horváth A., & Földesi P. (2023) Effects of Cognitive Biases and Their Fuzzy Measure During Freight Transportation. *Lecture Notes in Logistics*, pp. 29–43. Doi: 10.1007/978-3-031-28236-2_3/COVER
- [16] Sós, E. & Nagy Z. A. (2020) Exploring options for reducing CO₂ emission from freight transport. *Annals of Faculty of Engineering Hunedoara: International Journal of Engineering*, pp. 157–162.
- [17] Western Cape Mobility Department. (2023). *Growing the economy with Freight*. Western Cape Government For You.
- [18] Whitepaper FuE-Themen. (2015). Plattform Industrie 4.0: Industrie 4.0.



VIII. International Symposium-2024

FACTORS AFFECTING MARKET ORIENTATION OF RICE FARMERS IN EKITI STATE, NIGERIA

**Felicia Itunu WOLE-ALO^{*}, Bosede Olufunmilayo AKINWALERE,
Gbolade Evelyn AGBOMUSERIN, Abosede ADESOLA**

Department of Agricultural Extension and Communication Technology, Federal University of
Technology, Akure, Nigeria

Corresponding Emails: fiwolealo@futa.edu.ng^{*}, evelynbolade@gmail.com

Abstract

Rice became a critical component of the Nigerian household diet and on the other side, a major consumer of the country's foreign exchange as the imported rice is preferred to the local rice. We have different types of rice that grow very well in different states in Nigeria and yet, Nigeria government has yet to harness these potentials to boost local rice production despite its nutritious quality, so this study examined the factors affecting market orientation of 110 rice farmers in Ekiti state, Nigeria. A total number of 110 rice farmers was purposively selected for the study using the multi-stage sampling technique. Data were analysed using descriptive statistics such as frequency, percentage, mean statistics etc. Result showed that only 6.3% of the respondents attempted and completed tertiary education. The major factors that affect market orientation were price fixing ($\bar{x}$ = 1.95), financial performance ($\bar{x}$ = 1.94), customer's preferences ($\bar{x}$ = 1.89), distribution channels ($\bar{x}$ = 1.88) and variety selection ($\bar{x}$ = 1.81). It was concluded the market orientation of the farmers is very low and this is due to the low educational level as it takes a certain level of educational exposure and knowledge to make business decisions that would guide an individual in meeting different consumer's needs and demands to help build strong relationship with consumers, ensuring repeat business and market loyalty. Hence, it was recommended that the rice farmers need to be educated on business marketing.

Keywords: Rice Farmers, Market Orientation, Consumers

INTRODUCTION

Rice is an important crop that doubles as both food crop and cash crop in most economies of the world. It is a staple food for half of the world population and about three quarters of a billion of the world's poorest people depend on the staple to survive (Akinyele, 2019). It ranks high among the most consumed staple food in Nigeria as such, a significant amount of money used to go to its importation before the Nigerian present government introduced a policy that discouraged rice importation so that domestic production may be encouraged. Market orientation is the organization-wide generation of market intelligence pertaining to current and future customer needs, dissemination of the intelligence across departments, and organization-wide responsiveness to it. Market orientation in agriculture is basically a production decision issue as influenced both by production conditions and market signals

In Africa, rice farmers faced a multitude of factors that impact their market orientation. One significant factor is the limited access to market information. Agricultural marketing information is scarce in Nigeria because the required data are not usually available and those available are not well managed to generate the required information to support decision making by the producers, consumers, government officials and other market participants. There are no official or organized ways of transmitting price information in Nigerians Agricultural markets; therefore, there is no mechanism for coordinating production activities of the millions of farmers, corporate and institution consumers (Agboola, 2014). It is generally agreed that one of the major constraints affecting the development of the Nigerian rice sector is the inability of locally grown rice to match the quality of imported rice (USAID, 2011). Consumers are the ultimate and foremost deciders when it comes to selecting between different types of goods (USAID, 2011). The quality differential between local and imported rice is an important consideration in consumers' choice of which to purchase. Price is, of course, also an important determinant, but it is only one factor among a wide range of attributes that characterize the product. Indeed, imported rice consumption in Nigeria has expanded rapidly despite a heavy custom duty (USAID, 2011). This implies that consumers are willing to pay a premium in terms of higher price on the market compared to local rice. Development policy in Nigeria has placed undue emphasis on increasing agricultural production to serve as a base for agricultural transformation to the neglect of agricultural marketing (Specifically the objective of the study was to:

1. Ascertain the socio-economic characteristics of the respondent in the study area.
2. Determine the extent of rice farmers' market orientation
3. Identify the factors that determine the level of market orientation of rice farmers in the study areas

MATERIALS AND METHODS

The study was carried out in Ado-Ekiti State, which is located in the Southwestern part of Nigeria. A total number of 110 rice farmers was purposively selected for the study using the multi-stage sampling technique for data collection. Primary data were collected from the respondents using a well-structured questionnaire that contained open and closed ended questions to elicit information about various areas of the study from the selected respondents.

Statistics such as frequency, percentage and mean were used to analyse the socio-economic characteristics of the respondent. For objective 2, determining the market activities the respondents were involved in has a cut-off mean of 1.5 which means any variable with a mean value below 1.5 showed low involvement in market activities while the variable with a mean value between 1.5 to 2.49 has a moderate involvement and variables with mean values of 2.5 and above has high involvement.

For objective 3, the cut-off mean that determines the level of market orientation of the rice farmers is 1.0. Any factor below the mean value of 1.0 is not a factor while factors between the mean value of 1.0 to 1.49 is a minor factor and values with 1.5 and above is a major factor.

RESULT AND DISCUSSION

Socio-economic Characteristics of Respondents

Result in Table 1 revealed that 50.4% Of the respondent was between 50-79 years, 45.9% of the respondents were between 20-49 years, and 3.6% of the respondent were between 80-108 of age. The mean age was therefore 51 years. Research indicated that younger farmers tend to engage more in market-oriented production due to their familiarity with digital tools and market trends (Aker & Mbiti, 2010). Majority (64.9%) of rice farmers were male, while (35.1%) were female implying that male participation in agriculture is more than female participation.

Findings presented in Table 1 showed that 37.8% of the respondent has no formal education, another 37.8% has primary education while 18.0% had secondary education and the remaining 6.3% had tertiary education indicating that most of the farmers has no higher education. This could cause limited

knowledge of modern farming practices and technologies and reduced ability to access and utilize market information. With an average farm size of 9.15 hectares, these smaller landholdings may present significant challenges in terms of achieving economies of scale. The relatively small farm sizes can limit farmers' bargaining power when negotiating with buyers and suppliers, as larger farms often have more leverage due to their higher production volumes (Alemu et al., 2020). The findings on years of rice farming showed that (75.6%) of the respondents had about 1-20 years of rice farming experience, (17.1%) had from 21-40 years, and (7.2%) had 41-60 years of rice farming experience. It was found that with long years of farming experience, the farmers will have effective farming practices since they have derived much benefit from it.

Table 1: Socio-economic Characteristics of Respondents

Socio-economic Characteristics	Frequency	Percentage	Mean
Age (Years)			
20-49	51	45.9	50.80
50-79	56	50.4	
80-109	4	3.6	
Sex			
Male	72	64.9	35.1
Female	39	35.1	
Level of Education			
No formal education	42	37.8	6.3
Primary education	42	37.8	
Secondary education	20	18.0	
Tertiary education	7	6.3	
Farm Size			
1-20	109	98.1	9.15
21-40	2	1.8	
Farming Experience			
1-20	84	75.6	7.2
21-40	19	17.1	
41-60	8	7.2	

Extent of Farmers' Market orientation

Table 2 showed the involvement of the rice farmers in some marketing activities. The farmers were highly involved in expanding into new market ($\bar{x}$ = 2.70), value chain activities ($\bar{x}$ = 2.51) and contractual agreement with buyers ($\bar{x}$ = 2.50). Majority of the farmers were interested in expanding into new market because it gives them the opportunity to attract new consumer base and access untapped demand. They also know that expanding into new market leads to higher sales volume and enhances economic of scale. A significant number of the respondents engage in value addition activities because it enhances farmers' income but also ensures that high-quality food products are accessible to local consumers, thereby supporting community health and nutrition (Afolabi et al. 2017). Value addition can lead to greater profitability, particularly for smallholder farmers who are often vulnerable to market fluctuations. Taylor and Francis. (2023) supported the above findings and emphasized that a vast number of the rice farmers have contractual or oral agreement with their clients because it ensures stable market brings a level of security and predictability to business transactions. Singh et al. (2020) supported the view that having a contract in place guarantees market access, which can be especially valuable in competitive sectors where securing a consistent buyer is critical to sustaining revenue. A significant number of the respondents engage in value addition activities because it enhances farmers' income but also ensures that high-quality food products are accessible to local consumers, thereby supporting community health and nutrition (Afolabi et al. 2017). Value addition can lead to greater profitability,

particularly for smallholder farmers who are often vulnerable to market fluctuations. Taylor and Francis. (2023) supported the above findings and emphasized that a vast number of the rice farmers have contractual or oral agreement with their clients because it ensures stable market brings a level of security and predictability to business transactions. Singh et al. (2020) supported the view that having a contract in place guarantees market access, which can be especially valuable in competitive sectors where securing a consistent buyer is critical to sustaining revenue.

Table 2: Extent of Farmers' Market orientation

Marketing Activities	Mean	Remark
Packaging	1.67	Moderate Involvement
Branding	1.23	Low Involvement
Quality Control	1.20	Low Involvement
Market Campaign	0.91	Low Involvement
Engagement in Value Chain activities (e.g. milling etc.)	2.51	High involvement
Social Media Involvement	0.44	Low Involvement
Market Research	0.42	Low Involvement
Well-structured Financial budget	1.92	High Involvement
Knowledge of Market demand	0.42	Low Involvement
New market expansion	2.70	High Involvement
Contractual Agreement with buyers	2.50	High Involvement

Source: Field Survey, 2024

Grand Mean= 1.43

The respondents were also moderately involved in keeping a detailed financial budget ($\bar{x}=1.92$) and packaging of their product ($\bar{x}=1.67$). Some of the rice farmers rely on financial planning and budgeting to enhance their operational efficiency and profitability.

A well-structured budget allows farmers to manage their finances effectively, ensuring they can cover expenses and plan for future investments. Branding ($\bar{x}=1.23$), quality control ($\bar{x}=1.20$), market campaign ($\bar{x}=0.91$), social media involvement ($\bar{x}=0.44$), market research ($\bar{x}=0.42$) and knowledge of market demand had low involvement ($\bar{x}=0.42$). Quality control is a critical component of agricultural production that directly influences product standards and consumer satisfaction. As noted by Kumar et al. (2023), implementing rigorous quality control practices not only increases the overall quality of the rice produced but also contributes to the sustainability of rice production systems but the low engagement in this practise by the respondent could be attributed to no training and knowledge in the activities. The low involvement in the use of social media as a means of promoting their business and getting relevant information about rice production was because of their lack of android phones and knowledge to operate it. The low engagement in market research led to low knowledge of the farmers in market demand and this would lead to low brand visibility and little to be diverse consumer's base. Involvement in each of these marketing activities contributes uniquely to the enhancement of product quality, consumer appeal, and market competitiveness.

