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SUPREMEGLASS – MY JOURNEY AS A STUDENT AND ENTREPRENEUR

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Abstract

Glass is a solid-like and transparent material that is used in numerous applications in our daily lives. Glass is made from natural and abundant raw materials (sand, soda ash and limestone) that are melted at high temperature to form a new material: glass. Glass manufacturing has an age-old tradition which dates to around 3500 BC. Since then, processes have constantly evolved from craftsmanship to today's high-tech industrial processes and the number of glass types and applications have multiplied. Glass has shaped Europe's cultural heritage, regions, industries, living conditions, technological deployments like no other substance. Glass creates the conditions for sustainable growth in Europe and contributes to Europe's Green Deal and to the United Nations' Sustainable Development Goals. *Glass products are indispensable to the transition towards a climate-neutral circular economy: for renovating buildings, producing more renewable electricity, decarbonising means of transport and making sustainable packaging. In short, glass creates the conditions of prosperity, a symbiosis with society and the environment. For the first time in the history of the United Nations' International Years, a man-made material was recognised as essential and awarded as* 2022 International Year of Glass*. We are living in a 'Glass Age' and the United Nations (UN) aimed for the International Year of Glass to underline the scientific, economic and cultural roles of glass throughout the world in the context of the UN 2030 sustainability goals.*
An idea is nothing without action, that's why the transition from student to engineering and environmental protection, and currently to engineering and management in constructions to entrepreneurship in the field of providing design and installation services for various works in which glass is involved was very well planned and thought out so as to harmoniously combine these activities. The purpose of this work is to present some of the interior design projects designed, realized and completed within my company, in which glass is used as a construction material due to the many advantages it presents.

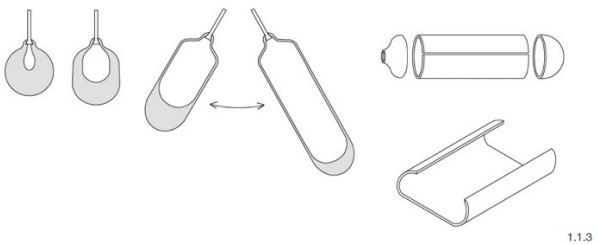
Key words*: construction material, entrepreneur, glass, student, interior design projects*

INTRODUCTION

Today, glass is a fundamental material in modern construction, transforming the architectural landscape with its transparency, versatility, and aesthetic charm. While its origins can be traced to ancient Mesopotamia and Egypt, the precise birthplace of glassmaking remains uncertain. Early forms of glass were likely discovered by accident, either from ash produced during copper smelting or from the firing of clay vessels used to glaze ceramics. Artifacts dating back to the 5th century BC have been found in Mesopotamia, while others from the early 4th century BC were uncovered in Egypt. Notably, when the tombs of Egyptian pharaohs were opened, greenish glass beads dating from around 3500 BC were discovered, further evidence of early glass use.

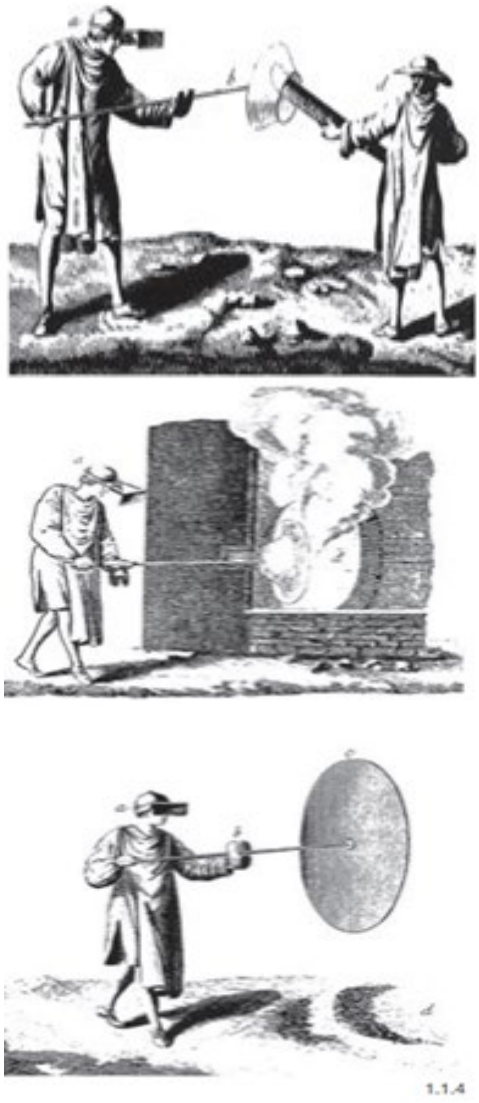
Since the early Middle Ages, two key production techniques—blown cylinder sheet glass and crown glass—have remained the foundation of glassmaking. These methods continued to dominate the industry until the late 19th and early 20th centuries.

The production of blown cylinder sheet glass



1.1.3

The production of crown glass, engraving from Encyclopédie, Diderot and d'Alembert, 1773



The 17th and 18th centuries marked a significant expansion in the use of glass. During this period, glass was no longer exclusively sold to churches and monasteries, but also to merchants in cities, who used it for glazing palaces and private homes. This shift in demand spurred glassmakers to innovate new production methods. One key development came from the Frenchman Bernard Perrot, who introduced the cast glass process. In this method, molten glass was poured onto a smooth, preheated copper table and then pressed into a flat pane by a water-cooled metal roller. The thickness of the glass depended on the height of the surrounding frame. However, it was not until the industrialization of glass production that the process truly scaled. In 1856, Friedrich Siemens patented an improved version of the melting furnace, which revolutionized glassmaking. This innovation made it possible to produce large quantities of glass panes, meeting the growing demands of the construction industry.
Machine-made glass panes of high quality became feasible around 1905, thanks to the work of Belgian inventor Emile Fourcault. He developed a process in which glass was drawn directly from the molten material. In this method, a nozzle made of fired clay was immersed in the molten glass, allowing it to flow through a slit. The glass was then gripped by iron tongs and, while cooling, was drawn vertically upwards in a manner similar to the slow flow of honey. This innovation enabled the production of large, high-quality glass panes.

MATERIALS AND METHODS

Glass – a definition
Glass is a homogeneous material that can be described as a solidified liquid. Its molecular structure is characterized by a completely random arrangement of molecules, rather than forming a regular crystal lattice. This lack of crystallinity is what gives glass its transparency. Since it is composed of a variety of chemical bonds, glass does not have a single, fixed chemical formula. Unlike most materials, glass does not have a distinct melting point. Instead, when heated, it gradually transitions from a solid to a plastic-viscous state and eventually to a liquid state. The type of glass commonly used in construction today is soda-lime-silica glass. During its production, raw materials are heated to extremely high temperatures, causing them to become viscous before they are allowed to cool and solidify

General physical properties of glass

Property	Symbol	Value with units
Density at 18 °C	r	2500 kg/m^3
Hardness		6 units on the Mohs scale
Modulus of elasticity	E	7×10^{10} Pa
Poisson's ratio	m	0.2
Specific heat capacity	c	0.72×10^3 J/(kg × K)
Average coefficient of thermal expansion	α	9×10^{-6} K^{-1}
Thermal conductivity	λ	1 W/(m × K)
Average refractive index in the visible range of wavelengths 380–780 nm	n	1.5

Methods of manufacture and composition
Composition
Modern glass is typically composed of the ingredients listed in the table below. In addition to the main components, small amounts of other substances may be added to modify specific properties, such as the coefficient of expansion or color. For example, the production of body-tinted glass involves the addition of minimal quantities of appropriate additives. These additives do not significantly affect the mechanical strength of the glass, but they can influence its optical characteristics and thermal properties.

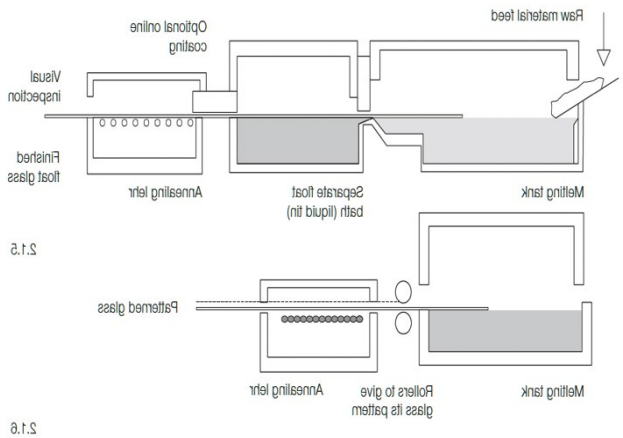
Composition of glass

Silicon dioxide	(SiO_2)	69%–74%
Calcium oxide	(CaO)	5%–12%
Sodium oxide	(Na_2O)	12%–16%
Magnesium oxide	(MgO)	0%–6%
Aluminium oxide	(Al_2O_3)	0%–3%

This composition has been standardized for Europe in EN 572 part 1.

2.1.2

In the 1950s, the Englishman Alastair Pilkington developed the float glass method, a revolutionary technique for producing flat glass. In this process, a viscous glass melt is poured onto a bath of molten tin, where it floats on the surface. The surface tension, along with the differing viscosities of the glass and the molten tin, causes the liquid glass to spread into a uniform layer approximately 6 mm thick. The temperature of the molten tin is maintained at 1000°C at the inlet and reduced to 600°C at the outlet. After exiting the molten tin bath, the glass undergoes a carefully controlled cooling process to relieve any residual stresses before being cut to the desired size.



Types of Glass
Soda-Lime Glass:

- Composition: Soda-lime glass, the most prevalent type of glass, is composed of silica sand, soda ash, and limestone.
- Properties: It is transparent, relatively inexpensive, and possesses good chemical resistance.
- Applications: Soda-lime glass finds widespread use in windows, containers, bottles, and tableware due to its affordability and versatility.

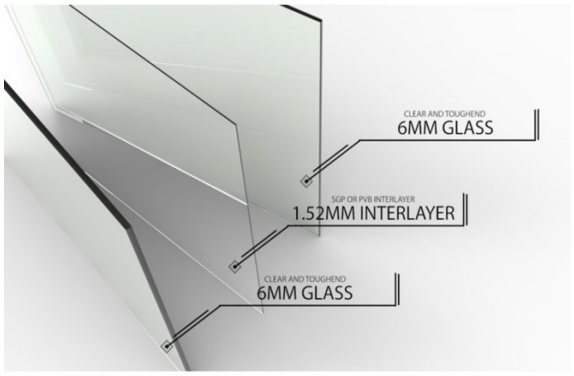
Borosilicate Glass:

- Composition: Borosilicate glass contains silica sand and boron trioxide, which imparts thermal shock resistance.
- Properties: It exhibits high thermal resistance, low coefficient of thermal expansion, and excellent chemical durability.
- Applications: Borosilicate glass is commonly used in laboratory glassware, kitchenware, and high-temperature applications such as ovenware and lighting fixtures.

Tempered Glass/ESG

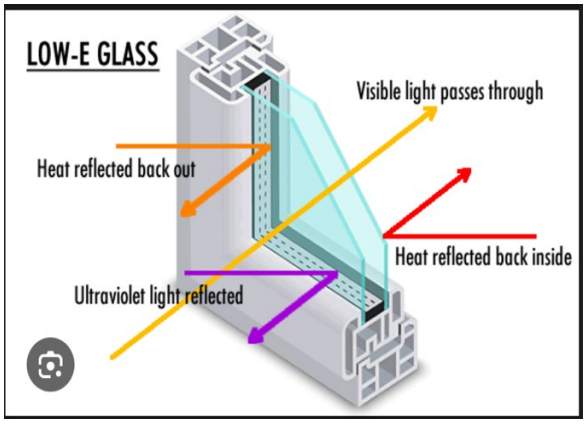
- Composition: Tempered glass undergoes a specialized heat treatment process to increase its strength and durability.
- Properties: It is four to five times stronger than standard glass and shatters into small, blunt fragments when broken, enhancing safety.
- Applications: Tempered glass is utilized in architectural applications such as doors, windows, shower enclosures, and automotive side windows.

Laminated Glass:



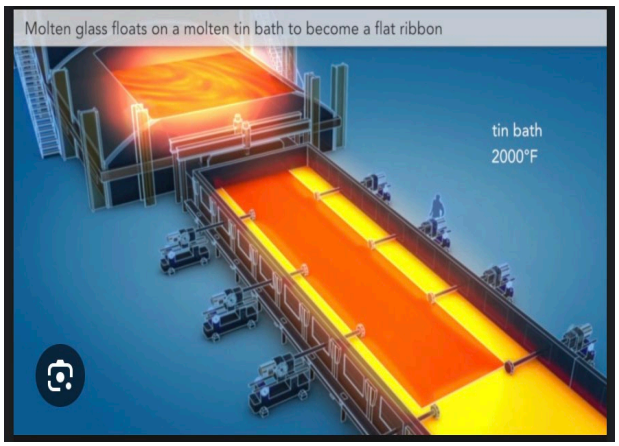
- Composition: Laminated glass consists of two or more layers of glass bonded together with an interlayer, typically made of polyvinyl butyric (PVB) or ethylene-vinyl acetate (EVA).
- Properties: It provides enhanced safety and security, as the interlayer holds the glass fragments together upon impact.
- Applications: Laminated glass is used in building facades, skylights, bullet-resistant windows and automotive windshields.

Low-E (Low-Emissivity) Glass:



- Composition: Low-E glass is coated with a microscopically thin layer of metal oxide to reduce heat transfer and improve energy efficiency.
- Properties: It reflects infrared radiation while allowing visible light to pass through, resulting in reduced heat loss or gain.
- Applications: Low-E glass is employed in energy-efficient windows, doors, and curtain walls to optimize thermal performance and reduce heating and cooling costs.

Float Glass:



- Composition: Float glass is manufactured by floating molten glass on a bed of molten tin, resulting in a smooth and uniform surface.
- Properties: It has excellent optical clarity, flatness, and surface quality, making it ideal for architectural glazing applications.

- Applications: Float glass is widely used in windows, mirrors, display panels, and architectural glass installations.

Specialty Glasses:

- Composition: Specialty glasses encompass a wide range of compositions tailored to specific applications, such as strengthened glass, fire-resistant glass, and UV-blocking glass.
- Properties: These glasses offer specialized characteristics, including enhanced strength, fire protection, and protection against harmful ultraviolet radiation.
- Applications: Specialty glasses find niche applications in industries such as aerospace, healthcare, telecommunications, and defense.

MY JOURNEY AS A STUDENT AND ENTREPRENEUR

In addition to my student activity, I also started to develop as an entrepreneur. A positive influence on my journey as an entrepreneur was the PWN START-UP WORKSHOP provided by USAMVB.

This workshop helps me to have a better understanding about the way I have to run my business, how to manage stress but the most important lesson I've learned so far is that it doesn't matter how many times you fail, the important thing is to keep going.