The integration of these approaches not only supports individual farmers in achieving better financial outcomes but also contributes to the sustainability and resilience of the rice production sector but with a grand mean of 1.43, it showed that the involvement of rice farmers in important marketing activities was low which implied that their market orientation is low. This could be as result of their low educational qualification which limits their knowledge on relevant information.

Factors determining market orientation

Results based on table 3 revealed that the factors determining market orientation. The major factors were quality decision ($\bar{x}=1.97$), price setting ($\bar{x}=1.95$), financial performance ($\bar{x}=1.94$), customers preferences ($\bar{x}=1.89$), distribution channels ($\bar{x}=1.88$), market information ($\bar{x}=1.65$) and export opportunities ($\bar{x}=1.62$). Quantity decision guides farmers to produce enough to meet customer demand ensuring a steady market supply and this indicate that the farmers carry out proper storage and handling to maintain

quality, making quantity decisions critical to prevent waste and consistent quantity supply helps build strong relationship with customers, ensuring repeat business and market loyalty. For the rice farmers, price setting in rice production is crucial, so price strategies is needed to determine the optimal price for the products in other to maximize revenue and profit and according to Gatner (2020) says 75% of firms adjust prices based on market trends.

Financial performance on the other hand is managing money to achieve business goals. This showed that financial performance affects employee satisfaction and retention (Chen et al (2019), Market oriented firms exhibit better financial performance than non-oriented firms. Understanding customer's needs, wants, and preferences determine market orientation for the respondents by guiding product development, marketing strategies, and customers' engagement.

Table 3: Factors determining market orientation

Market Information	1.65	Major Factor
Customer's Preference	1.89	Major Factor
Quality Decision	1.97	Major Factor
Financial Performance	1.94	Major Factor
Price fixing	1.95	Major Factor
Distribution Channel	1.88	Major Factor

Sources: Field Survey, 2024

Grand Mean: 1.88

A study by Kumar et al. (2020) revealed that customers' value personalized experiences and services. Furthermore, 85% of customers prioritize products quality when making purchasing decisions (Kotler & Keller,2016) and 60% of customers consider brand reputation when making purchasing decisions Distribution channel affects market orientation by influencing customer access, convenience, and experience which serve as pathways through which products flow from the producer to the end–consumer and most customers expects seamless Omnichannel experiences according to Salesforce,(2020). Other factors include market information which play a vital role in providing farmers with valuable insights on prices, demands and trends and it can be accessed through various channels, including online platforms, mobile apps, and agricultural extension services.

CONCLUSION AND RECOMMENDATION

Findings revealed that the mean age of the farmers was 51 years with the larger proportion of farmers as male. The market orientation of the farmers was poor as they were only involved in expanding into new market, value chain activities and contractual agreement with buyers. This attributed to be no training of the farmers on marketing strategies and low level of educational level. Further result showed that the major factors affect market orientation was quality decision, price setting, financial performance, customers preferences, distribution channels, market information and export opportunities.

RECOMMENDATION: The government should organize seminars and training on business marketing to educate the rice farmers.

REFERENES

- [1] Afolabi, B., and Ogoh, S. (2017). Industrial output and economic growth in Nigeria. *European Journal of Scientific Research*, 147(1), 87-96. ISSN: 1511-4554.
- [2] Agboola, A.K. (2014). Agricultural Development in Nigeria: Communicating the Roles of National Universities. *IOSR Journal of Humanities and Social Science*, 19(5), 82-89. e-ISSN: 2279-0837, p-ISSN: 2279-0845. Retrieved from www.iosrjournals.org.
- [3] Aker, J. C., & Mbiti, I. M. (2010). Mobile Phones and Economic Development in Africa. *Journal of Economic Perspectives*, 24(3), 207-232
- [4] Akinyele, B.O. (2019). Plant Genetics for Nutrition and Food Security. Inaugural Lecture Series 110, Federal University of Technology, Akure, Nigeria.

- [5] Alemu, W.G., and Melesse, A.M. (2020). Impacts of long-term conservation measures on ecosystem services in Northwest Ethiopia. *International Soil and Water Conservation Research*, 8, 47-55.
- [6] Gartner Research. (2020). Market Trend Analysis: June 2020. Retrieved from <https://www.gartner.com/en/documents/3987599>.
- [7] Kotler, P., and Keller, L.K. (2016). *Marketing Management* (15th ed.). Pearson Education.
- [8] Kumar, S.S., and Anbazhagan, B. (2020). Customer loyalty in the banking industry: An empirical study in Madurai district. *Our Heritage*, 68(30), 7224–7232.
- [9] Kumar, A., Singh, R.K.P., Mishra, J.S., Singh, D.K., Raman, R.K., and Kumar, U. (2023). Changing pattern of rice production in Eastern India: An economic analysis. *Indian Journal of Extension Education*, 58(2), 71-76. <https://doi.org/10.5958/2454-552X.2022.00058.5>.
- [10] Salesforce. (2020). A Year of Change: 10 Salesforce Research Stats to Sum Up 2020. Retrieved from <https://www.salesforce.com/news/stories/a-year-of-change-10-salesforce-research-stats-to-sum-up-2020/>.
- [11] Singh, S., Jones, A.D., DeFries, R.S., and Jain, M. (2020). The association between crop and income diversity and farmer intra-household dietary diversity in India. *Food Security*, 12(2), 369–390. <https://doi.org/10.1007/s12571-020-01012-3>.
- [12] Taylor and Francis. (2023). The role of climate-smart agricultural practices on household income and food security: A propensity score matching approach. *Cogent Social Sciences*, 9(2), 2273959. <https://doi.org/10.1080/23311886.2023.2273959>.
- [13] USAID. (2011). The development of Nigeria's rice sector: Progress and challenges. United States Agency for International Development.



VIII. International Symposium-2024

FACTORS AFFECTING CONSUMERS ATTITUDE TOWARDS LOCAL RICE PRODUCTION AND CONSUMPTION IN OGUN STATE, NIGERIA

Felicia Itunu WOLE-ALO*, Gbolade Evelyn AGBOMUSERIN, Matthew Olalekan
IYANDA

Department of Agricultural Extension and Communication Technology, Federal University of
Technology, Akure, Nigeria

Corresponding Emails: fiwolealo@futa.edu.ng, evelynbolade@gmail.com

Abstract

Rice is a staple food in many parts of the world, including Nigeria. The demand for rice in Nigeria is increasing due to population growth and urbanization but the local rice popularly known as 'Ofada rice' is less preferred among consumers for imported rice, so the study identified the factors affecting consumers' attitude towards local rice production and consumption in Ogun state. A multi-stage random sampling was employed to generate primary data with the aid of well-structured questionnaire and a total of 108 respondents were selected for the study. Data were analysed using descriptive statistics such as frequency, percentage, mean statistics etc. The major factors influencing the attitudes were low price of local rice ($\bar{x}$ = 3.72), its rich quality ($\bar{x}$ = 3.70) and its freshness ($\bar{x}$ = 3.17). It was also discovered that the respondents have positive perception ($\bar{x}$ = 2.89) towards local rice because its freshness and nutritious quality. Further results also showed that there is a moderate level of consumption (66.0%) of local rice in the study areas due to its taste compared to the imported rice, suggesting that it is already a staple food in the study area. Issues like stones in local rice ($\bar{x}$ = 3.65) and negative experience such as lower flavour ($\bar{x}$ = 3.37) were the major issues that affects the consumption of local rice. In conclusion, it was recommended that quality control mechanisms should be put in place to ensure that local rice meets high standards for texture, taste, and cooking consistency.

Keywords: Local Rice, Attitudes, Barriers, Perception

INTRODUCTION

Rice is a crucial staple food for over half of the world's population, and it is a major source of calories and protein in many developing countries, including Nigeria. Globally, rice is a vital staple, ranking third in production and consumption after wheat and maize. In West Africa, rice cultivation faces challenges with low yields and high consumption rates, leading to heavy reliance on imports. Rice production in Nigeria has significantly increased over the years. Nigeria is the largest rice producer in Africa (Zenna, 2017) with an annual production of about 8,435,000 tonnes. Despite being a major producer, Nigeria still faces challenges meeting local demand, leading to imports. To boost production,

mechanization is crucial, with a potential to double production to 7.2 million tonnes by increasing mechanization rates. Water scarcity remains a hindrance, but reusing wastewater for irrigation could enhance production and food security, aligning with global sustainability goals. The global food market has undergone notable transformations in recent years, driven by changing consumer preferences, environmental concerns, and economic shifts. In Nigeria, one of the most populous countries in Africa, (Obih, 2018) rice stands out as a staple food, with significant implications for both dietary habits and the agricultural sector.

Ogun State, located in the southwestern region of Nigeria, is a key player in the nation's rice production landscape, yet the consumption of locally produced rice remains a subject of nuanced attitudes and behaviours among consumers. The growing awareness of the importance of food security, sustainability, and self-reliance has sparked renewed interest in locally produced foods, including rice (Osagie, 2020).

Local rice production offers numerous benefits, from boosting the local economy and reducing dependency on imports to promoting agricultural sustainability and preserving cultural heritage. However, despite these advantages, consumers still continue to prefer imported rice over locally produced rice (Osabuohien, 2018).

Consumers' attitudes towards local rice in the study area (Osagie, 2014) are influenced by a myriad of factors, ranging from cultural perceptions to economic considerations. Understanding the intricacies of consumer attitudes towards local rice production and consumption in Nigeria is essential for several reasons.

Firstly, it provides insights into the factors driving consumer choices in the rice market, which can inform marketing strategies and product development initiatives.

Secondly, to offer valuable information for policymakers and agricultural stakeholders to design interventions aimed at promoting local rice production and consumption.

Lastly, to contribute to the broader discourse on food security, agricultural sustainability, and economic development in Nigeria.

So, the study so the study identified the factors affecting consumers' attitude towards local rice production and consumption in Ogun state. Specifically, the study:

1. identified the factors influencing consumers' attitude towards production and consumption of local rice.
2. determined the perception of consumers about local rice.
3. examined consumer preferences, cooking techniques and taste of local rice production and
4. identified the barriers that affect the availability of locally produced rice among consumers.

MATERIALS AND METHODS

The study was carried out in Ogun State, which is located in the Southwestern part of Nigeria. A multi-stage sampling procedure was used to randomly select 108 rural consumers for data collection.

Primary data were collected from the respondents using a well-structured questionnaire that contained open and closed ended questions to elicit information about various areas of the study from the selected respondents.

Objective 1, 2 and 4 was analysed with mean statistic. Its cut-off mean was 2.50 which means any variable with the mean of 2.50 and above is an effect and any variable below 2.50 is not an effect. Objective 3 was presented with bar and pie chart.

Factors Influencing Consumers' Attitude towards Local Rice Production and Consumption

The survey results in Table 1 indicated major factors influencing consumer attitudes toward local rice production and consumption. The major factors influencing the consumers' attitudes were price ($\bar{x}$ = 3.72), quality of the rice ($\bar{x}$ = 3.70), health benefits ($\bar{x}$ = 3.35), freshness ($\bar{x}$ = 3.17), sweet taste and aroma ($\bar{x}$ = 3.12) and environmental impact ($\bar{x}$ = 3.02). Other factors include availability ($\bar{x}$ = 3.00), nutritional value ($\bar{x}$ = 2.99), packaging ($\bar{x}$ = 2.95), and support for local farmers is high ($\bar{x}$ = 2.93).

These findings align with the literatures on consumer behaviour in agriculture. This finding aligns with research by **Ahmed et al. (2019)**, which underscores the importance of price as a determinant of consumer behaviour in agricultural markets. Price sensitivity is a significant predictor of consumer purchasing decisions in the rice market. This supports earlier research by Mohammed et al. (2019), who highlighted that quality perception directly influences consumer preferences for local agricultural products. Additionally, the strong emphasis on quality illustrates that consumers are willing to invest in higher-quality products, which is consistent with findings by **Umar et al. (2020)**, who noted that perceived quality significantly influences consumer preferences in food products. Taste plays a critical role in the consumption of local food products. The significant recognition of environmental impact also indicates that consumers are becoming more aware of sustainability issues, the result implied that there is a correlation between consumer preferences for local products and their perceptions of environmental sustainability. Also, Oyekale et al. (2022) found that consumers increasingly consider environmental sustainability in their purchasing decisions, which is reflected in the high percentage of respondents who agree on environmental impact. Nutritional value received strong support which indicated that health-conscious consumers are more likely to purchase locally produced foods that they perceive as healthier. The positive feedback regarding packaging highlights the role of effective marketing and presentation in consumer decision-making. Hassan et al. (2019) noted that effective packaging can significantly influence consumer perception and increase purchase intent for local products.

Table 1: Factors Influencing Consumers' Attitude towards Local Rice Production and Consumption

Factors	Mean
Price	3.72
Quality	3.70
Sweet taste and aroma	3.12
Availability	3.00
Environmental impact	3.02
Nutritional value	2.99
Packaging	2.95
Health benefits	3.35
Freshness	3.17
Perceived health and safety standards	2.97

Source: Field survey, 2024.

Perception of Respondents on Local Rice Production

Results from the Table below revealed that the farmers had positive perception towards locally produced rice with the grand mean of 3.04. The consumer perceptions of locally produced rice reveal several key insights like the use of traditional farming methods makes local rice healthier ($\bar{x}$ = 3.22), it benefits the local economy ($\bar{x}$ = 3.18) and it supports local farms ($\bar{x}$ = 3.01). This positive perception aligns with the belief that local rice is produced with fewer preservatives ($\bar{x}$ = 3.15), and it lacks proper branding ($\bar{x}$ = 2.82), which may affect consumer trust and purchasing decisions.

Additionally, locally produced rice is perceived it to be more expensive ($\bar{x}$ = 2.74). These findings underscore the complexity of consumer attitudes, balancing positive support for local production with concerns about quality control, branding, and pricing. **Adesina (2019)** also shows that addressing these concerns could enhance the competitiveness of local rice against imported varieties.

These findings suggested that consumers are aware of the socio-economic advantages of supporting local agriculture, as echoed in studies like Osuagwu et al. (2018), which found that consumers in Nigeria are increasingly motivated by the desire to boost local economies and sustain smallholder farmers when choosing local food products. Also, price sensitivity is an issue for consumers. It was agreed that locally produced rice is competitively priced and more expensive, highlighting a paradox in consumer perception. This indicated that while some consumers recognize that locally produced rice can offer value for money, others may perceive the cost as higher than imported alternatives, which can deter wider acceptance. This aligned with the findings of Sanni et al. (2020), who noted that the higher cost of production for local rice, due to less mechanization and economies of scale, is often passed on to consumers, making it seem less competitive.

Table 2: Perception of Respondents on Local Rice Production

Perceptions	Decision				Mean
	Strongly Agree (%)	Agree (%)	Disagree (%)	Strongly Disagree (%)	
Purchasing locally produced rice benefits the local economy	24 (22.2)	82(75.9)	-	2(1.9)	3.18
Local rice is healthier because of its low preservatives	37(34.3)	60(55.8)	2(1.9)	9(8.3)	3.15
Local rice is healthier because it is produced with traditional farming methods	35(32.4)	62(57.4)	11(0.2)	-	3.22
Local rice is competitively priced	25(23.1)	74(68.5)	9(8.3)	-	3.14
Local rice lacks proper branding and marketing	-	89(82.4)	19(17.6)	-	2.82
Perceive local rice to be more expensive	11(10.2)	63(58.3)	29(26.5)	5(4.6)	2.74

Source: Field survey, 2024.

Grand Mean: 3.04

Consumer preferences, cooking techniques and taste of local rice production

Preferred Methods of Cooking

The data as shown in figure 1 indicates that majority (79.6%) of the respondents prefer boiling and steaming as their primary method of cooking locally produced rice. This shows a clear preference for traditional methods like boiling and steaming, likely due to cultural practices and the texture local rice offers when boiled. Several studies support this trend, indicating that consumers of local rice, particularly in rural areas, are more comfortable with traditional cooking methods. Lawal et al. (2019) found that boiling is often preferred because it retains the texture and flavour of locally produced rice, which is highly valued by consumers. Similarly, Olayemi and Ibrahim (2020) argued that steaming is also appreciated because it maintains the grain's integrity, a key factor in taste preference for many households. However, the low adoption of modern cooking devices like rice cookers may stem from a combination of cost and limited access to these devices, particularly in rural regions where most local rice is consumed.

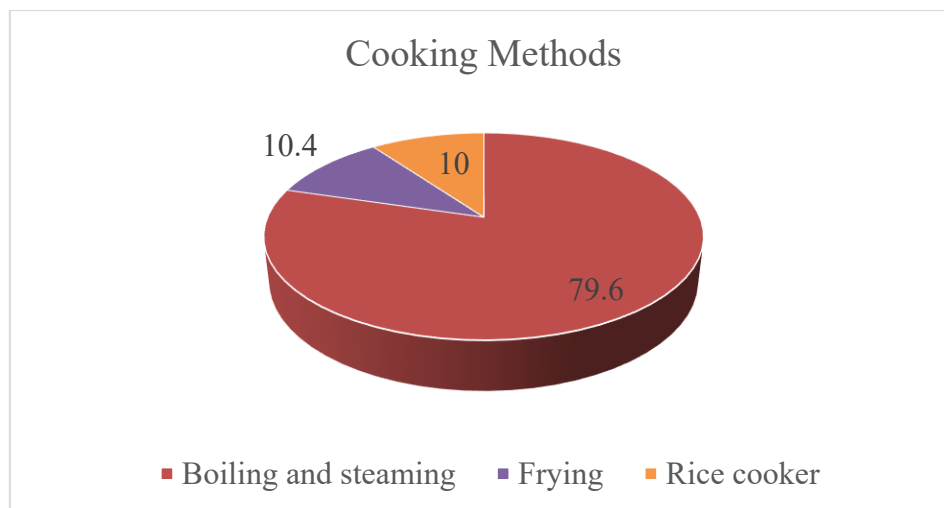


Figure 1: Consumer cooking techniques
Source: Field Survey, 2024

Consumption of Local Rice

The data on the frequency of local rice consumption in figure 2 showed that the majority of respondents (66.7%) consume it several times a week, followed by 16.7% who consume it daily, 13.9% once a week, and 2.8% a few times a month.

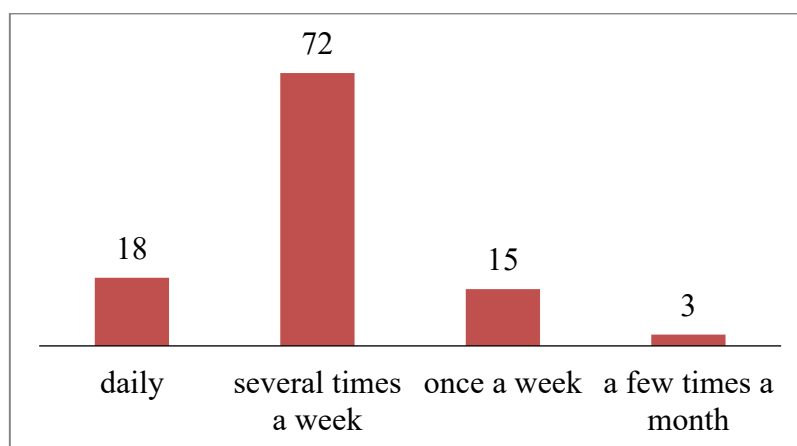


Figure 2: Consumption of Local Rice

This high frequency of consumption indicated a strong acceptance of local rice among consumers which suggested that it has become a staple in many households. This finding aligns Adekoya et al. (2022) which affirm that increased awareness of the nutritional benefits, lower prices compared to imported rice, and support for local farmers significantly boost local rice consumption in Nigeria. On the other hand, Madu and Ihuoma (2021) pointed out that occasional consumption might be due to issues like inconsistent quality or concerns about preservation methods, which align with the lower percentage of respondents who consume it less frequently.

Perception of Consumers on the taste of local rice

The result in figure 3 shows that majority (82.4%) of respondents perceived the taste of local rice as "better," and 15.7% rate it as "much better," while only 1.9% find it "much worse." This positive perception of taste suggested that local rice is widely accepted for its flavour, which could influence consumer preference and consumption patterns. This finding revealed that taste plays a significant role in shaping consumer attitudes toward local rice in Nigeria. Local rice is often preferred to other rice due to its freshness and taste, reinforcing the importance of local production in consumer preferences.

Similarly, **Hassan et al. (2020)** noted that sensory attributes, including taste, significantly influence consumer choices for rice in Nigeria, with many preferring the taste of local varieties over imported ones.