PWN Start-up Workshop team

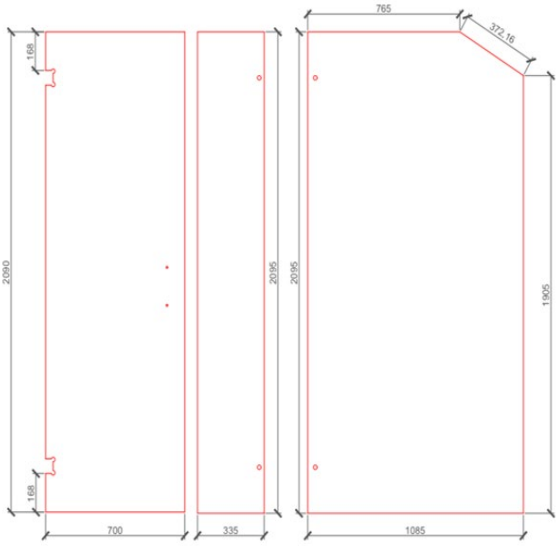
SUPREMEGLASS

Is a company created out of my passion to work with glass. From the very beginning, when I had my first contact with this industry, I knew that I would become a glass service provider.

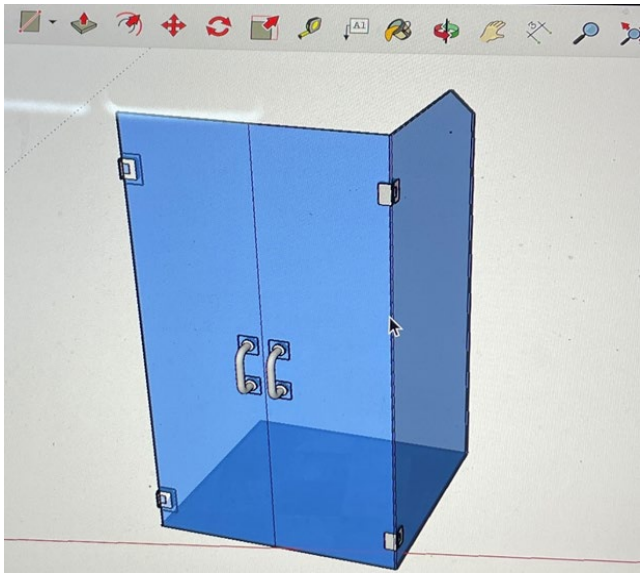
Now we supply a variety of products that use glass like enclosure shower, glass railing, decorative mirror.

Working with glass requires both skill and precision, as the material's properties can be both rewarding and challenging.

The daily operation starts with a measurement on the field, then the measurements are processed true **SketchUp** and **AutoCad**, after the final design go to the customer for future changes and validation.



AutoCad design



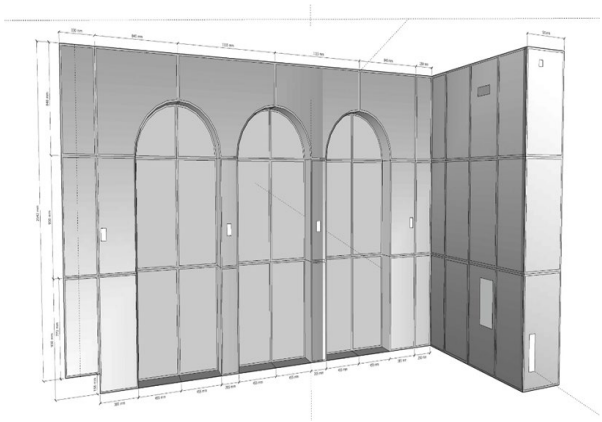
Sketch Up design

When the design it is ready, the mesurament go to the glass service provider where the glass is cut, drilled, tempered and edged.

Edging machine

Everything ends with the installation, the final step. Installation it is a labor consuming process because glass can be damaged very easy and requires a lot of care in order to have a right installation.

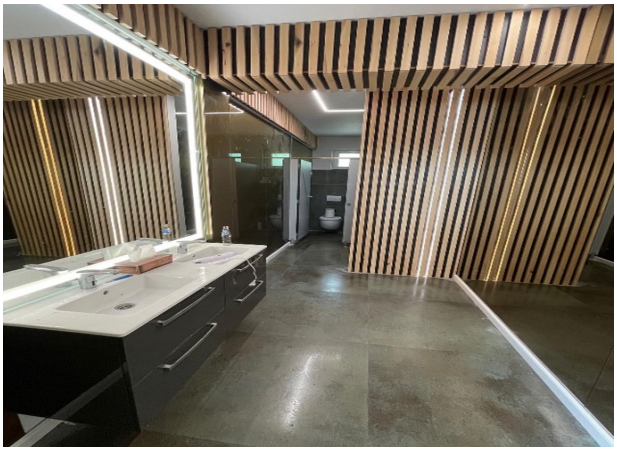
MY PERSONAL PROJECTS



SketchUp design for Condesa

The final product

SketchUp design for AquaBlue



The final product

CONCLUSIONS

The knowledge and skills acquired as a student, together with the PWN workshop, helped me improve my skills as an entrepreneur.

Glass is one of the most recyclable materials available, making it an environmentally friendly option for packaging and other uses. Unlike many materials, glass can be recycled indefinitely without losing its purity or quality. This infinite recyclability stems from its composition and the way it is processed during recycling.

Energy Conservation: Recycling glass uses about 30% less energy than creating new glass from raw materials. Since cullet melts at a lower temperature, it requires less energy in the furnace, leading to significant energy savings.

Reduced Raw Material Usage: Each ton of recycled glass used in manufacturing saves approximately 1.2 tons of raw materials. This conservation of natural resources helps preserve the environment and reduces the ecological footprint of glass production.

Decreased Landfill Waste: Glass is non-biodegradable and can take thousands of years to break down in a landfill. Recycling glass reduces the volume of waste sent to landfills, mitigating landfill overflow and pollution

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SOIL EROSION: CHALLENGES AND SOLUTIONS FROM NIGERIA TO EASTERN EUROPE

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Abstract

Soil erosion, the displacement of the upper soil layer, poses a significant threat to agricultural productivity, environmental sustainability, and socio-economic stability globally. This study compares the challenges and solutions to soil erosion in Nigeria and Eastern Europe. Using literature review, field observations, and data analysis from the MODIS MCD12Q1 dataset, the study highlights the similarities and differences in erosion control strategies between these regions. The insights from the Aldeni/Buzau Soil Erosion & Conservation Laboratory and the Berca-Muddy Volcanoes in Romania underscore the importance of sustainable land management practices. The results indicate that while both regions face severe erosion issues, tailored strategies involving community engagement and institutional support are essential for effective mitigation. This study emphasizes the need for integrated soil conservation efforts to enhance resilience against soil erosion.

Key words*: Erosion control, Sedimentation, Soil Conservation, Soil erosion, Watershed management*

INTRODUCTION

The displacement of the topsoil layer through erosion poses significant threats to agriculture, environmental stability, and socioeconomic well-being worldwide. This research will focus on Nigeria and Eastern Europe, as these areas are experiencing severe erosion problems due to deforestation, overgrazing, and intensive agricultural activities. The paper aims to compare the erosion control efforts in these regions and underscore the importance of sustainable land management and community involvement in addressing this issue.

MATERIALS AND METHODS

A thorough literature review was conducted to examine the challenges and solutions related to soil erosion in Nigeria and Eastern Europe. The review encompassed academic journals, government reports, and project documentation that focus on soil erosion processes, mitigation strategies, and regional studies.

Field studies were performed in Romania at two prominent locations:

At the Laboratory for Soil Erosion and Conservation in Aldeni-Buzau (UASVM), direct observations were carried out to study ongoing research and conservation efforts related to soil erosion.

At the Berca-Muddy Volcanoes site, photographic documentation was undertaken to capture natural soil displacement phenomena and evaluate existing erosion control measures.

The study utilized the following data sources to analyze land cover in Nigeria and Romania:

Land Cover Data: Extracted from the MODIS MCD12Q1 dataset for the year 2020, providing a detailed classification of land use types at a spatial resolution of 500 meters.

Country Boundaries: Utilized the USDOS/LSIB_SIMPLE/2017 dataset to define and visualize the boundaries of Nigeria and Romania.

To generate the comparative land cover maps for Nigeria and Romania, the following steps were undertaken:

Data Filtering and Selection: The land cover data for the year 2020 was filtered to select the specific land cover classification (LC_Type1).
Data Visualization: Visualization parameters were defined to display the land cover data with appropriate colour coding for different land cover types. Opacity was set to 0.6 to enhance visibility.
Clipping and Layering: The land cover data was clipped to the boundaries of Nigeria and Romania using the boundary data. Separate layers for each country were added to the map for clear visualization.
Map Centering and Boundary Highlighting: The map was centered to show both countries clearly. Country boundaries were highlighted in red for Nigeria and blue for Romania for better clarity and distinction.

Figure 1: Field study location in Nigeria showing a typical erosion site.

Figure 2: Shows use of speed breakers as control measure in Nigeria.

Figure 3: Researchers and students conducting soil erosion studies in Nigeria.

Figure 4: Laboratory for Soil Erosion and Conservation Aldeni-Buzau (UASVM).

Figure 5: Researchers en route to the Laboratory for Soil Erosion and Conservation Aldeni-Buzau (UASVM) engage in a field observation.

Figure 6: Researchers at the laboratory site, with the essential water runoff collection system in the background.

RESULTS AND DISCUSSIONS

In Nigeria, soil erosion is primarily driven by deforestation, overgrazing, and poor land management practices. The impacts include reduced agricultural productivity, loss of arable land, and increased flooding. Community-driven initiatives, such as tree planting and terrace construction, alongside government projects like the Nigeria Erosion and Watershed Management Project (NEWMAP), have been crucial in addressing these challenges (Igwe, 2012; NEWMAP, 2018).

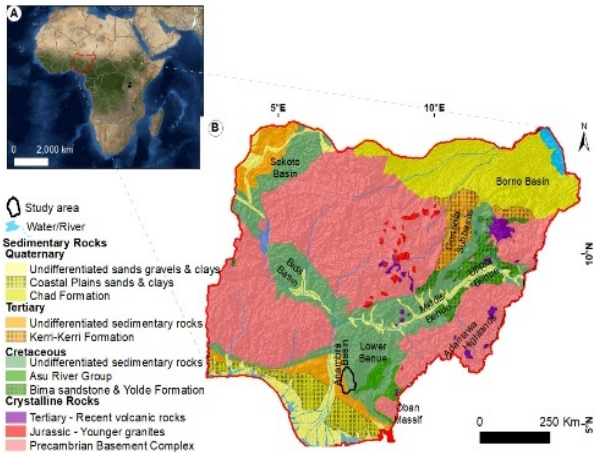

Figure 7: Geological map of Nigeria showing regions susceptible to soil erosion.

The regions most susceptible to erosion in Nigeria include the Coastal Plains, River basins, and Sedimentary basins like the Niger Delta, Chad Basin, Sokoto Basin, Bida Basin, and Anambra Basin. Areas with Precambrian Basement Complex rocks and regions with Jurassic granites or volcanic rocks, such as the Jos Plateau, are less susceptible to erosion. The presentation also emphasizes the significant impacts of soil erosion in Nigeria, including air and water pollution, loss of farmland, soil acidification, climate change, desertification, flooding, soil degradation, and reduced soil fertility (Grant, 1971; Hilborn, 1985; Obidimma & Olorunfemi, 2011).

Key prevention strategies highlighted include planting vegetation, contour farming, mulching, avoiding overgrazing, reforestation, barrier building, optimal land use, and geotextile covering.

Similarly, Eastern Europe faces soil erosion due to intensive agricultural practices, deforestation, and land abandonment. The region's diverse climate exacerbates erosion rates. Sustainable agricultural practices, reforestation, and EU-funded initiatives under the Common Agricultural Policy (CAP) are key solutions implemented to combat soil erosion (Borrelli et al., 2017; European Commission, 2020).

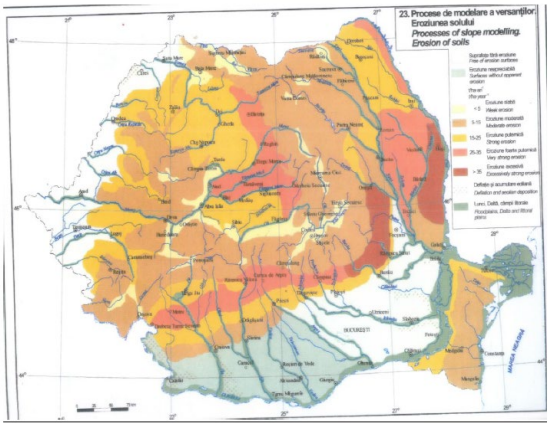

Figure 8: Map of Soil erosion in Romania

During the visit to the Laboratory for Soil Erosion and Conservation Aldeni-Buzau (UASVM), observations were made about ongoing research and practical demonstrations on soil conservation techniques. The laboratory focuses on studying soil erosion processes and developing mitigation strategies, particularly for the Sub-Carpathian Curvature region in Buzau County, Romania. This region, characterized by a mix of plain, hilly, and mountainous areas, experiences severe soil loss due to water erosion, with estimates of about 30-40 tons per hectare per year.

Figure 9: The unique geological formations at the Berca-Muddy Volcanoes illustrate natural soil displacement processes.

The Berca-Muddy Volcanoes, another

significant site in Romania, are natural reserves where natural gas from deep underground pushes water and clay to the surface, forming conical mud structures. While these formations are more of a natural geological phenomenon, they underscore the complex interactions between natural processes and the landscape.

Figure 10: The Berca-Muddy Volcanoes

The site is a vivid example of how geological activity can influence soil displacement and landform development.

Table 1: Soil Characteristics and Sustainable Practices

Aspect	**Nigeria**	**Romania**
Types of Soil	Sandy, Clay, Lateritic, Ferruginous	Alluvial, Mountainous, Podzolic, Chernozem
Composition	High in iron and aluminum, variable organic matter	Rich in organic matter, variable in minerals
Common Problems	Deforestation, Overgrazing, Intensive agriculture	Intensive agriculture, Land abandonment
Control Measures	Reforestation, Terrace construction, NEWMAP	Sustainable farming practices, Reforestation, EU policies
Impacts	Reduced agricultural productivity, Soil acidification, Desertification	Soil loss due to water erosion, Land displacement

The comparison highlights that while both regions face severe soil erosion issues, the underlying causes and specific soil characteristics differ. Nigeria's challenges are closely linked to deforestation and overgrazing, whereas Romania's issues are largely due to agricultural practices and land use changes. Both regions, however, emphasize the importance of sustainable land management practices and community involvement to mitigate soil erosion.