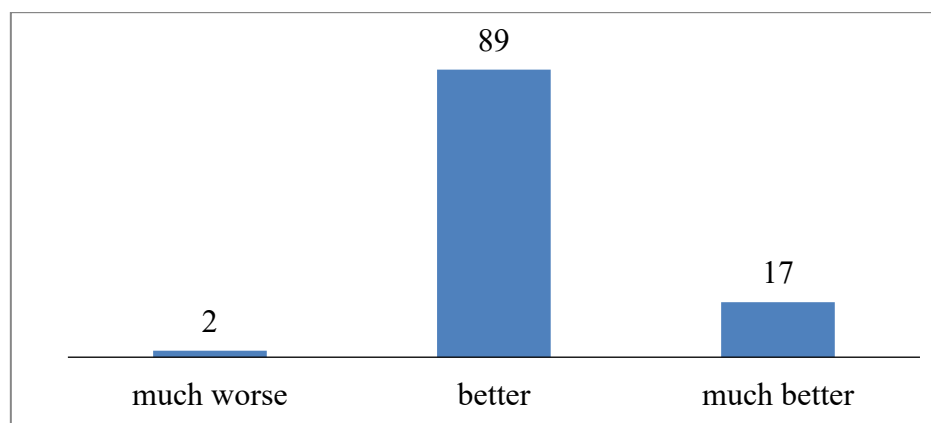


Figure 3: Perception of Consumers on the taste of local rice

Barriers in Adopting Locally Produced Rice

Table 2 revealed the barriers in consuming locally produced rice. Stones in rice is major problem for the consumers ($\bar{x}$ = 3.65). Other major barriers are high cost of local rice ($\bar{x}$ = 3.39), low to no branding and labeling of local rice ($\bar{x}$ = 3.42), negative past experiences with local rice, such as perceived lower flavour ($\bar{x}$ = 3.37), hygiene issues ($\bar{x}$ = 2.99), inconsistency of the quality of local rice is ($\bar{x}$ = 2.95) and rough texture ($\bar{x}$ = 2.75). Concerns about hygiene are overwhelmingly prominent. Inadequate processing facilities, along with poor handling and storage practices, contribute to contamination with foreign particles such as stones and dirt in locally produced rice (Oguntade, 2011). This issue was reinforced in this study, with respondents in agreement that local rice contains stones. These physical impurities undermine consumer confidence and deter many from purchasing local rice. Nigerian rice often suffers from post-harvest inefficiencies, leading to contamination and reduced product quality. The quality and texture of local rice also emerged as significant concerns. High cost stands out as a significant barrier and this is consistent with findings from Nwafor and Ijirshar (2022) with the assertion that the cost of production for local rice is higher due to limited mechanization, inefficient farming practices, and high post-harvest losses. This increases the final price of local rice, making it less competitive compared to imported rice varieties, which benefit from economies of scale and government subsidies in their countries of origin.

The issue of branding is another critical concern, according to the respondents, branding of local rice is not as informative as imported rice. According to Akinyele (2010) opined that poor branding and packaging can significantly affect consumer choices, particularly in competitive markets like rice. In Nigeria, many locally produced rice brands fail to differentiate themselves from imported varieties, both in terms of packaging quality and the information provided on the product. This lack of clarity could affect consumers' trust and willingness to try local rice brands.

Local rice suffers from inconsistent quality. This inconsistency in quality and texture can be attributed to varying production methods, lack of standardization, and minimal government regulation of rice milling processes (Erenstein, 2010).

In comparison, imported rice, which benefits from superior technology and more standardized production processes, is often perceived as having better cooking properties. Negative past experiences with local rice and a lack of trust in local brands further contribute to negative consumer attitudes and this Implied that there is a need for more consistent quality control and better branding to regain consumer trust. According to Adepoju and Oyewole (2014), consumer trust can be rebuilt through stringent quality control measures and certifications that assure consumers of the safety and quality of locally produced rice.

Table 4: Barriers in Adopting Locally Produced Rice

Barriers	Mean
High cost compared to imported rice	3.39
Branding not informative	3.42
Concerns about hygiene and safety standards	2.99
Texture of local rice is not as good as imported rice	2.75
Inconsistent quality	2.95
Local rice contains stone	3.65
Negative past experience with local rice	3.37
Lack of trust in local rice brands	2.99

Source: Field survey, 2024.

CONCLUSION AND RECOMMENDATION

It was discovered that the preferred cooking methods were boiling and cleaning. The respondents have positive perception towards locally produced rice because it boosts local economy, and it is healthier than improved rice. Consumers' level of consumption of local rice is very high because of good taste and texture. Finally, the major factors influencing consumer attitudes toward local rice production and consumption are the price, quality of the local rice, health benefits, freshness, sweet taste and aroma and environmental impact.

Recommendation: Quality control mechanism should be put in place to ensure that local rice meets high standards for texture, taste, and cooking consistency

1. To attract more consumers and enhance the perception of local rice, producers and marketers should invest in better packaging materials that are aesthetically appealing and practical
2. Government should also support local farmers by offering training programs on best practices in local rice production, processing and packaging.

REFERENES

- [1] Adekoya, A. O., Olayemi, J. K., and Ajayi, O. O. (2022). Consumer preferences and perceptions of local versus imported rice in Nigeria. *Journal of Agricultural and Food Economics*, 10(4), 315–329.
- [2] Adepoju, A. A., and Oyewole, O. (2014). Determinants of consumer preference for locally produced rice in Nigeria. *Nigerian Journal of Agricultural Economics*, 5(2), 45–57.
- [3] Adesina, A. A. (2019). Improving the competitiveness of local rice production in West Africa. *International Food Policy Research Institute*. Retrieved from <https://www.ifpri.org>
- [4] Akinyele, S. T. (2010). The influence of advertising on consumer brand preference in the Nigerian food and beverage industry. *Journal of Economics and International Finance*, 2(10), 232–241.
- [5] Ahmed, S. I., and Abubakar, A. (2019). The role of price in the purchase decision of rice consumers in Nigeria. *International Journal of Agriculture and Food Security*, 8(3), 12–21.
- [6] Erenstein, O., Lancon, F., Osiname, O., and Kebbeh, M. (2006). Rice production systems in Nigeria: A survey. Wageningen University and Research.
- [7] Hassan, G. A., Mukhara, S. J., and Oghenekaro, M. E. (2020). Sensory characteristics of rice varieties: Consumer preference and acceptability. *Journal of Food Science and Technology*, 57(7), 2675–2681. <https://doi.org/10.1007/s11483-020-01225-8>

- [8] Keller, K. L., and Lehmann, D. R. (2019). Brands and branding: Research findings and future priorities. *Marketing Science*, 38(2), 207–230.
- [9] Lawal, A. O., Adekunle, T., and Musa, I. O. (2019). Exploring cooking preferences among Nigerian rice consumers: A case of local versus imported rice. *African Journal of Food Science*, 13(6), 115–124.
- [10] Madu, C. E., and Ihuoma, C. A. (2021). Challenges in promoting local rice production and the attitude of Nigerian consumers. *Journal of Development Studies*, 57(4), 602–617.
- [11] Mohammed, N. M., Al-Mamun, A., and Fadare, O. O. (2019). Assessing consumer preferences for local rice: A case study in Nigeria. *Sustainable Agriculture Research*, 8(2), 72–84.
- [12] Nwafor, M., et al. (2019). Awareness and preferences for local food products in Nigeria. *Journal of Food Products Marketing*, 25(3), 301–314. Retrieved from <https://scholar.google.com>
- [13] Obih, U., and Baiyegunhi, L.J.S. (2018). Consumers' acceptability of local rice brands in Nigeria: Which marketing functions really matter? *Journal of Agribusiness and Rural Development*, 48(2), 183–196.
- [14] Oguntade, A. (2011). Processing and marketing of rice: Nigeria's experience. *Journal of Rural Studies*, 27(2), 106–114.
- [15] Olayemi, J. K., and Ibrahim, M. I. (2020). Consumer behavior towards cooking methods and technology in rural Nigeria. *Journal of Rural Development and Technology*, 15(4), 233–245.
- [16] Osabuohien, E., Okorie, U., and Osabohien, R. (2018). Rice production and processing in Ogun State, Nigeria: Qualitative insights from farmers' association. In *Food Systems Sustainability and Environmental Policies in Modern Economics* (pp. 188–216). IGI Global. <https://doi.org/10.4018/978-1-5225-3631-4.ch009>.
- [17] Osagie, C. (2014). Rice importation ban: Disregard US report, FG urged. This Day Live. Retrieved from <http://www.thisdaylive.com/articles/2015-rice-importation-ban-disregard-us-report-fg-urged/168731/> [Accessed 17/05/24].
- [18] Osuagwu, G. O., et al. (2018). Consumer preferences and willingness to pay for local rice in Southeast Nigeria. *International Journal of Agricultural Economics and Rural Development*, 10(2), 49–59.
- [19] Oyekale, A. S. (2022) Factors influencing willingness to be vaccinated against COVID-19 in Nigeria. *Int. Journal of Environmental Research and Public Health*, 19 (11): 6816
- [20] Sanni, L. O., et al. (2020). Economic and quality determinants of local rice demand in Nigeria. *Nigerian Journal of Agriculture, Food and Environment*, 16(3), 145–152.
- [21] Zenna, N., Senthilkumar, K., and Sie, M. (2017). Rice production in Africa. In B. Chauhan, K. Jabran, and G. Mahajan (Eds.), *Rice Production Worldwide* (pp. 123–143). Springer. https://doi.org/10.1007/978-3-319-47516-5_5.
- [22] Umar, S. M., & Ismail, M. (2020). Impact of Quality on Consumer Preferences for Local Rice in Nigeria. *Journal of Agricultural Economics and Development*, 9(2), 25–34.



VIII. International Symposium-2024

EFFECT OF DEFICIT IRRIGATION ON BARLEY YIELD AND WATER PRODUCTIVITY THROUGH FIELD EXPERIMENT AND MODELING AT KOGA IRRIGATION SCHEME, AMHARA REGION, ETHIOPIA

Bekalu Melis ALEHEGN¹, Dagnenet Sultan ALEMU²

¹Assosa University, college of Agriculture, Department of Soil Resource and Watershed Management, Ethiopia. Email.bekalumelis6@gmail.com

²Bahir Dar university faculty of civil and Water Resource Engineering, Ethiopia

Abstract:

The insufficiency of water is the most severe restraint for the expansion of agriculture in arid and semi-arid areas. An important strategy for increasing water productivity and improving water productivity deficit irrigation at different growth stages is important to advance the yield and Water Productivity of barley in water scarce areas. A field experiment was conducted at the Koga irrigation scheme in Ethiopia to examine barley yield response to different irrigation regimes and validate the aqua crop model. The experimental setup comprised six randomized treatments (T) with three replications for one irrigation season because of financial limitations. The irrigation regimes were selected 100%, 75%, and 50% application level in different growth stages of gross irrigation requirement using try and error in order to selecting the optimal water application level. The treatments were: no stress at all (T1), 25% stressed during all crop stages (T2), 50% stressed at all stages (T3), 50% stressed at development stage (T4), 50% stressed at mid-stage (T5) and 50% stress at initial and late season (T6). The agronomic parameters including canopy cover, biomass, and grain yield were collected to compare the ground-based crop yield and the aqua crop model. The results showed that the initial and late stages and stress 25% through the whole season were the right time for practice deficit irrigation without significant yield reduction. The highest (2.62kg/m³) and the lowest (2.03 kg/m³) water productivity were found under T3 and T4, respectively. The stress of 50% at the mid-growth stage and stress 50% of the full irrigation water requirement at all growth stages significantly ($\alpha=5\%$) affected the canopy expansion, biomass and yield production. The aqua Crop model performed well in simulating the yield of barley for most of the treatments ($R^2 = 0.84$ and $RMSE = 0.7 \text{ t ha}^{-1}$).