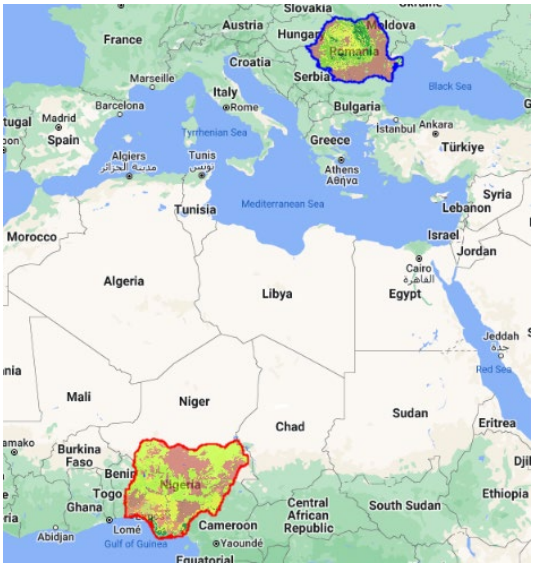

Figure 11: Comparative map showing land cover types in Nigeria and Romania for 2020.

CONCLUSIONS

Soil erosion remains a critical environmental challenge in Nigeria and Eastern Europe. Despite regional differences, the need for sustainable land management and community involvement is universal. Nigeria's community-driven initiatives and Eastern Europe's institutional approaches offer valuable lessons for developing resilient strategies against soil erosion. Combining traditional knowledge with modern techniques and ongoing research can enhance soil conservation efforts and protect vital soil resources globally.

The insights gained from our visit to the Laboratory for Soil Erosion and Conservation Aldeni-Buzau and the Berca-Muddy Volcanoes highlight the importance of ongoing research and practical conservation efforts. These experiences emphasize the need for a holistic approach to soil management that considers both scientific research and community involvement.

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We would like to extend our heartfelt gratitude to the UASVM FIFIM for their warm hospitality and invaluable support during the Blended Intensive Programme (BIP). The field trip to various erosion sites during the programme sparked the ideas explored in this study.

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This study was inspired by the ideas generated during the BIP titled "2023-1-RO01-KA131-HED-000125626-9 - From sensors to the data analysis soil-water holistic approach". It provided a foundational framework for our exploration of soil erosion challenges and solutions across various regions.

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PHYTOREMEDIATION OF CONTAMINATED LAKE USING WATER LILIES

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Abstract

The paper aimed to present the phytoremediation of one of the artificial lakes located in the Campus of the University of Agronomic Sciences and Veterinary Medicine Bucharest, using aquatic plants. Phytoremediation is a treatment method that uses plants to extract, accumulate and degrade water pollutants. Water lilies play a crucial role in maintaining water quality by absorbing both organic and inorganic pollutants present in the water. Particularly noteworthy is their effectiveness in removing heavy metals from aquatic environments. Through this filtration process, they aid in creating cleaner and more wholesome habitats for aquatic life. Lake eutrophication is a significant environmental concern, impacting water quality in lakes worldwide. Also, the water lilies have the possibility to prevent eutrophication, halting the algae growth process. As a conclusion, water lilies are not just aesthetically pleasing, also offer remarkable advantages for environment.

Key words*: phytoremediation, pollutants, water lilies.*

INTRODUCTION

Natural resource pollution, such as land and water, with organic and inorganic pollutants, has become a significant problem caused by rapid industrialization (Kristanti & Hadibarata, 2023). Eutrophication of water promotes algae growth, plankton, and the life of other aquatic plants, causing detrimental changes in the water quality and ultimately leading to the degradation of ecological communities (Wang et al., 2022).

Phytoremediation emerges as a feasible, economical, and environmentally friendly sustainable approach for restoring high-nutrient aquatic ecosystems (Li et al., 2021). Floating-leaved macrophytes play a crucial role in regulating water and sediment dynamics and provide an effective solution for restoring high-nutrient aquatic ecosystems. Floating-leaved macrophytes acquire increased nutrients and enhance microbial processes, especially for nitrogen, through processes like nitrification and denitrification (Wang et al., 2022).

Floating-leaved microphytes effectively decreased algae growth and water opacity while enhancing water clarity in shallow eutrophic lakes (Ji et al., 2016). Floating–leaved *Nymphaea* species are distributed worldwide for landscape and floral designs, economic importance, and cultural significance.

Nymphaea species are crucial for phytoremediation as high-capacity accumulators in diverse aquatic ecosystems. *Nymphaea* water lilies can absorb ionic elements and different metals, even in small quantities, from water through their roots, accumulate them in their tissues, degrade and transform pollutants into less harmful forms, and help prevent eutrophication, thereby inhibiting algae growth (Chen et al., 2017).

Hence, in this research, *Nymphaea alba* and *Nymphaea rosenymphe* water lily species were evaluated for their ability to recover the water in an artificial lake. The eutrophication potent indicators were evaluated, such as nitrogen species (nitrite nitrogen and ammonium nitrogen), pH value, and dissolved oxygen.

MATERIALS AND METHODS

Site and Sampling Points Description

The artificial lakes studied are located in the Dendrological Park of the Campus of the University of Agronomic Sciences and

Veterinary Medicine of Bucharest (Figure 1A, Google Maps 1). In March 2024, a sampling study was performed involving collecting water samples from three points. The three sampling points, P1, P2, and P3, and their coordinates are presented in Table 1 and Figure 1B (Google Maps 2).

Water Sampling and Analytical Methods

The sampling of water samples was carried out in accordance with the Sampling water guide from natural and artificial lakes (HG No. 890 /12.11.2013) by hand sampling at 0.5 m depth into polyethylene recipients, which are placed in a cold box (4 °C) for transport to the laboratory. The samples were kept until they reached room temperature before being analysed.

Some parameters of all individual water samples, such as pH, conductivity, total dissolved solids, salinity, and dissolved oxygen, were evaluated in situ, while the other parameters were analysed within 24 to 48 hours of sampling.

Turbidity was determined by turbidity meter. Mohr's titration method with a silver nitrate solution, utilizing potassium chromate as the indicator, was used for chloride quantification. Titration with disodium ethylenediaminetetra-acetic acid, using Eriochrome Black T as the indicator, was used to determine the total hardness. Two spectrophotometric methods were used to evaluate the nitrogen species, such as nitrite nitrogen (λ of 540 nm) and ammonium nitrogen (λ of 650 nm) (Sandu et al., 2023).

The analytical equipment used for analysis was calibrated for the measurements to guarantee the quality of the analytical procedures and the accuracy of the data collected. Each analysis was carried out three times to calculate the average and standard deviation.

Water quality classification of the lake water quality to determine the ecological health was carried out according to HG No. 932 of 20.11.2013, Annex no. 1: Systematic monitoring and record of the state of surface waters. The physicochemical parameters, procedures, and technical measures required for monitoring water quality are categorized into five distinct water quality. The values obtained according to the data processing methods were compared with the admissible limit values (HG No. 932/20.11.2013).

The chemical state of the waters was established, as stipulated in the Regulation on environmental quality requirements for surface waters based on the concentrations measured for the monitored indicators, the concentration of priority/priority dangerous substances being decisive (HG No. 890/12.11.2013).

Water lilies cultivation and experimental location

Two species of water lilies, *Nymphaea alba (N. alba)* and *Nymphaea rosennymphe (N. rosennymphe)*, were cultivated in one of the lakes (P2) located in the Dendrological Park of the Campus of the University of Agronomic Sciences and Veterinary Medicine of Bucharest (Figure 2). Five water lilies belonging to the *N. alba* species and five to the *N. rosennymphe* species were cultivated.

The cultivation process occurred after the following: soil compost was added in biodegradable bags, filling the bags about 3/4, after the water lily tuber was placed horizontally within the soil layer. The root end should be close to the bag's wall, while the growing tip points upward and remains exposed above the soil compost. A gravel layer was added to protect the water lily root in the compost. In total, 10 biodegradable bags with water lilies were obtained. The bags were placed at the bottom of the lake.

RESULTS AND DISCUSSIONS

Water Quality Analysis and Interpretation

A summary of the data related to the primary physical-chemical parameters can be found in Table 2, which corresponds to the surface water quality classes.

An increased turbidity value of water is associated with a decline in water transparency, which leads to the appearance of cloudy or turbid water. This condition mainly arises from the presence of particulate matter, organic matter, algae, and microscopic organisms. In our research, the nephelometric evaluation of turbidity of the water samples showed a range of 12.65 to 43.15 NTU (Table 2).

Figure 1. Location of the Dendrological Park (A) and the sampling points (B).

Table 1. Coordinates of sampling points

Sampling Points	Latitude, North	Longitude, East
P1	44°28.2649' N	26°04.0247' E
P2	44°28.2451' N	26°03.9512' E
P3	44°28.2618' N	26°03.9214' E

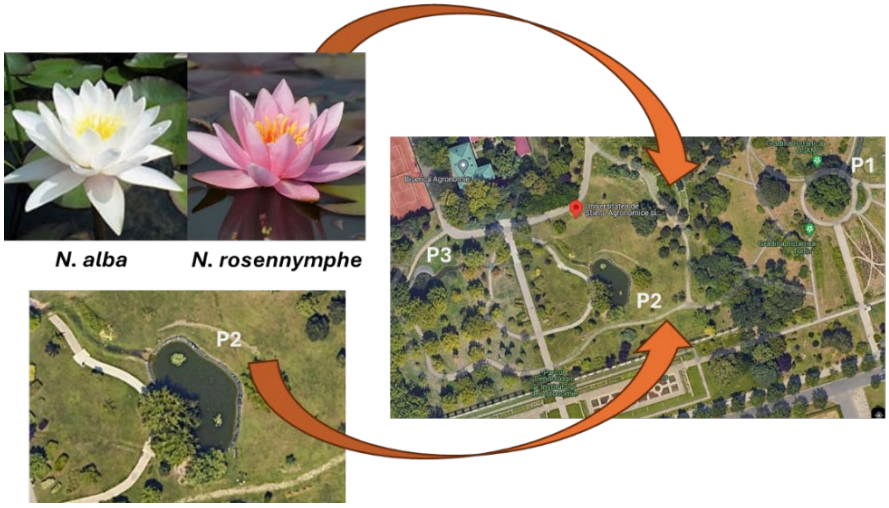

Figure 2. Water lilies and experimental location.

Table 2. Determined values for the water quality parameters and water quality classes assignment.

Sampling Points	pH (pH units)	C (µS/cm)	TDS (mg/L)	SAL (g/L)	DO (mg O_2/L)
P1	6.84	448	233	0.28	3.80
P2	6.51	221	111	0.11	2.18
P3	7.03	233	118	0.11	3.24
Quality class					
P1	6.50–8.50	NA	NA	NA	V
P2	6.50–8.50	NA	NA	NA	V
P3	6.50–8.50	NA	NA	NA	V
Sampling Points	**T (NTU)**	**TH (mg CaO/L)**	**Cl^- (mg/L)**	**N-NO_2^- (mg N/L)**	**N-NH_4^+ mg N/L)**
P1	17.55±3.04	24.39±0.22	105.01±1.00	0.10±0.01	13.57±0.21
P2	12.65±0.64	11.90±0.81	26.16±0.20	0.13±0.01	7.37±0.30
P3	43.15±2.47	13.19±1.20	37.56±1.80	0.21±0.02	28.09±0.15
Quality class					
P1	NA	NA	III	IV	V
P2	NA	NA	II	IV	V
P3	NA	NA	II	IV	V

C - Conductivity; TDS - Total dissolved solids; SAL – Salinity; DO - Dissolved oxygen: T – Turbidity; TH - Total hardness; Cl^- - Chloride; N-NO_2^- - Nitrite nitrogen; N-NH_4^+ - Ammonium nitrogen. Values are expressed as mean ± the standard deviation (SD). NA = not available.

The pH value determination of water samples revealed a range between 6.51 – 7.03, which is in accordance with Romanian legislation concerning surface waters. The pH value is particularly important for aquatic life, as a high value can increase ammonia toxicity, while a low value can heighten the toxicity of certain metals (Sandu et al., 2023).

The conductivity parameter refers to the dissolved ions capable of conducting electricity. The conductivity values of the water samples ranged from 221 to 448 µS/cm.

The total concentration of dissolved substances in water refers to the total dissolved solids parameter. These substances include inorganic salts and a small quantity of organic substances. The total dissolved solids of the water samples were between 111 and 233 mg/L.

Salinity, also known as the saltiness of water, refers to the quantity of dissolved salts present in a body of water. The salinity values of the water samples were between 0.11 – 0.28 g/L.

Dissolved oxygen is an essential parameter for aquatic life and is defined as the level of oxygen dissolved in water. The dissolved oxygen levels measured for the water samples ranged from 2.18 to 3.80 mg O_2/L. According to regulations, these levels correspond to a V quality class for surface water (Table 2).

When dissolved oxygen values fall below 3 to 4 mg O_2/L, it can lead to an increase in anaerobic bacteria activity, resulting in the production of methane and hydrogen sulfide.

The total hardness of water is mainly related to the presence of divalent cations, particularly calcium (Ca^{2+}) and magnesium (Mg^{2+}). These essential minerals play a crucial role in the biological processes of aquatic organisms. Water samples measured total hardness values ranged from 11.90 to 24.39 mg CaO/L.

Chloride ions are naturally in various concentrations in water. Over the past decade, their levels have risen due to population growth, agricultural practices, and environmental pollution. Based on the chloride concentrations assessed for the water samples, 26.16 – 105.01 mg/L. According to Romanian legislation, the water samples were classified as II and II quality classes (Table 2).

Nitrogen species (nitrite - NO_2^-, nitrate – NO_3^- and ammonium (NH_4^+), play a crucial role in promoting the growth of algae and other aquatic plants. Nonetheless, when their concentrations become excessive, they can cause eutrophication, adversely affecting dissolved oxygen levels in water.

The nitrite and ammonium nitrogen concentrations were recorded at 0.10 to 0.21 mg N/L and 7.37 to 28.09 mg N/L, respectively. The nitrite nitrogen levels indicated that the water quality fell within class IV. However, the higher ammonium nitrogen concentration led to a V classification for water quality (Table 2).

CONCLUSIONS

This research was conducted as an extension of our earlier discoveries and interests regarding water quality monitoring. Additionally, ensuring the equilibrium of quality parameters holds significant importance for the sustenance of aquatic life. This study research examines the physico-chemical parameters that influence water quality, along with the acceptable or imposed limits, and their impact on water quality and aquatic life.

The water lilies will help to improve the physico-chemical parameters and prevent eutrophication of the artificial lakes located in the Dendrological Park of the Campus of the University of Agronomic Sciences and Veterinary Medicine of Bucharest.

In conclusion, *Nymphaea* waters lily species are not only aesthetically pleasing, but they also offer important environmental benefits.

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WHERE HAVE YOUR PAWS BEEN, MISS KITTY?

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Abstract

The number of pets like dogs, cats, rabbits and parrots in European families has increased. Domestic animals provide social benefits to their owners, including reduced loneliness and anxiety, and are also used in Animal-Assisted Therapy (AAT). However, the interaction between humans and animals is also associated with health problems such as allergies, asthma and zoonotic diseases. This study aims to detect the presence of filamentous fungi on the cats' paws. Results of the investigation showed that there was a difference in the fungi isolated from cats and their living environment. The number and species isolated from the front paw samples of cats kept outdoors were greater and more varied than those samples from cats kept indoors. The results of this preliminary study highlight the importance of monitoring companion animals. Preventive measures are necessary to limit the spread of zoonotic pathogens from companion animals to people within the home environment.

Key words*: bacteria, cats, companion animals, paws.*

INTRODUCTION

The majority of households worldwide are pet-owning. According to Growth from Knowledge - GfK more than half (57%) of the global population is estimated to have a pet at home. Dogs and cats are the most popular pets, but other animal species may be kept as companion animals: rabbits, ferrets, birds, reptiles, and amphibians. The 2016 research from GfK shows that pet ownership is most common in Argentina, where two out of three people (66%) own dogs, followed by Mexico (64%) and Brazil (58%). On the other hand, people in Asia are the least likely to own a pet. For example, only 14% of people in Hong Kong own a dog. This compares to half of Americans (50%) and over a third of Italians (39%). There are approximately 91 million (46%) households owning pets in Europe.

On average, dogs are officially man's best friend with a third (33%) of households worldwide owning one. In fact, worldwide, there are 471 million dogs and around 370 million cats kept as pets (Figure 1), https://worldanimalfoundation .org/advocate/pet-ownership-statistics/. New data from the European Pet Food Industry Federation - FEDIAF highlighted that in 2022, there were 340 million pets in Europe, mostly cats (127 million) and dogs (104 million). In 2021, the total number of pets was 305 million. Eastern Europe tops the podium of countries with at least one dog: Poland leads with 49%, followed by Romania (43%) and the Czech Republic (42%). For households that own at least one cat, Romania stands at 48%, Poland at 40% and Hungary at 35%.

The millennial generation is an expanding group of pet owners because they're more likely to have children later in their lives, to work from home or in hybrid arrangements, and to be more affluent and educated. Gen Z is an emerging pet-owning segment (18% in U.S.) that may accelerate this "pet boom" (Figure 2) (https://www.americanpetproducts.org/press_releasedetail.asp?id=1242).

Studies have consistently shown that having a pet helps improve human health. This is the One Health power of pets. Keeping pets offers an array of therapy, physiology, psychological and social benefits (Wood et al., 2015). Some of these include physical activity is increased, emotional support through increased sensory stimulation, improved physical and mental wellbeing.

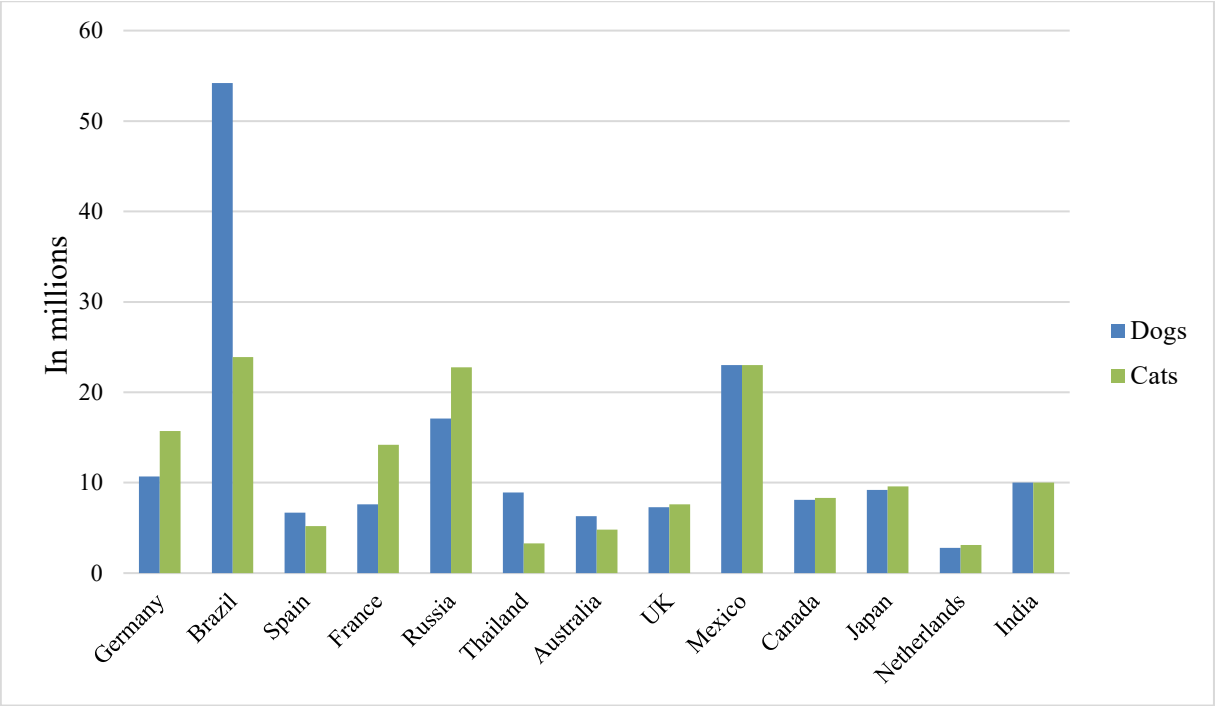


Figure 1. The population of pets in the markets. Adjusted after:
https://worldanimalfoundation.org/advocate/pet-ownership-statistics/

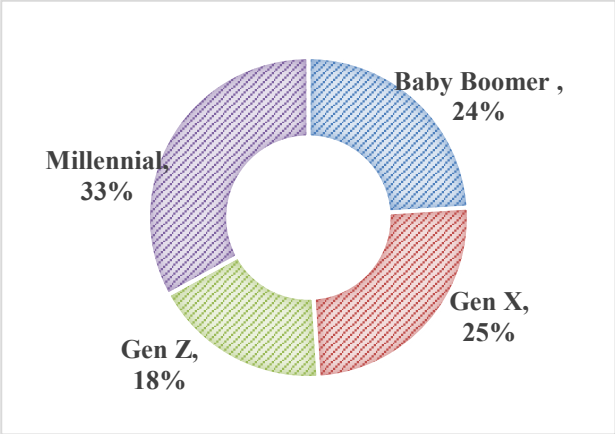


Figure 2. Pet ownership by generation (percentage of current pet owners)

Scientists say there's a strong link between owning a pet and being healthier (Kazi, 2019). Moreover, dogs, cats, horses, rabbits, and hamsters are frequently used in Animal-assisted Therapy (AAT). Despite these benefits, there is a risk of health problems when people interact with animals, such as allergies, asthma, bites and scrapes (Friedman & Krause-Parello, 2018). One of the primary challenges in addressing the impact of mold and indoor environments on health is the scarcity of dedicated research. Although studies on these topics are gradually emerging, researchers still lack a clear understanding of the mechanisms by which indoor mold affects the body and the extent of its impact. The situation is even more pronounced for pets, with even fewer studies investigating how toxic environments influence their health.

Pets can harbor bacterial agents without showing disease, or in other cases developing from mild to severe clinical forms. When companion animals are affected by zoonotic pathogens, they become an important source of infection for their owners, particularly immunocompromised persons, such as elderly people, children, pregnant women, and people with pathologies. Zoonotic diseases are caused by harmful germs like viruses, bacterial, parasites, and fungi.

Most pets spend most of their time in homes, so they're constantly exposed to whatever is in that indoor environment. These contaminants like mold spores and mycotoxins are making their way into your pet's little body all day every day, either through inhalation, absorption through a little cut, or ingestion by eating or licking all of the random thing's pets tend to get into, whether they should or not. Their tiny size means that these indoor contaminants are able to be inhaled, ingested, and absorbed into the body (Wild et al., 2010).

Cats keep themselves pretty clean — much cleaner than dogs. Still they're using those paws in the litterbox, and walking around on them too,

which raises the potential that they're picking up dangerous germs and bacteria (Figure 3).

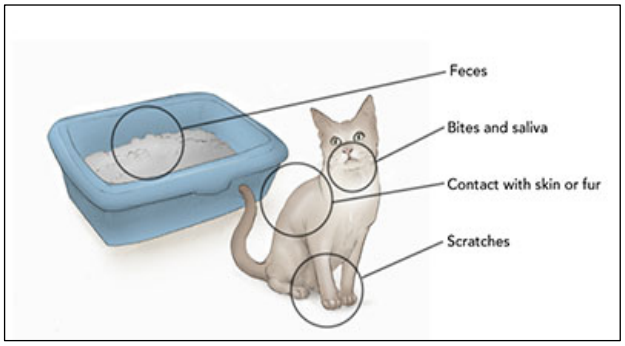


Figure 3. Exposure points through which cats can spread diseases to humans (Cornell College of Veterinary Medicine)

The aim of this article is to investigate the presence of pathogens on the paws of indoor cats and the differences between fungi from indoor and outdoor cats.

MATERIALS AND METHODS

Tested cats

Seven cats were enrolled in this study: 3 of them were fully indoor cats while the other 4 were indoor-outdoor or fully outdoor cats (Table 1). Samples were taken from the front paw of cats (Figure 4). All of the samples were taken to the laboratory for further analysis.

No animals were harmed nor tested during the entire study. All sample were gathered and used for the study with verbal proprietor assent who knew that the samples were being used for research purpose.

Table 1. Data regarding cat subjects

Sample id	Treatment	Age	Breed	Gender	Activity level	Name
C1.	indoor cat	10 years	domestic long hair	male	average	Messi
C2.	indoor cat	2 years	domestic short hair	male	very active	Tazz
C3.	indoor-outdoor cat	15 years	domestic short hair	male	very active	Bâzdâc
C4.	fully outdoor cat	n/a	domestic short hair	female	n/a	Caminito
C5.	indoor-outdoor cat	1 year	domestic short hair	male	very active	Oliver
C6.	indoor cat	3 years	domestic short hair	female	very active	Tofi
C7.	indoor-outdoor cat	9 years	domestic short hair	female	average	Keila

Figure 4. Cats front paw sampling

Isolation and identification of fungi

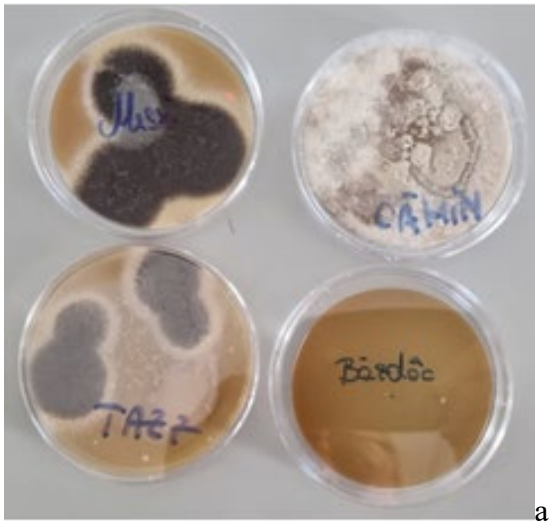
We used a simple plating technique whereby each substrate is placed onto potato dextrose agar (PDA) and adjusted pH to 6.0 using 10 N NaOH. The culture media were incubated for 48 h at 37oC then for 24 h at 25oC and the growing colonies were identified (Ojima et al., 2002). The plates for fungus filamentous were incubated at 28º C, in the dark, for 3-5 days (Figure 5).

Figure 5. Sample incubation

In order to identify microorganisms by microscopic analysis, smears were performed with a simple Gram stain and double to highlight the spores. For the identification of microorganisms by microscopic analysis, fresh preparations were made between the slide and the coverslip to identify the cellular form of the type of microorganism. The Siemens microscope was used, where the smears were observed with the 100 objectives, in a drop of cedar oil.

RESULTS AND DISCUSSIONS

Identification of the fungi isolated from the front paws of the cats is shown in Figure 6. The obtained results showed a large variety of molds in the environments investigated: for all indoor cats have been identified the presence of molds *Aspergillius spp*. and *Penicillium spp*., and for all indoor-outdoor cats have identified the presence of molds Mucor, *Rhizopus spp* and *Bacillus spp* (Figure 6).



a

b

Figure 6. Images of fungal colonies isolated from the front paw of cats a - indoor/outdoor cat; b - indoor cat

We were able to isolate 5 different fungal from the front paw of tested cats. *Aspergillus spp* and *Penicillium spp* (for all indoor cats) and *Mucor spp.*, *Rhizopus spp*. (for one indoor cat) were the predominantly identified saprophytic fungi. *Bacillus spp* (for all indoor-outdoor cats), *Penicillium spp* (for one indoor-outdoor cat) were identified.

Colonies of the genus *Penicillium spp*. they are of various shades of blue-gray, and microscopically the conidiospores appear as a brush. Macroscopic investigation (Figure 7 - *Penicillium*):

- gray/whitish mold quick growth up to 37ºC;
- colonies with woolly appearance, diaphane with aerial mycelium;
- white-gray colour/dark gray – sporulate.

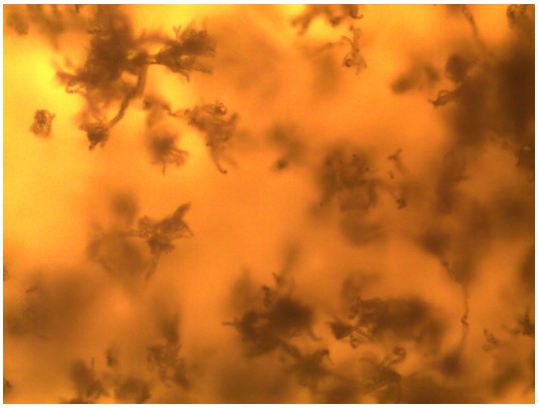


Figure 7. Penicillium spp identifided macroscopic and microscopic

Mucor colonies typically have a white or beige colour that becomes grey to brown as they age. Mucor species are fast growers that extend by sporangiophore that are typically aseptate, not having a thin wall or membrane separating cells (Figure 8).

Figure 8. Mucor spp identifided macroscopic and microscopic

Colonies of *Aspergillus spp*. are colored colonies from light yellow, yellow green to black (*Aspergillus niger*), microscopically chains of conidia and fan-shaped conidiospores appear. Microscopic investigation (Figure 9 - *Aspergillus spp*.):

-sporocysts easily visible to the stereo-microscope;

- septate filaments or rarely septate, wide and

irregular;
- sporangiophores.