Keywords: Aqua Crop, barley, deficit irrigation, irrigation regimes, water productivity,

INTRODUCTION

Water is an invaluable resource in the Nile Region. Hence, efficient and effective use will have far-reaching implications. In the Ethiopian part of the Blue Nile, the subsistence rain-fed agriculture is under

the clemency of erratic rainfall and water resource development and is known to have an imperative role in the agricultural, socio-economic and industrial development. Although the country is known to have plenty of water resources, its availability is constrained by a number of factors. In Ethiopia, barley yield over the past decade varied from 0.7 to 1.5 Mg/ha depending on the cultivar, soil fertility, climatic factors, and pressure of biotic stress (Mulatu & Grando, 2011). Reported that the national average yield of barley (1.75 mg/ha) in Ethiopia is lower than the world average (2.6 mg/ha). Among these, the poor water productivity and inefficient irrigation water management were the leading challenges. According to a sustainable water use in Ethiopia and other water-scarce countries, it is more about maximizing yield per unit of water rather than maximizing yield per unit of area. The increasing demand for water is necessitating major changes in irrigation management and scheduling to increase the productivity of water to agriculture. Scarcity and growing competition for irrigation water resources between upstream and downstream users and inefficient water management practices of the farmers reduced its availability for irrigation. The Koga irrigation scheme is one of the schemes which suffer from serious water shortage, specifically during late growing periods. Under these conditions, the irrigation management strategy has to shift from maximizing the yield per unit area to maximizing the productivity per unit of water used by the crop or water productivity. Deficit irrigation is one important way of maximizing water use efficiency for higher yields per unit of irrigation water applied (Celebi, 2014). Therefore, the need to use the available water cautiously and efficiently is indubitable. One of the most important options that can help to save irrigation water under these conditions is the adoption of deficit irrigation practices by the farmers in the scheme. Deficit irrigation (DI) application to enhance water productivity is getting a new momentum (English & Raja, 1996; Yihun, 2015). The correct application of DI requires a thorough understanding of the yield response to water (C Kirda & R1 Kanber, 1999; C Kirda & R Kanber, 1999) and of the economic impact of reductions in harvest.

The reason for initiating the research was that Koga and many other developed schemes in the region suffer from serious water shortage, specifically during late in the dry season and Aqua Crop models are not done and evaluated yet on barley crops. The potential irrigable area is 7005 ha. However, the maximum actually irrigated area was 5123 ha in 2011/12 and 5144.36 ha in 2012/13 (Tewabe & Dessie, 2020). This is 73.5% of the design command area. Abiyu and Alamirew (2014) also found that the actually irrigated area was below the design capacity, which is 5000 ha of land. This implies there is poor irrigation water management and inefficient irrigation water application by the farmers. There are some researches done on the scheme under deficit irrigation strategy only, but this research was done by combining field experiment with aqua crop model to assess the yield response of barley crop under different water application levels.

MATERIALS AND METHODS

Description of study area

The experimental site is located some 35 km southwest of Bahir Dar within the upper Blue Nile basin in Koga River at Kudmi keble, Mecha Woreda of Amhara National Regional State, Ethiopia and at latitude of 11° 10' N to 11° 25' N & longitude of 37° 2' E to 37° 17'

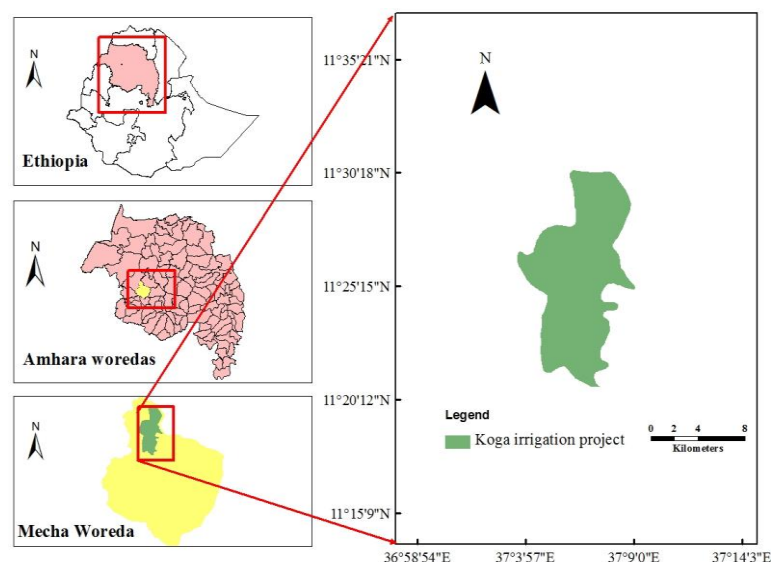


Figure 15. Map of the study area at the Koga irrigation scheme in Ethiopia

Field layout, cultural practice and measurements

A total of 18 experimental plots were set in a randomized complete block design with six treatments and three replications, and the number of treatments and replications were enough for one irrigation season. Each of the 18 experimental plots has a size of 4.0 m × 2.0 m with 1.5 buffers between the plots (Abrha et al., 2012) and barley was sown at a seeding rate of 125 kg ha⁻¹ on 11th December 2018 as per the recommended agronomical practices of Koga irrigation scheme. Each plot was fertilized with 100 kg ha⁻¹ Urea and 100 kg ha⁻¹ Di-ammonium phosphate. Half of the urea dose and full dose of Di-ammonium phosphate were applied during sowing of barley, whereas the remaining half the dose of urea was applied 25 days after sowing for the first time weed removal. Three irrigation regimes of 100%, 75%, and 50% of the total crop water requirement were applied in six different treatments. The difference of this water application method from the cultural practice was the water applied by watering can minimize the water loss. The crop water requirements were calculated using cropWat-8 software. The combination of the treatments was shown in table 1.

Table 1. Description of the irrigation treatments

Water applied at different growth stages as % of GIR*				
Treatment	Initial period	Development	Mid-season period	Late- season period
T1	100	100	100	100
T2	75	75	75	75
T3	50	50	50	50
T4	100	50	100	100
T5	100	100	50	100
T6	50	100	100	50

*GIR= Gross irrigation requirement estimated by CropWat -8 software, T1- supply 100% of GIR during all growth stages, T2-supply 75% of GIR during all growth stages, T3- supply 50% of GIR during all stages, T4-supply 50% of GIR during the development stage and supply 100% GIR the remaining stages, T5-supply 50%GIR during mid-stage and supply 100% GIR the rest stages, T6-supply 50%GIR during initial and late season.

Framework of the study

The methodological framework that was followed in this study is schematized in Figure 2. The details of the field experimental setup and assessment of water availability in the river basin are specified in this chapter. Expounding on irrigation schedules merely based on field research is rather difficult and time

consuming, justifying the need of using of models is required. A water-driven model (Aqua Crop) was applied to emphasize the fundamental process involved in crop water productivity and in response to water deficits, both from physiological and agronomic perspectives. They allow studying possible scenarios that might occur in the future to adopt better management strategies. The field experiments and modeling consequently (Figure 2) provide a sound scientific basis for planning and water management scenario analysis.

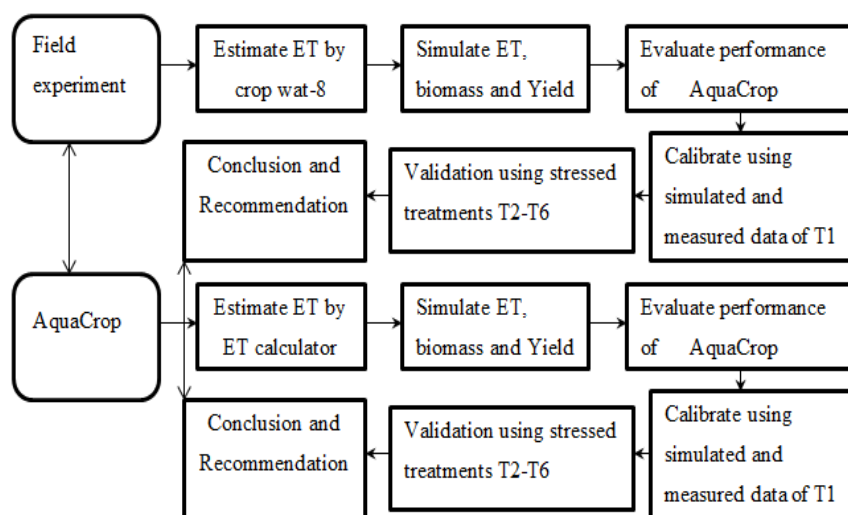


Figure 16. Methodological work

Estimation of barley water requirements

To calculate the crop evapotranspiration (Equation 1), the FAO CropWat model for window 8.0 was used to calculate the reference evapotranspiration (ET_o) and the crop factor (K_c) for different growth stages was taken from (Droogers & Allen, 2002).

$$ET_c = ET_o * K_c$$

Where: ET_c is the crop evapotranspiration (mm), K_c is the crop factor in fraction, and ET_o is the reference evapotranspiration (mm).

Water application method of the study

Based on cropwat-8 software scheduling, the study was applied irrigation water by known volume watering can creating water ponding around the experimental plots and apply to the crops by watering cans manually, this application method has less water loss and accurate to apply the required water for experimental treatment. The volume of applied water was calculated as:

$$V = GIR * L * W \quad (3.9)$$

Where, V = volume of water to be applied (Liter), GIR = gross irrigation requirement (m), W = furrow (row) spacing (m) in this cause 0.2m, L = furrow length (m) in this cause 4m

Therefore, the total amount of water applied for full treatment (T1) was 578 mm

Crop parameters and measurements

Canopy Cover:

Canopy cover of the plant was measured using the LAI-2000 plant canopy analyzer (Li-Cor, 1992) by taking image of each plot in every 7days.

Above ground biomass: Aboveground biomass was measured in every 15days interval within a 0.25 m² area (Xiu-liang et al., 2014) by cutting plants from each plot during the irrigation season. All plant samples were dried at 65°C for 48 hours and measured until a becomes constant weight, and the final dry weights (DW) were recorded.

Calibration and validation of Aqua Crop model

Aqua crop was calibrated using the measured data set of the 2018/2019 experimental season for full irrigation (T1). However, the reaming treatments were used to validate the models. Calibration was performed by matching the ability of the fully irrigated treatment in canopy cover (CC), biomass (B), and yield (Gy). During the experimental period, initial canopy cover (CCo), growth canopy coefficient (CGC), and canopy decline coefficient (CDC) was estimated.

The stress index for water stress affecting the explanation and early senescence is the most important canopy cover parameter. The water stress parameter and curve shapes were changed manually around the default value to reproduce the measured value of canopy cover development and are entered continuously until satisfactory results for all irrigation treatments in the calibrated experimental season.