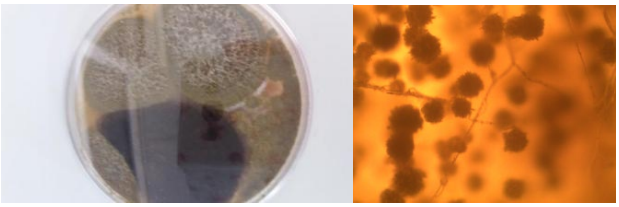


Figure 9. Aspergillus spp identifided macroscopic and microscopic

The results obtained show the presence of filamentous fungi that can over time affect the health of both the cats and the pet owners because:
- *Rhizopus species* is an opportunistic agent, producing fungal infections in humans which in some cases can be fatal. Rhizopus infections can give serious complications for diabetics.
- *Aspergillus species* produces pulmonary aspergillosis or a series of allergic reactions.
- Infections caused by *Penicillium* includes: pulmonary infections, cerebral diseases, paravertebral infections, prosthetic valve endocarditis endophthalmitis, upper urinary tract infection and intracranial infection (Dumitrache C. et al., 2016).

CONCLUSIONS

Fungus is found commonly in the environment. The pathogenic species, or those capable of causing disease in humans or animals, are typically found in soil, although they can also be transmitted through contaminated materials or other animals. Fungal infections can affect cats through direct contact, particularly through the skin in cases of a compromised barrier, as well as via the respiratory or digestive tracts if spores are inhaled or ingested. The opportunistic fungal organisms exploit the weakened immune systems of their hosts, often manifesting in the form of concurrent infections, wounds or other conditions that compromise the host's defences. The co-occurrence of fungal and bacterial infections in a single individual is a common phenomenon, yet the order of their appearance is often difficult to determine.
While fungal infections can affect indoor-only cats, those who are kept outside are at greater risk. Some cats may act as asymptomatic carriers of the disease, exhibiting no outward symptoms but nevertheless spreading the infection to other animals and humans. While outdoor cats are at a higher risk of exposure to the fungi, the contamination can also be transferred to indoor cats through the introduction of contaminated materials by the owners or by other animals, including through footwear and clothes.
As a conclusion, the possibility of mold posing a toxic threat to pets is a compelling reason for pet owners to understand how to respond in the event of a fungal outbreak and how to prevent such incidents. Preventive measures against indoor mold growth include:

- Store the bag of pet food in a sealed container to minimize moisture and prevent mold spores from contaminating the food.
- Wash food and water bowls daily with mild soap and warm water, ensuring they are thoroughly cleaned and dried before use.
- Every two weeks, deep clean the bowls by soaking them in white vinegar for 30 minutes, wiping them with a microfiber towel, then washing with mild soap and warm water. Ensure they are completely dry before returning them to their designated spots.
- Clean cages and accessories every two weeks: use a microfiber towel to wipe down the surfaces and allow them to dry completely before reassembling the cage.
- Deep clean regularly: Employ a HEPA vacuum, botanical cleaning products, and microfiber towels to thoroughly clean floors, furniture, appliances, mattresses, windowsills, and other surfaces. This helps eliminate food sources for mold and remove mold spores that have entered the home.
- Choose stainless steel or ceramic bowls: Unlike plastic, which is porous and can trap moisture in tiny pockets, stainless steel and ceramic are less prone to scratching and provide fewer places for mold to grow.
- Wash beds and toys weekly. This helps remove food particles and mold spores. For toys, soak them in white vinegar for five minutes, wipe with a microfiber

towel, then wash gently with mild soap and warm water.

- Maintain indoor humidity levels between 35% and 50%: Humidity levels above 60% can promote mold growth.
- Routinely inspect mold hotspots. Regularly check areas prone to mold, such as the kitchen, bathroom, appliances, attic, basement, and crawlspaces. Early detection can prevent widespread contamination.

ETHICS STATEMENT

The cats in this study were examined during routine care of the owners of the indoor cat group. No treatment decisions were made based on the results of this test. All samples were collected and used for this analysis with verbal owner consent who were aware that these samples were taken for research purpose only.

ACKNOWLEDGEMENT

The cat owners who participated in this study are gratefully acknowledged by the authors.

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COMPARATIVE EVALUATION OF WATER QUALITY STANDARDS ACROSS FIVE COUNTRIES FOR SUSTAINABLE AQUACULTURE AND IRRIGATION: A CASE STUDY OF MOARA DOMNEASCĂ POND, ROMANIA

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Abstract

Water quality is crucial for aquaculture and irrigation, influencing the health of aquatic ecosystems and crop productivity. This study examines the water quality of Moara Domnească pond in Romania, benchmarking it against standards from Romania, Hungary, Croatia, Indonesia, and Colombia. Parameters such as temperature (T), pH, electrical conductivity (EC), dissolved oxygen (OD), and nitrogen forms (nitrites, nitrates, ammonium) were measured. International comparisons highlight the need for localized water management strategies to ensure sustainable use of water resources. Romania generally follows EU standards with specific adjustments for local conditions. Hungary has similar to EU standards, with additional guidelines for specific water bodies. Croatia adheres to EU Water Framework Directive with local adaptations. Indonesia has national standards set by the Ministry of Environment and Forestry. Colombia uses national standards regulated by the Ministry of Environment and Sustainable Development. While there are broad similarities in the goals and some parameters of water quality standards, the differences underscore the importance of tailoring regulations to local conditions and specific environmental needs. This nuanced approach helps ensure the sustainable management of water resources globally.

Key words*: aquaculture, comparative analysis, pond, water quality.*

INTRODUCTION

Water quality monitoring is a fundamental practice in water resource management, essential for assessing the health of aquatic ecosystems and their capacity to support aquatic life and other human uses. Commonly measured parameters include temperature, pH, electrical conductivity, dissolved oxygen, and key nutrients such as nitrogen in its various forms: nitrites, nitrates, and ammonium (Boyd and Tucker, 1998). The quality of water in aquatic ecosystems is affected by the interaction between a variety of parameters, including water hardness, nutrient levels, dissolved oxygen, and other factors. These interactions can have significant implications for the health and survival of aquatic organisms (Sandu et al., 2023a).

Water quality is monitored globally, with specific regulations and standards varying by country. In Europe, the Water Framework Directive establishes rigorous parameters for maintaining and improving surface and groundwater quality (European Environment Agency, n.d.).

Water is the fundamental component in aquaculture, affecting the health, growth, and reproduction of fish and other aquatic organisms. Good water quality is essential to maximize production and minimize disease risks (Lazzaro, 1997).

Aquaculture has evolved from ancient practices in China over 4,000 years ago to sophisticated modern systems using advanced technology to monitor and maintain water quality. Today, it

significantly contributes to global food production and security (Pillay and Kutty, 2005).

Water quality affects various aspects of aquaculture, including growth rate, mortality, and disease incidence. For instance, inadequate dissolved oxygen levels can cause stress and mortality in fish, while elevated nutrient levels can promote harmful algal blooms (Martínez-Porchas and Martínez-Córdova, 2012). It is widely recognized that the eutrophication of surface water bodies is a significant water quality issue, impacting both economic and social environments (Radu et al., 2019).

Aquaculture modalities range from extensive systems using natural resources like lakes and ponds to intensive systems with rigorous water quality control. Each modality presents different challenges and requires specific water management strategies (Turcios and Papenbrock, 2014).

International water quality standards vary by country and organization, but several key parameters are commonly monitored to ensure the safety and sustainability of water used in aquaculture and irrigation. The common parameters for evaluating water quality are:

- Temperature (T) - influences the metabolic rate of aquatic organisms.
- pH - affects nutrient availability and the toxicity of chemical compounds.
- Electrical Conductivity (EC) - indicates the number of dissolved salts in the water.
- Dissolved Oxygen (DO) - essential for the respiration of aquatic organisms.
- Nitrogen forms (Nitrites, Nitrates, Ammonium) - indicators of contamination and the nutrient cycle in water.

Poor water quality can adversely affect crop irrigation by causing soil salinity problems and promoting eutrophication. This impacts plant health and agricultural product quality (Turcios and Papenbrock, 2014).

The physico-chemical parameters of water were monitored for the purpose of evaluating the ecosystem's health (Pinto et al., 2023; Sandu et al., 2023b; Stavrescu-Bedivan et al., 2023); furthermore, this type of work is being sustained by many research studies.

MATERIALS AND METHODS

The Pasărea River is a tributary of the Dâmbovița. The river's source is located within the Otopeni Forest. The Pasărea River has a length of 48 km and a sinuous course which makes water drainage more difficult and favors the appearance and development of marsh vegetation. A total of 24 lake units, named after the localities in which they are located have been developed along the river's course (Figure 1). These are mainly used for fish farming and irrigation, and, together, they cover an area of 434 hectares (Cocoş, 2006).

Figure 1. Course of the Pasărea River from its origin to its discharge

Moara Domnească pond belongs to the Pasărea Lake chain. This pond is used for the irrigation of neighboring agricultural areas and for pisciculture. The sampling campaign was conducted on May 21, 2024, collecting water samples from six sampling points (SP) located in Moara Domnească pond (Figure 2).

The parameters of temperature, pH, electrical conductivity (EC), and dissolved oxygen (DO) were measured in situ using water quality sensors. Water quality sensors are typically deployed in water bodies to monitor parameters directly at the source. Appropriate calibrations of the devices employed in analyses were performed before determinations to ensure the quality of the analytical procedures and correctness of the obtained data. Other parameters, such as nitrogen in the form of nitrites ($N\text{-}NO_2\text{-}$), nitrates ($N\text{-}NO_3\text{-}$), and

ammonium (N-NH_4+), were analyzed in the laboratory within 24-48 hours after collection. Water samples were collected in sterile recipients, labeled and stored at 4°C for as short time as possible before analysis to minimize physical and chemical changes.

Analyses, methods and instrumentation are centralized in Table 1.

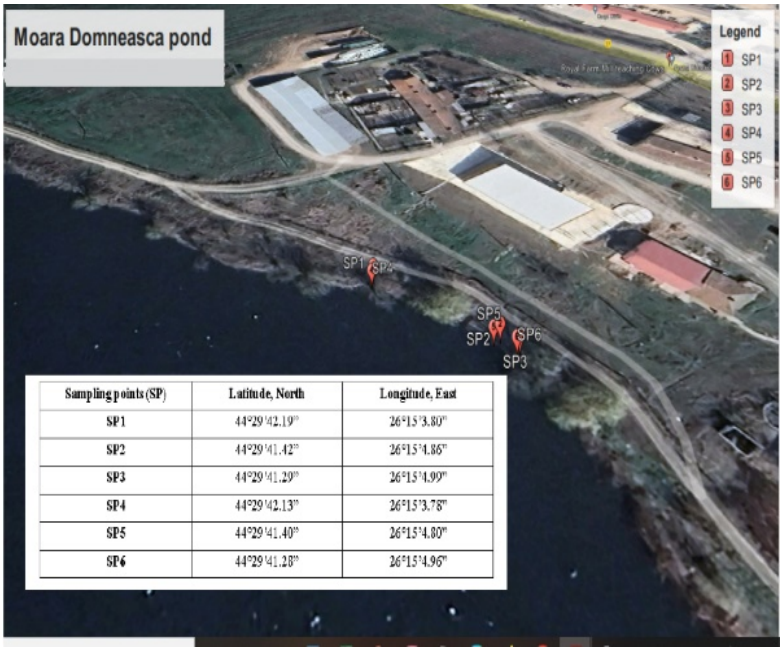

Figure 2. Map of Moara Domnească pond, showing the six sample collection points (SP1 to SP6)

Table 1. Determined parameters, analytical methods and instrumentation

Parameter	Abbreviation	Unit	Instrumentation	
Temperature	T	°C	Portable PH/EC/TDS Meter – HI9810-61	
pH	pH	pH units		
Electrical conductivity	EC	µS cm^{-1}		
Dissolved oxygen	DO	mg O_2 L^{-1}	Dissolved Oxygen Meter - HI9147	
Nitrite nitrogen	N-NO_2^-	mg N L^{-1}	Nitrite Photometer – HI97708	
Nitrate nitrogen	N-NO_3^-	mg N L^{-1}	Nitrate Photometer - HI97728	
Ammonium nitrogen	N-NH_4^+	mg N L^{-1}	Ammonia Photometer - HI97715	

RESULTS AND DISCUSSIONS

The data resulted from physico-chemical analyses are depicted in Tables 2 and 3.

Results concerning Temperature

Temperature is one of the most essential parameters of water quality, as it influences biological activity and growth in water, plus it has a direct effect on the water chemistry, influencing the other main water quality parameters. When temperature levels increase, the pH level drops. As temperature increases, DO levels dissolved decrease because dissolved oxygen and temperature have an inverse relationship.

Results concerning pH

The pH parameter assumes particular significance with regard to aquatic life, in view of the fact that values at the upper range enhance the toxicity of ammonia, while those at the lower range intensify the toxicity of specific metals. pH values above 8.5 can be harmful to aquatic life, as the alkaline environment may reduce fecundity in some fish species (Mihai et al., 2022). The consequences of pH levels outside the optimal range include reduced fish growth, diminished fish reproduction and impaired phytoplankton growth.

Determination of the pH values provided values in the range 7.30-7.80, with an average of 7.50 ± 0.19 (Tables 2 and 3 and Figure 3).

Results concerning Electrical Conductivity (EC)

Electrical conductivity (EC) is essential to measure when assessing the quality of water because it can detect the level of contaminated water. Water that has a high EC has a greater number of contaminants, whereas water that has good water quality such as drinking water has fewer contaminants, and therefore cannot conduct electricity.

In our study, the EC ranged between the values of 1405-1416 µS cm−1 (Tables 2 and 3 and Figure 4), which characterizes a desirable range for most fish species.

Results concerning Dissolved Oxygen (DO)

Dissolved oxygen (DO) refers to the amount of oxygen dissolved in water. DO is a parameter that is essential for aquatic life. Dissolved oxygen concentration is an important water quality parameter, indicating the balance between oxygen-producing processes (such as photosynthesis) and oxygen-consuming processes (such as chemical oxidation) (Mihai et al., 2022). Many factors affect DO levels in the water, but changes in the temperature of the water are the most common, followed by salinity and pressure.

The levels of DO determine for the water samples from the Moara Domnească pond were between 8.10-8.50 mg O_2 L−1 (Tables 2 and 3 and Figure 5).

Results concerning nitrogen pollutant species

In aquatic ecosystems, nitrogen is primarily found in the forms of nitrite (NO_2−), nitrate (NO_3–), and ammonium (NH_4^+). Elevated concentrations of these forms of nitrogen are the primary drivers of eutrophication, a process that negatively affects the quality of the living environment for fish.

The nitrite, nitrate and ammonium nitrogen concentrations assessed in the Moara Domnească pond were between 0.10-0.11 mg NL^{-1}, 2.30-3.80 mg NL^{-1} and 2.44-3.32 mg NL^{-1}, respectively (Tables 2 and 3 and Figures 6, 7 and 8).

Furthermore, the literature indicates that the optimal nitrite concentration for fish is 0–0.2 mgL^{-1}. Concentrations above 0.5 mgL^{-1} are considered to be harmful, while values exceeding 1.6 mgL^{-1} are lethal (Akhter et al., 2021).

Table 2. Determined values for water quality parameters at 6 sampling points (SP) located on Moara Domnească pond

Sampling point	T (°C)	pH	EC (μScm^{-1})	DO (mgO_2L^{-1})	NNO_2^- ($mgNL^{-1}$)	$N\text{-}NO_3^-$ ($mgNL^{-1}$)	$N\text{-}NH_4^+$ ($mgNL^{-1}$)
SP1	21.3	7.6	1405	8.1	0.1050	3.4	2.78
SP2	21.0	7.5	1405	8.5	0.1000	2.9	3.28
SP3	20.8	7.3	1412	8.2	0.1035	3.8	3.32
SP4	20.7	7.5	1416	8.3	0.1025	2.3	2.44
SP5	21.3	7.8	1410	8.5	0.1020	3.4	2.84
SP6	21.0	7.3	1409	8.4	0.1025	3.5	2.81

Table 3. Ranges, means, standard deviations and assignment of water quality classes for samples collected from Moara Domnească pond

Parameter	Unit	Range (min-max)	Mean value ± SD
pH	pH unit	7.30-7.80	7.50 ± 0.19
EO	µS cm^{-1}	1405-1416	1409.50 ± 4.23
DO	mg O_2 L^{-1}	8.10-8.50	8.33 ± 0.16
$N\text{-}NO_2^-$	mg N L^{-1}	0.10-0.11	0.10 ± 0.00
$N\text{-}NO_3^-$	mg N L^{-1}	2.30-3.80	3.22 ± 0.53
$N\text{-}NH_4^+$	mg N L^{-1}	2.44-3.32	2.91 ± 0.33

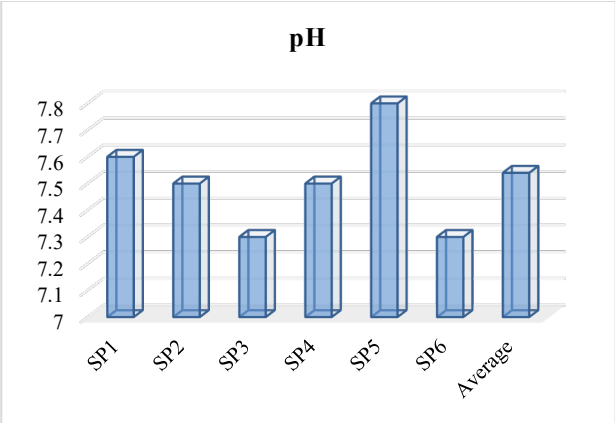

Figure 3. pH values in Moara Domnească pond

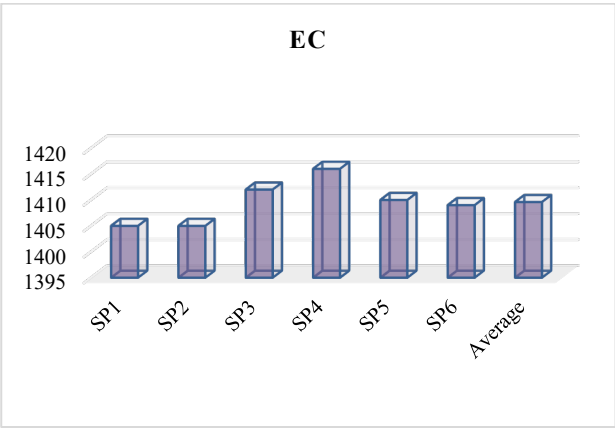

Figure 4. EC values in Moara Domnească pond

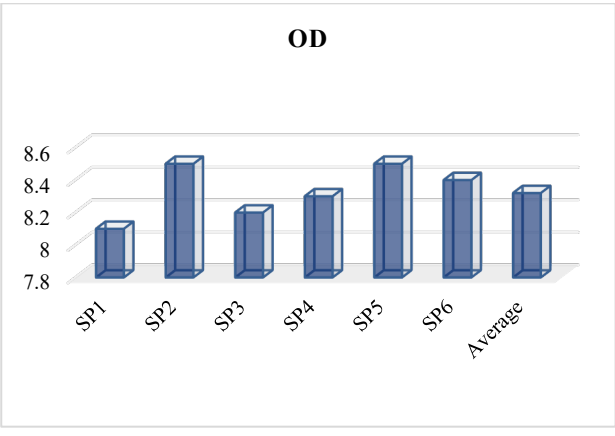

Figure 5. OD values in Moara Domnească pond

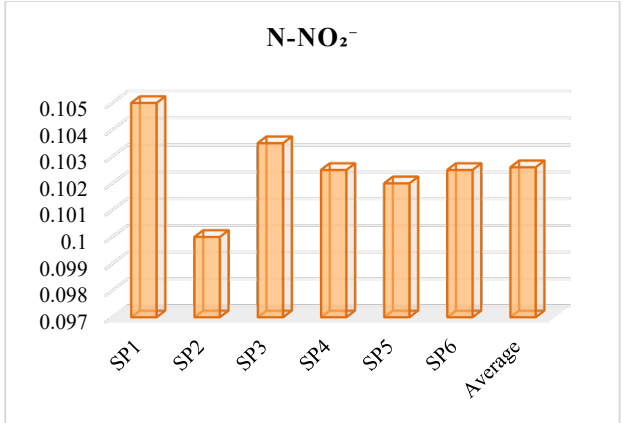

Figure 6. $N\text{-}NO_2^-$ values in Moara Domnească pond

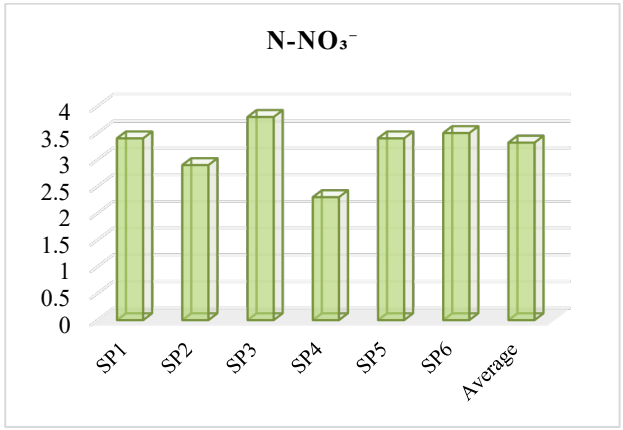

Figure 7. $N\text{-}NO_3^-$ values in Moara Domnească pond

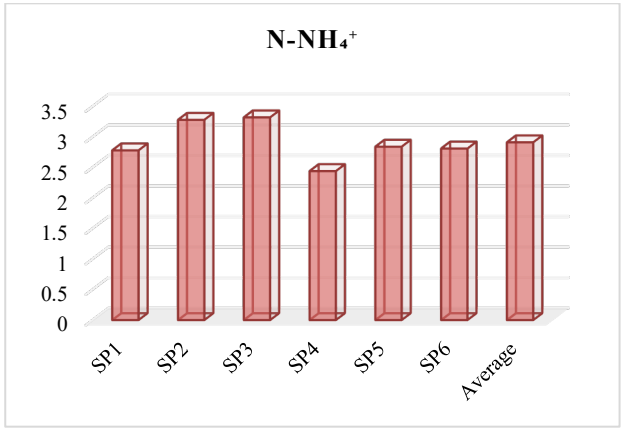

Figure 8. $N\text{-}NH_4^+$ values in Moara Domnească pond

For **Romania**, the water samples were interpreted according to Order 161/2006 for the approval of the Normative concerning the classification of surface. Collected water samples from Moara Domnească pond present pH values within recommended range (6.50-8.50) according to Order 161/2006, with an average of 7.50 (Table 3). For EC parameter, legislation does not provide a safe interval or a certain reference value, but literature studies indicate that water pond with EC between 60-2000 µS/cm may accommodate most fish species. The amount of DO find in water samples collected from Moara Domnească pond are within 8.10-8.50 mg mg O_2/L, with an average of 8.33 ± 0.16 mg O_2/L which allow to classify the water in II end class quality. Nitrite average level (0.10 mgN/L) for Moara Domnească water samples is so elevated that the water is framed into IV th quality class. Nitrate concentrations identified by analysis are 3.22 mg N/L, as average. Determined ammonium nitrogen levels and considering average value (2.91 mg N/L) it may be concluded that water from Moara Domnească pond correspond to IV th quality class according to Romanian legislation. Moara Domnească's nitrogen levels are comparatively raised, indicating an influence of agricultural or industrial contamination sources. Romania's water quality management is heavily influenced by EU directives, including the Water Framework Directive, the Nitrates Directive, and the Urban Waste Water Treatment Directive. Compliance with these directives has led to significant improvements in water quality monitoring and management.

Hungary, as a European Union member, adheres to Water Framework Directive (2000/60/EC), which aims to achieve good qualitative and quantitative status of all water bodies. It mandates the protection and improvement of aquatic ecosystems. Also, the Hungarian Act LVII of 1995 on Water Management law regulates the sustainable use of water resources, ensuring their protection and restoration. The water bodies classification in Hungarian is based on the annual average of the components, which are then assigned a classification code rank (1–2–3–4–5), considering the quality limit for each component. The component group code rank is obtained by calculating the average of the code ranks of each physico-chemical characteristic within the group. In Hungary, studies of the Danube River in Rajka revealed parameters such as a temperature of 12.4°C, pH of 8.2, and electrical conductivity of 700 µS/cm, with dissolved oxygen concentrations of 10.2 mg/L, nitrites of 2.09 mg/L, nitrates of 6.98 mg/L, and ammonium of 0.50 mg/L (Dauta et al., 1990).

In **Croatia**, the basic physical and chemical water quality parameters are defined in the Decree on Water Quality Standards and its additions (Official Gazette 78/2015). Croatian standards classify water quality from "very good" to "very bad" based on parameters such as temperature, pH, DO, and nutrients. Moara Domnească's dissolved oxygen levels are comparable, but nitrate and other nutrient levels are stricter in Croatia, indicating a more rigorous approach to preventing eutrophication (Narodne Novine, n.d.). Considering determined values of the 50th percentile for pH of surface water, it can be concluded that surface waters of the Moara Domnească pond area is classified as very good. Furthermore, the decree specifies limiting values of eutrophication indicators for each category, with each parameter having a distinct limiting value for every ecoregion and type of surface water. In Croatia, water quality indicators include detailed limit values for physico-chemical parameters, establishing classifications from "very good" to "very bad" based on nutrient and oxygen concentrations (Narodne Novine, n.d.).

The concentration of physico-chemical water parameter from Moara Domnească pond is compared with lake water quality standards based on **the Republic of Indonesia** Government Regulation Number 22 of 2021. There are four quality standards categories: class-A for drinking water, class-B for water recreation, class-C for aquaculture, and class-D for irrigation. Indonesian standards focus on temperature, pH, DO, and nutrient levels (Total Nitrogen), similar to European standards but adapted to local conditions with a focus on preventing industrial and agricultural runoff (Siagaairbersih.com, n.d.). The concentration of pH from Moara Domnească pond meets the quality standards for class-C (6-9). The DO parameter meets the quality standards for class-

A (6 mg/l) and the EC parameter corresponds to class-C.

Indonesia and Colombia also have specific regulations for water quality, tailored to their local conditions and water resource management needs (Siagaairbersih.com, n.d.; Colombian Water Quality Regulations, n.d.).

Colombian regulations set specific standards for temperature, pH, DO, and nutrient concentrations. For example, pH should range from 6.5 to 8.5, with minimum DO levels of 5 mg/L. Nitrites should be less than 1 mg/L, and nitrates less than 10 mg/L (Colombian Water Quality Regulations, n.d.).

Reflection on Similarities and Differences

Reflecting on the similarities and differences in water quality regulations across different countries, including Romania, Hungary, Croatia, Indonesia, and Colombia, reveals a complex landscape shaped by local environmental conditions, legislative frameworks, and international agreements.

Romania, Hungary, Indonesia, and Colombia, all these countries set similar pH standards for surface water, generally ranging between 6.5 and 8.5, which ensures a suitable environment for aquatic life. Croatia also follows a similar range, maintaining a conducive environment for aquatic ecosystems.

In Romania, Hungary, Indonesia, and Colombia the minimum DO levels are consistently set around 5-6 mg/L to support aquatic life. Croatia emphasizes high DO levels to prevent eutrophication, similar to the standards seen in other European countries.

All mentioned countries emphasize controlling nutrient levels (nitrites and nitrates) to prevent eutrophication, albeit with varying strictness. While there is a global consensus on critical water quality parameters, permissible nutrient limits and other parameters vary due to environmental conditions and specific regional challenges.

Romania, Hungary, and Croatia as EU members, these countries follow the Water Framework Directive (2000/60/EC), aiming to achieve good water status by setting stringent water quality standards.

The analysis of water quality standards across these countries highlights a shared commitment to maintaining ecological health and supporting aquatic life. However, the approaches to classification, specific parameter limits, and local adaptations reflect the unique environmental and regulatory contexts of each country.

CONCLUSIONS

This analysis of Moara Domnească pond's water quality highlights the importance of continuous monitoring and localized water management strategies. Implementing rigorous regulations and appropriate management practices is essential to protect water quality, ensure the health of aquatic ecosystems, and optimize its use for irrigation and aquaculture. Adapting these strategies will help sustain water resources and support environmental and human health.

The EU's main aim is to ensure that all Europeans have access to good quality and sufficient water, and to guarantee the good status of all water bodies across Europe. EU rules aim to ensure that water is managed sustainably in the long-term, water pollution is reduced, and aquatic ecosystems are protected.

While there are broad similarities in the goals and some parameters of water quality standards, the differences underscore the importance of tailoring regulations to local conditions and specific environmental needs. This nuanced approach helps ensure the sustainable management of water resources globally.

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SLOPE STABILITY CALCULATIONS FOR A PETROLEUM WELL PERIMETER IN DÂMBOVIȚA COUNTY

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Abstract

Petroleum, discovered thousands of years ago, it is found in sedimentary layers composed of limestone, clay or sand. The petroleum extraction industry plays a crucial role in the global economy and meeting the growing energy demand. Oil extraction involves retrieving mineral fuel from underground reservoirs and processing it. An essential aspect of this project is represented by the environmental impact of the petroleum production. Fossil fuel extraction wells serve as local pollution sources, emphasizing the need for pollution reduction. In this research paper, there is analysed slope stability for a petroleum well perimeter located in Dâmbovița county, calculating various slope stability scenarios, considering different types of soils and materials. The results obtained conclude that the retaining wall's slope is stable across all of the scenarios, with no risk of landslides.