Performance evaluation of Aqua Crop model

The root mean square error or RMSE is one of the most widely used statistical indicators (Mishra & Homa, 2019) and measures the average magnitude of the difference between predictions and observations.

$$RMSE = \sqrt{\frac{\sum_{i=1}^n (oi - si)^2}{N}}$$

The index of agreement (d) was proposed by (Willmott, 1982) measure the degree to which the observed data are in line with the simulated data.

$$d = 1 - \frac{\sum_{i=1}^n (si - oi)^2}{\sum_{i=1}^n (|si - MO| + |oi - MO|)^2}$$

Where Si = simulated value, Oi = observed value, N = number of observations, MO = mean of observed value.

The correlation coefficient(r) is an indicator of the degree of closeness between the observed values and model estimated values.

$$r = \frac{\sum_{i=1}^n (oi - MO)(si - MS)}{\sqrt{\sum_{i=1}^n (oi - MO)^2 \sum_{i=1}^n (si - MS)^2}}$$

Where Si = simulated value, Oi = observed value, N = number of observations, MO = mean of observed value, MS = mean of simulated value.

Data Analysis

To identify optimal deficit irrigation management practices and effects of different water application levels on barely crop yield and water productivity were statistically analyzed using statistical package SAS (version 9.4) analysis of variance (ANOVA) technique and mean separation were done using the Least Significance Difference (LSD) method at 5% level of probability.

RESULTS

Physical and chemical properties of soil

The analysis of soil physical and chemical properties at different soil depths of the experimental area was given in Table 2.

Table 2. Physical and chemical properties of soil

Soil depth (cm)	Organic content (g/kg)	bulk density (g/cm ³)	Texture Class	Field capacity		Permanent wilting point		TAW (mm/m)
				w/w	v/v	w/w	v/v	
0-20cm	3.8	1.13	silt clay	36.42	41.15	22.46	25.38	157.70
20-40cm	3.1	1.33	Clay	35.68	47.49	24.31	32.36	151.25
40-60cm	3.6	1.42	clay	35.57	50.69	24.46	34.86	158.30
Mean	3.5	1.29	clay	35.89	46.45	24.46	30.87	155.75

The soil of the study area was dominantly clay soil type with 57% clay, 31% silt, and 11 % sand. Thus, as per the USDA soil textural classification, the soil was classified as clay soil. According to (Debele, 1980) the organic content of the koga irrigation scheme was categorized as medium ranging from (2.6-5.2 g/kg).

Crop water Requirement and Irrigation Water Application Depths

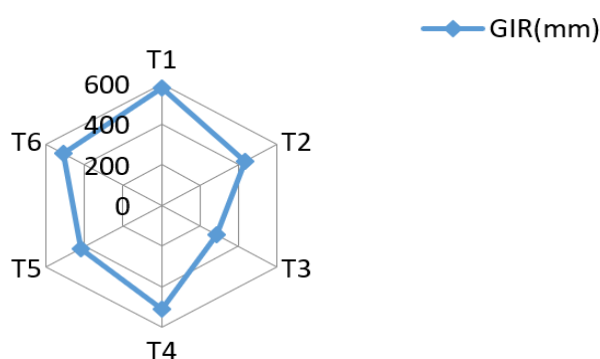


Figure 3. Crop water requirement vs water application depth

The total maximum application depth (513 mm) was obtained at 50% deficit during the initial and late growth stages (T6) while the minimum (289 mm) value was obtained in treatment (T3) which was 50% deficit throughout the whole growth period. (Figure 3) shows the total amount of water applied and the amount of water saved per treatment assuming a maximum irrigation attainable efficiency of 70%. The amount of water varied from as high as 578 mm to as low as 289 mm (Table3).

Table 3. Irrigation water applications and water saving under different treatments

Treatment	NIR		GIR		Water saved		
	(mm)	(m ³ /ha)	(mm)	(m ³ /ha)	(mm)	(m ³)	(%)
Dall,0 (T1)	404.9	4049	578	5780	0.00	0.00	0
Dall,25 % (T2)	303.4	3034	434	4340	145	1450	25
Dall,50% (T3)	202.4	2024	289	2890	289	2890	50
Db,50% (T4)	357.2	3572	510	5100	68	680	12
Dc,50 % (T5)	283.3	2833	422	4220	156	1560	30
Da,d, 50 % (T6)	359.3	3593	513	5130	65	650	11

Remarks: - a, b, c, and d indicate growth stages, respectively

The effect of water application level on yield and yield components

The final canopy cover, biomass yield, and water productivity for the experimental measured data analysis results. The response of barley yield to various levels of irrigation water is different at each treatment (Table 4).

Table 4. Yield reduction and harvest index with respect to applied water

Treatment	GIR (mm)	Biomass (ton/ha)	Yield (ton/ha)	HI (%)	Yield reduction (ton/ha)	Yield reduction (%)	saved water related to full (T1)
T1	578	11.83 ^a	3.58 ^a	30.3	0	0	0
T2	434	10.01 ^b	3.49 ^{ab}	34.8	0.09	2.67	25
T3	289	7.58 ^c	1.58 ^c	20.8	1.92	54.8	50
T4	510	10.33 ^{ab}	3.12 ^b	30.2	0.47	13.1	12
T5	422	9.33 ^{bc}	1.88 ^c	20.1	1.62	46.4	30
T6	513	10.49 ^{ab}	3.55 ^a	33.4	0.04	1.03	11
	LSD	0.56	0.1925				
	Cv	9.80	8.23				

Remarks: The numbers with the same letter show that these treatments are not statistically different at the 5% level of significant,

The maximum grain yield was found to be (3.58 tons/ha) when full irrigation, i.e., 100 % of GIR. On the other hand, a deficit of 50% at the initial and late growing period and a 25% deficit throughout the growing season did not affect the yield compared to full irrigation. The yield obtained at T6 was 3.55 tons/ha with 1.03 % yield reduction. This result has shown that stress at 50% at the initial and late season was not affecting the yield compared to full (T1) and a deficit of 25% throughout the growing season was not affecting the yield compared to full that was (3.49 tons/ha). More significantly, yields of 1.58 ton/ha were obtained for treatment T3 (50 % of GIR application) throughout the whole growing season and T5 (50 %GIR application) stress at mid stage was obtained (1.78ton/ha). This result shows that stress 50 % causes significant yield reduction (54.8 % yield reduction) with 50 % water save and 46.4 yield reduction and save 30% water save at treatment(T5). The results of grain yield and yield components indicated that drought stress treatment during the grain filling period reduced grain yield by decreasing the number of fertile spikes and grains per plant. The result of this study was strongly agreed with some previous studies of (Mulatu & Grando, 2011) 3-3.5 ton/ha, Study of (Yigezu et al., 2015) 3.5 -5 ton/ha with in the same local barley and the result of this study disagreed with the result of (Simion, 2018) 2.028ton/ha. The correlation coefficient for the water application and yield was obtained as $R^2 = 0.72$, which shows the relationship of water application and yield was a power correlation function as shown (Figure 4).

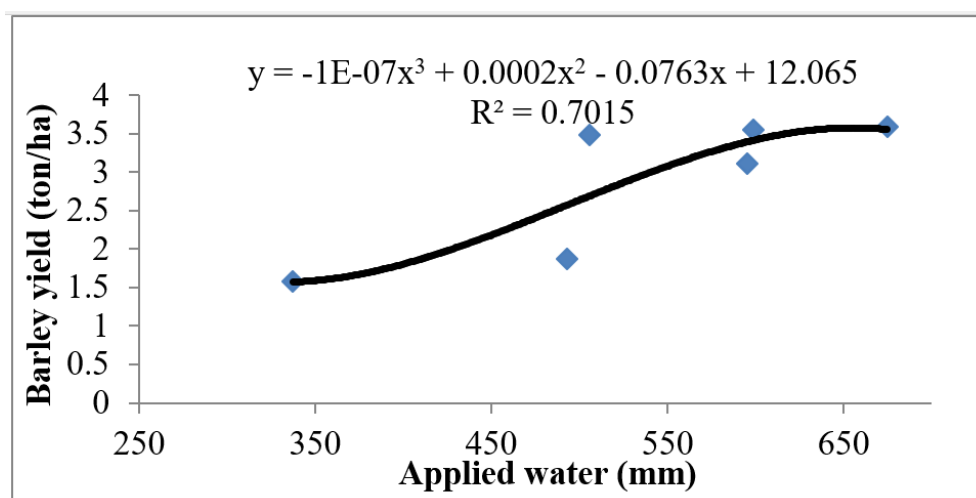


Figure 4. Crop yield response to seasonal irrigation

Analysis of biomass and components

Table 5. Biomass and plant parameter components

Treatment (T)	Final biomass(ton/ha)	Plant height(m ²)	spike length(cm)	Seed No. per spike(m ²)	weight of10 ³ grains(g)
T1	11.83 ^a	90.70 ^a	10.33 ^a	22.30 ^a	52.66 ^a
T2	10.01 ^b	81.60 ^{ab}	7.40 ^b	19.00 ^{ab}	49.17 ^{ab}
T3	7.58 ^c	64.30 ^d	5.00 ^c	13.00 ^b	42.00 ^c
T4	10.33 ^{ab}	76.80 ^{bc}	6.63 ^{bc}	18.00 ^{ab}	50.67 ^{ab}
T5	9.33 ^{bc}	66.73 ^{cd}	5.33 ^{bc}	14.00 ^b	45.33 ^{bc}
T6	10.49 ^{ab}	82.40 ^{ab}	7.00 ^{bc}	18.00 ^{ab}	50.00 ^{ab}
Cv	8.6	16.6	24.84	6.91	
LSD	5.4	0.94	3.52	2.72	
mean	77.11	6.97	17.38	48.30	

Remarks: The numbers with the same letter show that these treatments are not statistically different at the 5% level of significant.

The final above ground biomass, plant height, and spike length, number of seeds per spike, and weight of thousand grains were affected by moisture levels in some treatments. The statistical result shows that the maximum biomass of 11.83 kg/ha was obtained at T1 (full irrigation application) (figure5). Lower biomass was observed for T3, which was subjected to a sustained deficit of 50%. Water deficit is known to reduce the 1000-grain weight by shortening the grain-filling period Mamnouie et al. (2006). There were significant differences in the number of grains/spikes between treatments (Table 5).