Key words*: petroleum well, slip surface, slope stability, retaining wall landslides.*

INTRODUCTION

The oil extraction industry plays a crucial role in the global economy and meeting the growing demand for energy. Oil extraction involves obtaining oil from underground deposits and processing it to obtain valuable energy resources.

Once deposits are identified, the drilling phase follows. This involves constructing wells used to penetrate rock layers until reaching the depth where the oil reserve is located. Advanced technologies are necessary for extracting oil from deep depths while minimizing environmental impact.

To ensure the extraction process, oil wells must be correctly built to prevent accidents such as land subsidence, which can lead to accidental oil spills and negatively impact the environment. Therefore, constructing a stable support structure is essential.

For well enclosure, calculating the stability factor of the terrain on which it is located is necessary. The process of calculation was done by using an extension software within the GeoStudio software suite, which facilitates geotechnical calculations and improves verification methods.

MATERIALS AND METHODS

For assessing the stability of an earth mass, various numerical calculation methods based on the existent finite element method (Chirilă et al., 2021a, 2021b). I have chosen to use one of the methods based on dividing the mass into slices, initially developed for homogeneous and unstratified clay rocks. It can also be applied to heterogeneous and stratified formations (Lazăr, Faur, 2015). I decided to perform the calculations using the SLOPE/W software program within the GeoStudio suite. Although calculations using the strip method can be conducted following Fellenius, Bishop, Janbu, Morgenstern-Price, the key provided as a student option allowed only the use of the latter. This method of limit equilibrium analysis has the particularity that the forces between strips are defined by arbitrarily chosen functions (constant, sinusoidal, semi-sinusoidal) (Boldurean, 2008).

The retaining wall is the most common solution for supporting a slope when space-saving is necessary (Boldurean, 2008).

GeoStudio is a suite of software tools for

geotechnical analysis, used to calculate the stability of slopes, groundwater pressure, and heat and mass transfer between soil and rock. It is widely used in the civil engineering industry for designing and analyzing foundations, slopes, retaining walls, dams, and other geotechnical structures.

In the SLOPE/W module, the program utilizes limit equilibrium equations to calculate slip circles and determine the minimum stability factor for slope stability. These equations are based on the principles of force and moments around a reference point, considering parameters such as soil properties, loading characteristics, and slope geometry.

In the WALLAP module, the program utilizes methods such as finite element analysis for determining the behaviour of retaining walls and their interaction with the soil. In this case, I have not used this extension because it is not available in the student version of the program. In this study, GeoStudio will be used to verify the stability of slopes in relation to the petroleum well.

RESULTS AND DISCUSSIONS

For the first calculation hypothesis with the SLOPE/W extension of the program, I have decided to attempt the Entry and Exit method for calculating slip surfaces. The materials introduced for this calculation variant are soil and concrete, and the chosen method for modelling the soil mass is Mohr-Coulomb.

After creating the necessary number of materials for building the model, we select the materials one by one. For the stability calculation of the slope, it is necessary to choose the material model. In this case, the chosen model is Mohr-Coulomb. We mention its specific weight, cohesion, and internal friction angle Φ; all these elements are defined in geotechnical literature (Olinic, 2021).

The program displays the slip circle, its center, and the sectors from which it is formed (Figure 1).

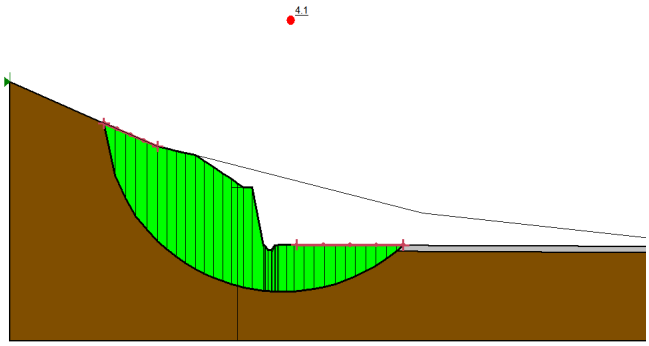

Figure 1. The result of running the first solution using the Entry and Exit method

From the analysis of the slices, we can observe that each of them is in equilibrium under the action of the loads acting upon them (Figure 2).

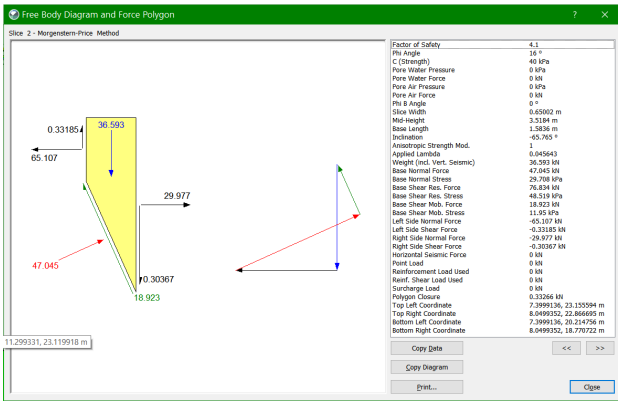

Figure 2. The diagram of forces applied to the slices with data

The smallest value of the stability factor is 4.1, and this value concludes that the slope is stable.

For the second calculation hypothesis, I have decided to attempt the Grid and Radius method for calculating slip surfaces. The materials introduced for this calculation variant are soil and concrete, where the soil is modelled using the Mohr-Coulomb method.

From the project definition window, by selecting the Slip Surface button, you can choose the method for defining the terrain's slip surfaces. For the second calculation variant, I have selected the direction of movement to be from left to right, using the Grid and Radius definition method (Figure 3).

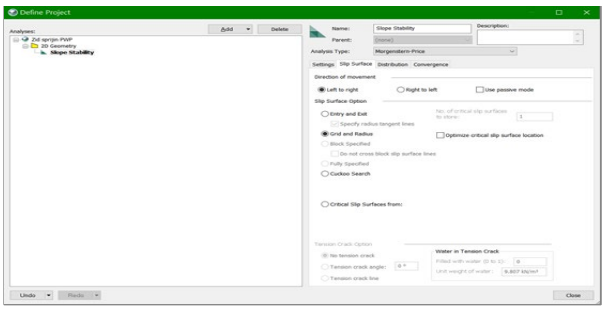

Figure 3. Selecting the Grid and Radius method of defining sliding surfaces

By choosing this method, the positions of the slip circle centres and the maximum depth they reach are determined.
Materials are assigned to regions just like in the first calculation hypothesis. Another visible element is represented by the green colour, in the form of a grid and lines. The grid in the upper part of the geometric model represents the centres of the sliding circles, while the lines in the lower part of the model represent the maximum depth reached by the rays of the circles.
In addition to displaying the critical slip surface and the strips, the program shows the sliding circle centres in the grid, stability factor values, and highlights their critical value (Figure 4).

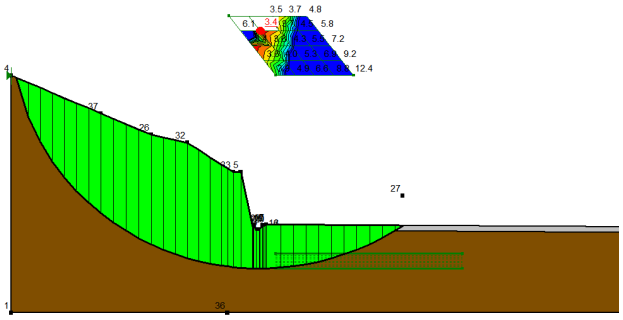

Figure 4. The result of running the second solution using the Grid and Radius method

The smallest value of the stability factor is 3.4, and this value concludes that the slope is stable.
For the third calculation variant, I have chosen to introduce a new material called saturated soil modelled with Mohr-Coulomb, and I will use the Grid and Radius method to define the slip surfaces. When displaying the result, we notice in the grid the stability factor values, with the critical value highlighted in bright red (Figure 5).

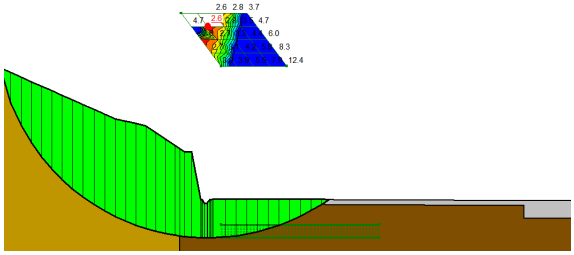

Figure 5. The result of running the third solution using the Grid and Radius method

The minimum stability factor value after introducing the new material into the calculation is 2.6, resulting that the slope is stable.
During the fourth and the final calculus hypothesis, the material named saturated soil remains present in the equation and another polygon of the model is represented by this material (Figure 6).

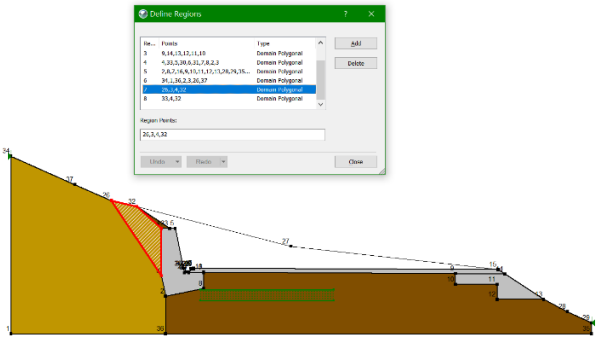

Figure 6. Defining the material in polygon Nr.7

When displaying the result, we observe in the grid the stability factor values along with the centres of the slip circles, with the critical value highlighted in bright red. The minimum stability factor obtained using this method is 2.5, which is an appropriate value to consider the slope stable (Figure 7).

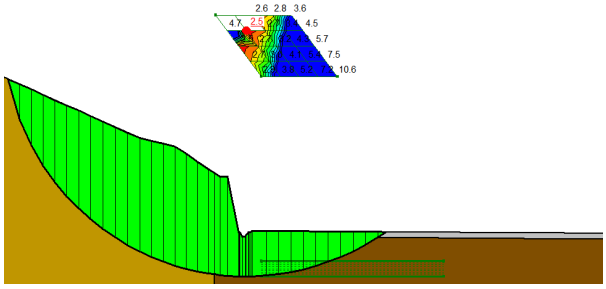

Figure 7. The result of running the fourth solution using the Grid and Radius method

CONCLUSIONS

The GeoStudio software suite proves to be very useful for calculating the stability of slopes.
The SLOPE/W extension available in the student version of the program was used to calculate several slope stability calculations involving different scenarios and materials. The advantages of using the program in the calculation of slope stability are the reduction of working time when performing the calculations and the presentation of the results, which are presented very clearly, the diagrams and models produced by the program being easy to query. The GeoStudio program is easy to use and intuitive.
After performing the calculations, we concluded that the slope on which the retaining wall is built is stable in all four calculation options and that there is no danger of it being subject to landslides.

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THE EFFECT OF THE EXPANSION OF THE WIND INDUSTRY ON THE ENVIRONMENT

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Abstract

This paper examines the environmental impacts of the expansion of the wind energy industry. The wind industry has experienced significant growth in recent decades, driven by concerns about climate change and the need for renewable energy sources. The construction and operation of wind farms can have various environmental impacts, including disruption to local ecosystems, damage to wildlife and changes to landscapes. However, it is important to note that these impacts can vary depending on the location and how projects are managed. In conclusion, careful assessment of environmental impacts before, during and after the construction of wind farms is necessary to minimize negative consequences and promote sustainable development in this sector.

Key words: *environmental impact, wind energy industry, renewable energy sources, climate change, ecosystems, wildlife, sustainable development, landscapes.*

INTRODUCTION

In order to meet the increasing demand for energy, a number of projects have been implemented, including North Cross Wind Park, which consists in the development of alternative renewable energy sources in order to reduce greenhouse gas emissions, with the main objective of reducing energy dependence on existing primary resources.

Figure 1. North Cross Wind Park

The study area for the project is located in Dobrogea, Constanța county, covering approximately 1950 hectares, including the wind turbine impact zone, access roads and future electricity infrastructure (Figure 1). The proposed project area is about 40 km from the Black Sea coast and more than 20 km from the Danube. It does not overlap with any protected natural areas, such as nature reserves, national parks, nature parks, biosphere reserves or the Natura 2000 network.

The project involves the installation and operation of 36 wind turbines with a total installed capacity of 108 MW. The turbines will generate electricity in a 33 KV collector grid and then be delivered to the national grid operated by Transelectrica. The turbines and transformer station will be located on private agricultural land, under surface leases with the landowners. The park and substation will be located on the agricultural periphery of the communities of Crucea, Vulturu and Pantelimon, next to private properties and existing roads, away from protected nature areas.

The proposed wind turbines, manufactured by Vesta's, are three-bladed, horizontal-axis, variable speed wind turbines with a speed range of 6.0 to 18.4 rpm, equipped with wind steering mechanisms and a rotor diameter of 112 meters

(Figure 2). The support tower is cylindrical, made of metal, with a base diameter of 4.2 meters, a height of 94 meters and a total turbine height of 150 meters. They will be equipped with night-time visual warning systems at nacelle height in accordance with the requirements of the aviation authorities. The siting of the turbines takes into account optimal land use, wind direction, minimum access distances and power grid requirements. Pre-assembly platforms of approximately 1000 square meters will be constructed for turbine component assembly and maintenance access. The internal park roads will consist mainly of existing roads, which will be upgraded, and new access roads to the turbines, with a width of 4.5 meters and a radius of curvature of 30 meters, meeting the turbine supplier's transmission specifications. Within the parcels, the road width will be approximately 5 meters.

From the environmental impact point of view, the project goes through several stages, the most important of which will be mentioned.

Prior to the start of construction, the pre-construction stages consist of geotechnical, topographical and site location studies. These studies provide information on the boundaries of the site, the existing geological structure, methods to prevent soil erosion, boundaries of protected areas, etc. The geotechnical study determines the capacity of the soil to support the weight of the installation. This stage is very important as it specifies possible problems and mentions possible solutions.

During the assembly of turbines, noise levels from heavy machinery operating with high-power engines can reach 80-85 dB. Noise propagation depends on environmental factors and obstacles between sources and measurement points. The maximum acceptable emission is 40 dB(A), although Romanian regulations do not specifically address wind farms as noise sources. The foundation pouring ensures the overall distribution of the construction load. The type of foundation depends on the soil geology. The turbines will be fixed to the ground by foundations with a diameter of 19 meters and a depth of about 5.6 meters. The underground reinforced concrete foundation of each turbine, covering approximately 300 square meters, will be connected to a metal ring anchored by pre-tensioning. Fixing will be by means of pre-tensioned bolts, with ground improvement by means of about 112 columns of granular material for each foundation, increasing the bearing capacity. The turbines are highly automated, with control systems allowing remote monitoring.