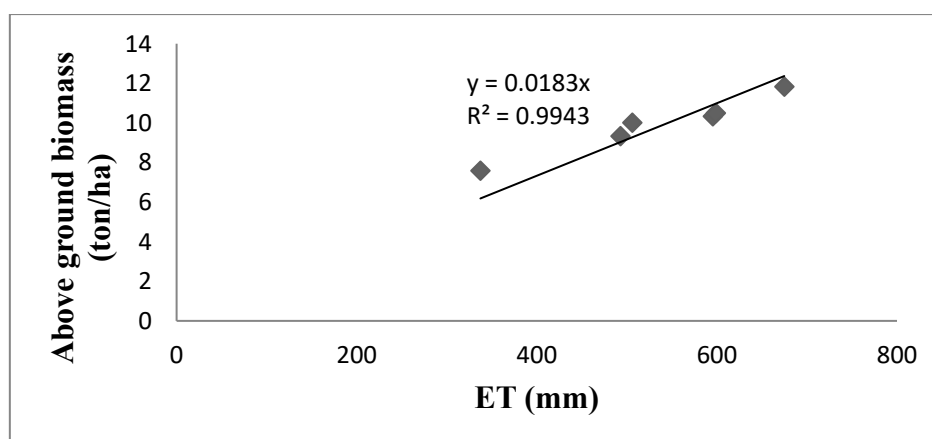


Figure 5. Above ground biomass vs Transpiration

Analysis of canopy cover and water productivity

The amount of moisture transpired by the crop and evaporated from the bare soil to satisfy the demand of the atmosphere is related to the leaf area development, which increases or decreases the area exposed to direct sunlight. The analysis of canopy cover using green crop Tracker (LAI-2000).

Table 6. Canopy cover and water productivity

Treatment(T)	GIR(mm)	CC (%)	Wp(kg/m ³)
T1	578	94.2 ^a	0.62 ^{bc}
T2	434	80.8 ^b	0.80 ^a
T3	289	69.3 ^c	0.55 ^{cd}
T4	510	80.9 ^b	0.61 ^{bc}
T5	422	74.7 ^{bc}	0.44 ^d

T6	513	83.8 ^{ab}	0.69b
CV: 7.49		LSD: 4.9294	Mean: 80.647

Remark: - GIR=gross irrigation requirement, CC=canopy cover, WP=water productivity

The highest and lowest mean value of water productivity was observed to be 0.8 kg/m³ and 0.44 kg/m³ for treatments T2 (stressed 25% throughout the growing season) and T5 (50% stress at flowering stage) respectively. Similarly, the stress 50 % T3 was significant ($p<0.05$) at T1, T4, and T6, respectively (Table 6).

Crop response factor (KY)

The crop response factor (KY) determines the slope of total grain yield and above ground biomass reduction with moisture stress.

Table 7. Crop response of barley crop

Treatment	GIR(mm)	(ton/ha)	(1-Ya/Ym)	(1-Eta/Etm)	KY
T1	578.4	3.5833	0	0	0.0
T2	433.8	3.4867	0.0267	0.25	0.12
T3	289.2	1.5833	0.558	0.5	0.88
T4	510.3	3.1167	0.131	0.12	1.08
T5	422.45	1.875	0.464	0.3	1.78
T6	513.25	3.5467	0.01	0.11	0.09

Remark:

GIR=Gross irrigation requirement,

1-ya /ym=Relative yield decrease,

1-Eta/Etm=Relative water deficit,

KY=crop yield factor

This study showed that barley crops at development and mid stage were highly sensitive to water deficit (Table 7) and proportional large yield reductions may occur, especially at mid stage since the Ky value in development and mid stage was greater than one ($K_y>1$) (Figure 6).

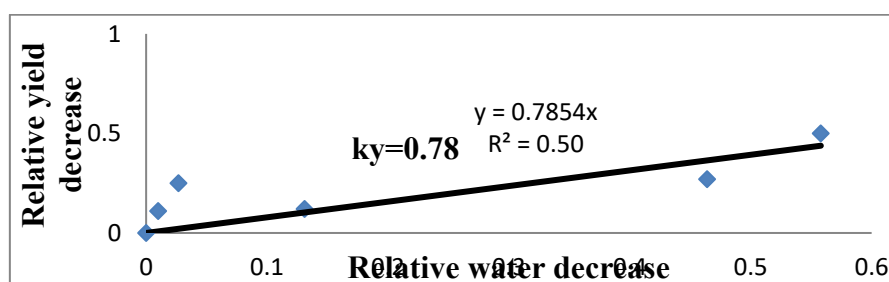


Figure 6. Yield response factor

Aqua crop model

Model calibration

Aqua Crop model was calibrated using the data for the period from December 11/2018 to April 09/2019. The model was calibrated using field data (canopy cover, biomass, and yield) for full irrigation treatment (100 % GIR). The simulation was performed with Aqua Crop version 6.0. Model calibration is powerful to reduce the parameter uncertainty. The main conservative and nonconservative input parameters were used to calibrate the model. The non-conservative inputs (Table 8) are water stress coefficient for canopy development, stomata closure, and curve shapes were iterated to calibrate the model.

Table 8. Observed and simulated canopy cover

DAS	15	25	34	44	52	67	80	120
Measured	10	25	62	74	83	95	80	3.5
Simulated	7.4	19.6	47.2	75.8	85.2	91.2	91.9	0
Deviation %	-26	-21.6	-23.87	2.43	2.65	-4.0	14.87	

Remark: DAS indicates days after sowing

Statistical model performance was a better relationship with the measured and simulated canopy cover (Table 9). The statistical result of ($R^2=0.92$, RMSE =9.8 and d=0.93) was received for calibration at full irrigation (Figure 7.)

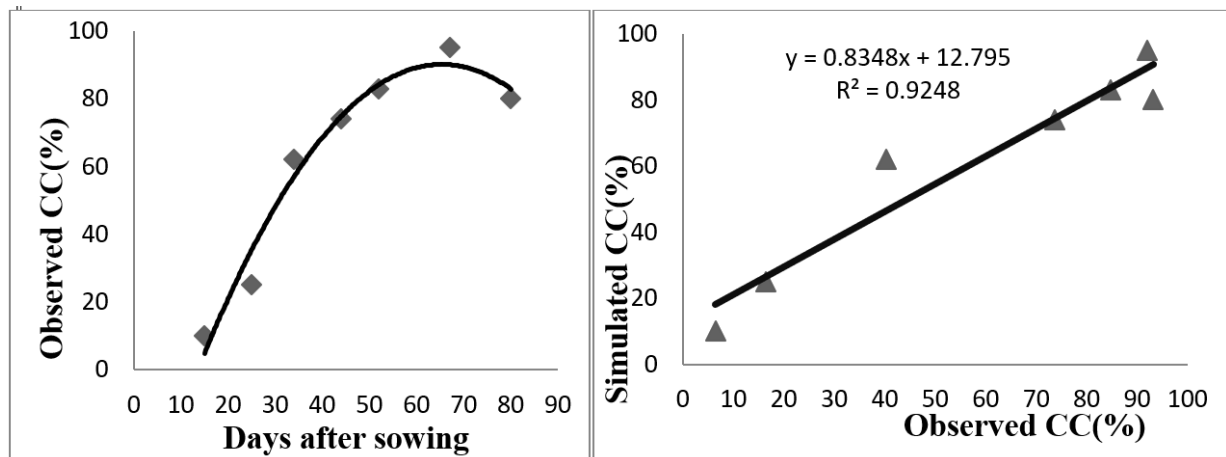


Figure 7. Measured and simulated canopy cover of treatment T1 (calibration)

Table 8.Measured and simulated Biomass for treatment 1 T1 (calibration)

DAS	15	34	52	75	120
Measured	0.12	1.28	4.12	9.6	11.83
Simulated	0.13	1.12	3.75	7.32	12.04
Deviation%	8.33	-12.5	-8.98	-23.75	1.78

The result of the aqua Crop model simulation in biomass was obtained (Table10) with the correlation coefficient of ($R^2>0.94$), RMSE of 1.1 and index of agreement (d) is 0.98 (Figure8) in Koga irrigation.

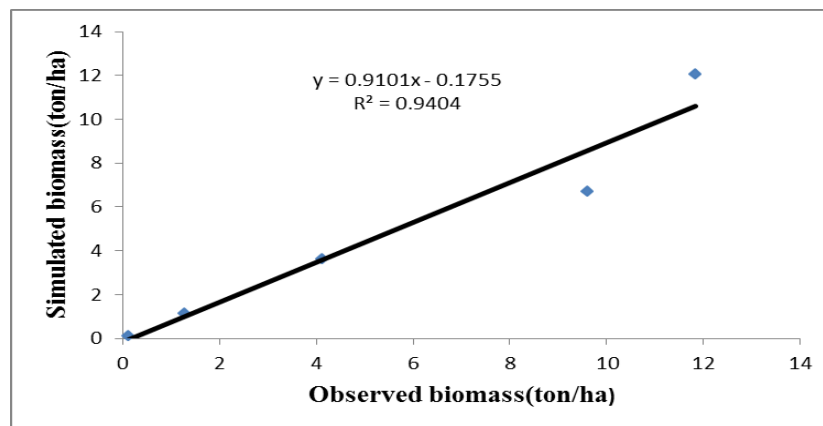


Figure 8. Measured versus simulated biomass for calibration

Model validation

The parameters derived from the calibration were used for validation and performance evaluation of Aqua Crop by using data from the remaining treatments (T2-T6) from December 11 / 2018 to April 9/2019. The cumulative yield, canopy cover, and biomass for the validation period for each treatment were simulated. The simulated yield agreed well with the measured yield for validation (Table 11). There was a strong relationship between measured and simulated yield R^2 of 0.85 (Figure 9).

Table 9.Statistical analysis of yield for validation

	Yield (ton/ha)				
Treatment	T2	T3	T4	T5	T6
Measured	3.49	1.58	3.12	1.87	3.55
Simulated	3.35	1.63	3.72	2.36	3.36
Deviation	-4.01	3.16	19.23	26.20	-5.35

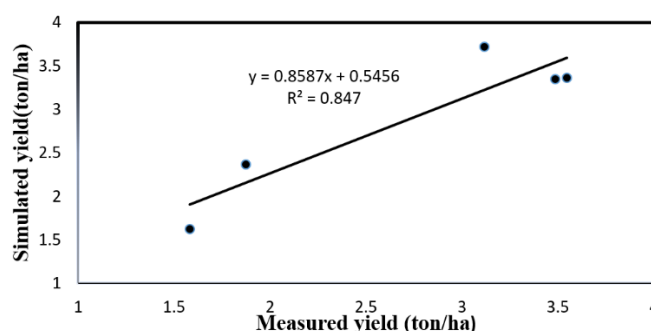


Figure 9. Measured versus simulated yield for validation

Table 10.Statistical analysis of Biomass for validation

	Biomass(ton/ha)				
Treatment	T2	T3	T4	T5	T6
Measured	10.01	7.58	10.33	9.33	10.49
Simulated	10.42	7.87	11.70	8.51	11.45
Deviation (%)	4.09	3.82	13.26	-8.79	9.15

The results above (Table 12) showed that there is a good relation between the measured and simulated values for biomass. There is a good correlation between Measured versus simulated biomass with $R^2=82$ (Figure10)

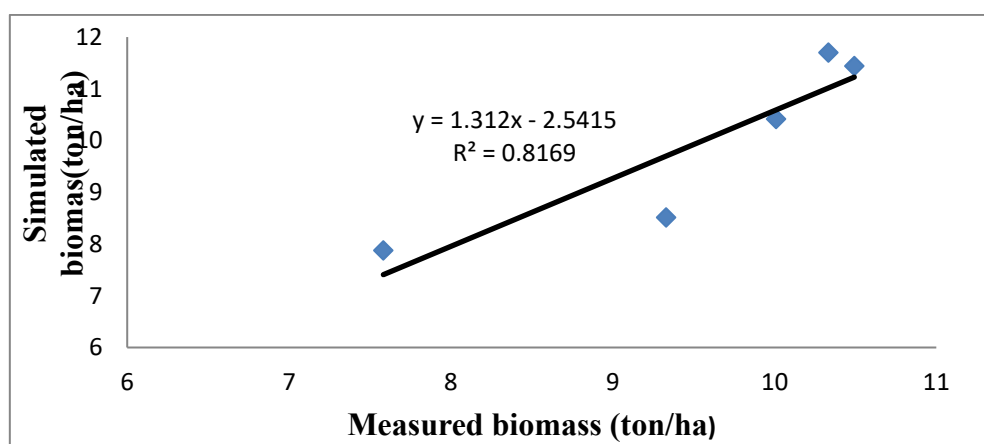


Figure10. Measured versus simulated biomass for validation

Simulation of canopy cover

Table 11. Statistical analysis of canopy cover for validation

CC (%)					
Treatment	T2	T3	T4	T5	T6
Measured	80.8	72.7	80.9	79	84
Simulated	79.8	69.8	84.4	78.1	91.2
Deviation	-1.2	-3.98	4.32	-1.1	8.57

The above results showed in (Table 13) the model estimates below and above in some treatments.

CONCLUSIONS

The advantage of deficit irrigation depends on saving water and increasing water and land productivity while stabilizing optimum crop yield as close as the full irrigation (Ayana, 2011). The results showed that no significant difference was observed between the yield of treatments which were stressed at 25% of GIR (3.49 tons/ha) and 50% stressed at initial and late stage (3.55 tons/ha) compared to the full irrigation yield (3.58 tons/ha). During stress, 25 % of GIR throughout the season and 50% stress at the initial and late stage can be saved water to irrigate additional land with the saved water to increase more production. Stress during 50 % of GIR of the whole stage and stress 50% at mid- stage were highly affecting the yield (1.58, 1.87 tons/ha respectively) and biomass production. In line with obtain the highest biomass and yield at full irrigation. However, it was not significantly higher than the treatment with water stress at 25% whole and 50% at initial and late growth stage. Generally, full irrigation has not significantly improved the biomass and yield when compared with their corresponding stress irrigation treatments. In line with (Araya & Afewerk, 2010) obtain the highest biomass and yield at full irrigation. However, was not significantly higher than the treatment with water stress at 25% the whole and 50% at initial and late growth stage. Besides to this, the most sensitive stage of any crop must be investigated to reduce the severe yield reduction effect. The knowledge of the sensitive stages of the crop to water deficit is crucial to manage and apply deficit technology. The seasonal sensitivity factor for the barley crop was found to be equal to 0.78. However, the crop sensitivity to water stress was highest during the mid-growth period and the crop was least sensitive to water stress during the initial and late seasons. Thus, the stress crops near end of the development crop growth period caused the highest reduction in grain yield. However, stresses at the initial and late stage did not reduce the yield. The result was supported by (Martini, 2018) who showed that the Aqua crop model could simulate canopy cover of corn in the treatment of optimum irrigation better than treatment of water stress and (Nielsen et al., 2012) Showed results similar to this research on the canopy cover of cotton. The model confirmed that there is a good agreement between simulations and observations of yield, canopy cover and biomass ($R^2=0.84$, RMSE= 0.31, d= 0.94) for yield ($R^2=0.81$, RMSE= 0.7, d= 0.96) for biomass and ($R^2=0.91$, RMSE= 3.2, d= 0.97) for canopy. Vanuytrecht et al. (2014) explain that the calibration of the water stress at late stage was no effect on the yield production of the cotton crop. The results of the research showed that the model is capable of simulating canopy biomass and grain yield of barley crops for full supplied irrigation and treatment with stress water.

RECOMMENDATION:

1. From water stressed treatment the highest yield was obtained T6 (3.55 ton/ha) by stressing 50% of crop water requirement during initial and late and stress 25% during the whole stage which is better to save water with less yield reduction compared to full irrigation. Therefore, we can recommend that the application water stress at 25% throughout the growing season and 50% stress at initial and late stage are best for barley crops at Koga irrigation scheme.
2. The amount of water saved with stressing 25% irrigation water application at all stages and stressful irrigation during initial and late season growth period can be used to irrigate additional command area. Thus, the overall crop production can be increased.

3. To demonstrate the profitability of deficit irrigation practice, an economic analysis is required.
4. The barley crop was sensitive to water stress during the middle (flowering) growth period. Therefore, irrigating at the end of developmental crop growth period was necessary to reduce high yield reduction.

REFERENCES

- [1] Abiyu, A., & Alamirew, T. (2014). Evaluation of Stage-Wise Deficit Furrow Irrigation Application on Water Advance-Recession Time and Maize Yield Components at Koga Irrigation Scheme, Ethiopia. *American Journal of Scientific and Industrial Research*.
- [2] Abbrha, B., Delbecque, N., Raes, D., Tsegay, A., Todorovic, M., Heng, L., . . . Deckers, S. (2012). Sowing strategies for barley (*Hordeum vulgare* L.) based on modelled yield response to water with AquaCrop. *Experimental Agriculture*, 48(2), 252-271.
- [3] Agegnehu, G., Nelson, P. N., & Bird, M. I. (2016). Crop yield, plant nutrient uptake and soil physicochemical properties under organic soil amendments and nitrogen fertilization on Nitisols. *Soil and Tillage Research*, 160, 1-13.
- [4] Araya, A., Habtu, S., Hadgu, K. M., Kebede, A., & Dejene, T. (2010). Test of AquaCrop model in simulating biomass and yield of water deficient and irrigated barley (*Hordeum vulgare*). *Agricultural Water Management*, 97(11), 1838-1846.
- [5] Burt, C., & Styles, S. (1999). Modern water control and management practices in irrigation. Impact on performance. *Water Reports* 19. FAO. Roma. Italia.
- [6] Celebi, M. (2014). The effect of water stress on tomato under different emitter discharges and semi-arid climate condition. *Bulgarian Journal of Agricultural Science*, 20(5), 1151-1157.
- [7] Debele, B. (1980). SURVEY OF STUDIES CONDUCTED ABOUT SOIL RESOURCES APPRAISAL AND EVALUATION FOR RURAL DEVELOPMENT IN ETHIOPIA.
- [8] Droogers, P., & Allen, R. G. (2002). Estimating reference evapotranspiration under inaccurate data conditions. *Irrigation and drainage systems*, 16(1), 33-45.
- [9] English, M., & Raja, S. N. (1996). Perspectives on deficit irrigation. *Agricultural Water Management*, 32(1), 1-14.
- [10] Fereres, E., & Soriano, M. A. (2007). Deficit irrigation for reducing agricultural water use. *Journal of experimental botany*, 58(2), 147-159.
- [11] Kirda, C., & Kanber, R. (1999). Water, no longer a plentiful resource, should be used sparingly in irrigated agriculture. *Crop yield response to deficit irrigation.*, 1-20.
- [12] Kirda, C., & Kanber, R. (1999). Water, no longer a plentiful resource, should be used sparingly in irrigated agriculture. *Crop yield response to deficit irrigation*, 1-20.
- [13] Kirda, C., Kanber, R., Tulucu, K., & Gungor, H. (1999). Yield response of cotton, maize, soybean, sugar beet, sunflower and wheat to deficit irrigation. *Crop Yield Response to Deficit Irrigation*. Kluwer Academic Publishers, Dordrecht, Boston, London, 21-38.
- [14] Li-Cor, I. (1992). LAI-2000 plant canopy analyzer instruction manual. LI-COR Inc., Lincoln, Nebraska, USA.
- [15] Mamnouie, E., Ghazvini, R. F., Esfahany, M., & Nakhoda, B. (2006). The Effects of Water Deficit on Crop Yield and the Physiological Characteristics of Barley (*Hordeum vulgare* L.) Varieties. *J. Agric. Sci*, 8, 211-219.
- [16] Mishra, P., & Homa, F. (2019). *Essentials of Statistics in Agricultural Sciences*: CRC Press.
- [17] Mulatu, B., & Grando, S. (2011). Barley research and development in Ethiopia: Ethiopian Institute of Agricultural Research, International Center for
- [18] Simion, S. M. T. (2018). Adaptability Evaluation of Early Maturing Food Barley in Highland Areas of Southern Ethiopia. *evaluation*, 71.
- [19] Tewabe, D., & Dessie, M. (2020). Enhancing water productivity of different field crops using deficit irrigation in the Koga Irrigation project, Blue Nile Basin, Ethiopia. *Cogent Food & Agriculture*, 6(1), 1757226.

- [20] Willmott, C. J. (1982). Some comments on the evaluation of model performance. *Bulletin of the American Meteorological Society*, 63(11), 1309-1313.
- [21] Xiu-liang, J., Feng, H.-k., Zhu, X.-k., Zhen-hai, L., Sen-nan, S., Xiao-yu, S., . . . Wen-shan, G. (2014). Assessment of the AquaCrop Model for Use in Simulation of Irrigated Winter Wheat Canopy Cover, Biomass, and Grain Yield in the North China Plain. *PLoS One*, 9(1), e86938.
- [22] Yigezu, Y., Yirga, C., & Aw-Hassan, A. (2015). Varietal output and adoption in barley, chickpea, faba bean, field pea and lentil in Ethiopia, Eritrea and Sudan. *Crop improvement, adoption and impact of improved varieties in food crops in Sub-Saharan Africa* (TS Walker and J. Alwang eds.). CGIAR and CABI, Wallingford, UK, 228-238.
- [23] Yihun, Y. M. (2015). Agricultural water productivity optimization for irrigated Teff (Eragrostic Tef) in water scarce semi-arid region of Ethiopia Agricultural water productivity optimization for irrigated Teff (Eragrostic Tef) in water scarce semi-arid region of Ethiopia: CRC Press/Balkema.



INVITATION

**The next scientific
MEETING WILL BE**

**the 15th ICEEE International Conference-2024
which will be in November 2024
in Budapest, HUNGARY**

ONLINE

**You are welcome, waiting for the contribution
Soon you will have the official invitation.**

*******Good Luck*******



ÓBUDA UNIVERSITY
REJTŐ SÁNDOR FACULTY OF LIGHT INDUSTRY
AND ENVIRONMENTAL ENGINEERING



PROCEEDINGS BOOK
VIIIth International Symposium-2024
Theme: Environmental Health and Biosecurity Strategy
May 9 – 10, 2024
ICEEE
RKK – Óbuda University, Budapest, Hungary
ISBN 978-963-449-365-5

www.iceee.hu