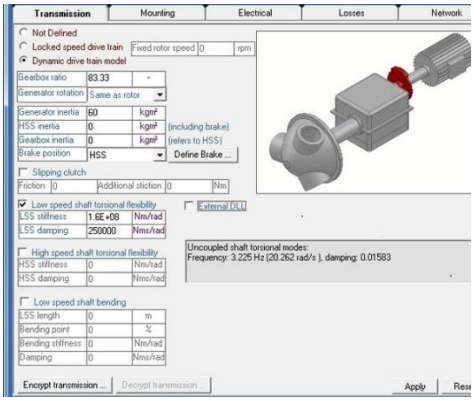

Figure 2. Wind turbine design software

They start at wind speeds of 3 m/s and stop at wind speeds above 25 m/s, operating in ambient temperature limits between -20°C and +40°C. They operate 24 hours a day, except in inclement weather conditions or for inspection and maintenance activities or unscheduled activities such as miscellaneous breakdowns (Figure 3).

Figure 3. General Maintenance of the turbine

During high winds or periods of frost, turbines automatically shut down by adjusting blade angles and activating the braking system. Maintaining a turbine through software involves monitoring performance parameters, analyzing data to identify potential problems, and implementing remote updates or adjustments to optimize efficiency and reliability.

In terms of assembly and erection of the turbine components, the components will be transported

from the port of Constanța Sud-Agigea to the wind farm site via county roads, respecting vehicle access restrictions. It is estimated that 10 flatbed trucks will be needed for each transportation of turbine components. Two cranes, a 600-ton crane and a 150-200-ton auxiliary crane, will be used for lifting (Figure 4).

Figure 4. Using a crane to install the wind turbine

The largest crane will lift the components from the trailer platforms, while the auxiliary crane will help lift the rotor. Both cranes will move to the next site after each turbine is installed, with an estimated installation time of 2-3 days for each turbine, including crane relocation time. The cranes require 160 square meters and 84 square meters of space respectively. Also the required material stocks will be stored as per the norms ensuring dust abatement measures in the respective locations. Accidental losses of cement and concrete will be cleaned up immediately and cement bags will be stored on covered wooden pallets, empty cement bags will be disposed of properly. Environmentally friendly anti-skid materials are used sparingly on roads. Some machinery, such as excavators and bulldozers, will operate continuously during construction while others, such as concrete mixers, will be temporary. Excavation areas will comply with existing regulations by covering excavated piles and transporting the earth in covered trucks for proper storage away from water bodies.

In terms of potential impact on habitats and biodiversity it should be mentioned that there are no priority or important habitats for conservation in the project area, also the impact on agricultural habitats is less significant for conservation, instead plant species or vegetation groups may be affected during construction, various plant species may invade the area along the new roads and habitat loss during construction will affect insects and other less mobile invertebrates such as molluscs, and artificial lighting may affect nocturnal flying insects. Habitat fragmentation may also affect reptiles and amphibians during construction.

MATERIALS AND METHODS

To assess the noise level generated by wind turbines in a wind farm in Romania, measurements were conducted using a digital sound level meter, the Lutron - Model SL-4012, adhering to IEC 61672 Class 2 standards (Figure 5).

Figure 5. Lutron SL-4012 Sound Level Meter

The instrument features A-weighted and C-weighted frequency response, a high-precision condenser microphone, and measures noise levels within the range of 30 to 130 dB.
Measurements were taken in close proximity to the turbines, following SR ISO 1996-1 regulations, at a distance of approximately 50 meters from each turbine. Measurements were conducted three times daily: in the morning around 7:00 AM, at noon around 1:00 PM, and

in the evening around 7:00 PM, daily for two weeks during each measurement phase.

Phase 1: January 2024

Jan-24					
zi	Ora măsurătorii	Nivel de zgomot (dB)	zi	Ora măsurătorii	Nivel de zgomot (dB)
1	7:00	78	8	7:00	82
1	13:00	80	8	13:00	80
1	19:00	79	8	19:00	81
2	7:00	81	9	7:00	79
2	13:00	80	9	13:00	78
2	19:00	82	9	19:00	82
3	7:00	78	10	7:00	80
3	13:00	79	10	13:00	79
3	19:00	81	10	19:00	81
4	7:00	80	11	7:00	82
4	13:00	82	11	13:00	80
4	19:00	81	11	19:00	78
5	7:00	79	12	7:00	81
5	13:00	78	12	13:00	79
5	19:00	82	12	19:00	80
6	7:00	80	13	7:00	78
6	13:00	81	13	13:00	81
6	19:00	82	13	19:00	82
7	7:00	78	14	7:00	80
7	13:00	81	14	13:00	78
7	19:00	80	14	19:00	79

Phase 2: March 2024

Mar-24					
zi	Ora măsurătorii	Nivel de zgomot (dB)	zi	Ora măsurătorii	Nivel de zgomot (dB)
1	7:00	79	8	7:00	80
1	13:00	80	8	13:00	81
1	19:00	82	8	19:00	79
2	7:00	80	9	7:00	79
2	13:00	81	9	13:00	80
2	19:00	79	9	19:00	82
3	7:00	82	10	7:00	81
3	13:00	79	10	13:00	82
3	19:00	80	10	19:00	78
4	7:00	81	11	7:00	80
4	13:00	82	11	13:00	79
4	19:00	78	11	19:00	81
5	7:00	80	12	7:00	82
5	13:00	79	12	13:00	80
5	19:00	81	12	19:00	79
6	7:00	82	13	7:00	81
6	13:00	80	13	13:00	78
6	19:00	79	13	19:00	82
7	7:00	81	14	7:00	80
7	13:00	78	14	13:00	81
7	19:00	82	14	19:00	79

Phase 3: may 2024

May-24					
zi	Ora măsurătorii	Nivel de zgomot (dB)	zi	Ora măsurătorii	Nivel de zgomot (dB)
1	7:00	79	8	7:00	81
1	13:00	81	8	13:00	79
1	19:00	82	8	19:00	82
2	7:00	80	9	7:00	80
2	13:00	82	9	13:00	82
2	19:00	79	9	19:00	83
3	7:00	81	10	7:00	79
3	13:00	79	10	13:00	81
3	19:00	83	10	19:00	80
4	7:00	80	11	7:00	82
4	13:00	81	11	13:00	79
4	19:00	82	11	19:00	83
5	7:00	79	12	7:00	80
5	13:00	82	12	13:00	82
5	19:00	80	12	19:00	81
6	7:00	83	13	7:00	79
6	13:00	79	13	13:00	81
6	19:00	81	13	19:00	82
7	7:00	82	14	7:00	83
7	13:00	80	14	13:00	80
7	19:00	79	14	19:00	79

RESULTS AND DISCUSSIONS

The North Cross Wind Park project is designed to address multiple challenges and opportunities in Romania's energy sector. Project objectives include diversifying the country's energy portfolio to meet growing energy demand, assisting Romania in meeting its commitments to reduce greenhouse gas emissions through the development of renewable energy sources, promoting long-term economic development in local communities and last but not least reducing Romania's energy dependence on primary resources.

Details of the project include the installation and operation of 36 wind turbines, manufactured by Vestas with horizontal axis, three-bladed, 150-meter-high metal support towers, with a total installed capacity of 108 MW, which will generate electricity in a 33 kV collector grid connected to the national grid. Optimal land use, wind direction and grid requirements were taken into account when siting the turbines.

From the environmental point of view various measures have been applied as follows:

In-depth geotechnical, topographical and site location studies were carried out to assess the environmental impact and propose adjacent solutions.

Regarding noise abatement, during construction, excavation areas were minimized as well as the covering of soil piles and environmental measures were implemented for waste management and dust reduction.

Careful siting of turbines and infrastructure development resulted in minimal impact on habitats and biodiversity.

The use of advanced automation systems and remote monitoring minimized environmental impacts during turbine operation.

Installation of underground cables followed best practices to minimize environmental disturbance.Regarding the noise level produced by the operation of wind turbines, the measurements taken indicate an average value of 80 dB. This value is exceeded during the construction phase of the wind farm due to the use of heavy machinery. These machines, which operate with high-powered engines, are typically used for activities such as digging foundations or assembling turbine components.

CONCLUSION

The North Cross Wind Park project presents a comprehensive strategy to address Romania's energy needs while contributing to environmental sustainability and local economic development. Through the installation and operation of 36 wind turbines, the project aims to diversify Romania's energy portfolio, reduce greenhouse gas emissions, promote long-term economic growth in local communities and reduce dependence on primary energy resources, and also adheres to strict environmental regulations and considerations, with careful siting of turbines, noise mitigation measures and comprehensive studies of geotechnical, topographical and siting factors. With a high level of automation and remote monitoring, wind turbines are designed to operate efficiently and safely, contributing to a sustainable energy future for Romania. In addition, the installation of underground cables follows best practices to minimize environmental impact.

The project area in Dobrogea, Constanta County, was strategically chosen to minimize the impact on habitats and biodiversity. Overall, the North Cross Wind Park project is an important step towards achieving Romania's renewable energy goals while promoting economic development and environmental protection in the region. From a noise perspective, it can be concluded that both during the construction and operation phases, the levels significantly exceed the maximum acceptable limit of 40 dB.

During the construction phase, considering it occurs within a limited timeframe, it does not have a significant environmental impact.

In contrast, during the operation phase, although the noise levels exceed the maximum acceptable limit significantly, the environmental impact is minimal. This is primarily because the area is not densely populated; harmful effects are limited to various species of insects and invertebrates, and secondarily to maintenance personnel working in the area. However, considering that they operate within restricted time intervals and use appropriate protective equipment, the noise effect is not significant.

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MAKE # NOT WASTING FOOD A PERSONAL RESOLUTION

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Abstract

At the end of a year, people make their wishes, and at the beginning of a new year or season, people set their mind on achieving new resolutions, such as living healthier, exercising regularly as part of a new lifestyle, reconnecting with nature, traveling and discovering new places and people to befriend, understanding the way they can contribute to the reduction of the carbon footprint or the use of natural resources and moving to a circular bioeconomy. Making a personal resolution with the slogan "# don't waste food" can be a good idea for everyone, as food loss and waste at all stages of the food supply system needs to be put an end to. FAO estimated that 14 percent of all food produced globally is lost, from post-harvest all the way up to but not including retail.
"Food waste" refers to all the food wasted unnecessarily, for instance when something goes off in one's fridge because it has not been consumed in time, or a person puts too much on their plate and throws away the leftovers instead of saving them for later.
In this work, we want to present the activity that we have carried out to raise awareness among young people about the unnecessary production of food waste. We have come up with some ideas and solutions to reduce food waste and made a contest entitled "How do your plates look before and after you ate". We also presented a simple method by means of which food waste can be utilized through composting. Composting is a process that implies food waste becoming a valuable resource, a fertile soil, which can be used in gardening, in urban agriculture projects or just in the flower pots that everyone has at home. The decomposition of organic matter is carried out by the class of decomposers, microorganisms such as bacteria and filamentous fungi, but also organisms from the mesofauna and macrofauna of the soil.

Key words*: composting, filamentous fungi, waste food.*

INTRODUCTION

Bio-waste is made up of discarded plant and animal residues, and includes garden/park and food waste. Between 118 and 138 million tonnes of bio-waste is generated across the EU every year, but less than 40% of this is currently recycled into useable products.
About 12 million tonnes of compost is produced annually across the EU, but this could be increased to just over 32 million tonnes a year if all collectable bio-waste was treated. With these 12 million tonnes (32 million tonnes) 1.3 million tonnes (3.5 million tonnes) of CO2-equivalents could be bound (www.compostnetwork.info).
Organic matter in European soils is decreasing. This negatively affects soil productivity. Organic matter contents can be raised by adding organic soil improvers or organic fertilisers.
Recycling bio-waste into compost and anaerobic digestate harnesses natural biological cycles, converting leftover plant and animal residues into useful products that can be returned to the soil.
Compost is the end product of the composting process and is a valuable soil improver as it contains stable organic carbon that can help (maintain and/or) increase the content of soil organic matter. (https://www.merriam-webster .com; https://dictionary.cambridge.org; https:// www.collinsdictionary.com). It also contains a diverse range of micro-organisms that form an essential part of a healthy soil ecosystem. Compost is the product manufactured through the controlled aerobic, biological decomposition of biodegradable materials. The product has undergone mesophilic and thermophilic temperatures, which significantly reduces the

viability of pathogens and weed seeds and stabilizes the carbon such that it is beneficial to plant growth. Compost is typically used as a soil amendment, but may also contribute plant nutrients. Finished compost is typically screened to reduce its particle size, to improve soil incorporation (https://www. compostingcouncil .org).

Relating the annual amount of bio-waste to the population in each country, Slovenia, with 320 kg bio-waste treated per capita, is surprisingly the leading country in bio-management in Europe, followed by the Netherlands with 223 kg, Belgium with 201 kg, and Sweden with 193 kg of biowaste per capita.

Recycling of bio-waste contributes significantly to circular economy objectives:

1. It completes the biogeochemical cycles and decreases the linearity of the economy of landfill storage of residual biomass.
2. It has an important contribution to the restoration of soil fertility and implicitly to long-term carbon storage by transforming into fertilizers and soil improvers, which directly contribute to the health of the soil.
3. It is possible to develop economic growth at the local level and employment opportunities for the young workforce. Each country can assimilate the customs in the field of recycling the biological fraction from the countries that have already developed these methods. Of course, it should also be mentioned that farmers' incomes can increase, which would ensure life safety and resilience in rural areas.
4. The recycling rate of the dry fraction - glass, plastic, paper and metals will be better recycled, for each category separately, if the wet fraction - biological waste will be collected and processed properly separately.

With the Circular Economy Package adopted in 2018, the EU initiated the way for better management of biological waste in Europe. It is important to mention that biological waste, by adopting this package, becomes a commodity, a product (soil improvers, fertilizers) that can generate important incomes, ensuring the resilience of rural communities in particular, but also that of urban communities.

The main objectives of the EU's circular economy are

- Reducing waste production in Europe,
- Promotion of recycling,
- Saving primary resources, and
- Establishing markets for secondary products - developing networks of producers and buyers.

With the adoption of the waste legislative revisions and the revision of the EU Fertiliser Regulation (EU) 2019/1009 in 2019 the legislative frame for achieving these objectives is set.

The main elements with relevance for improving bio-waste managing in Europe are

- The overall recycling target of municipal waste of 65 % by 2035,
- The mandatory separate collection of bio-waste by 2023,
- The exclusion to account mechanical biological treatment of municipal waste for recycling by 2027, and
- The 10 % reduction target of municipal solid waste being landfilled by 2035.

Besides the final recycling target of municipal solid waste, intermediate targets with 55 % by 2025 and 60 % by 2030 were set.

Compoststyle technology

To date, the best European technology available for household use is Saec Group's Compostyle, which is able to reduce the weight and volume of food waste, which on average amounts to 90%, turning the remaining part into natural fertilizing soil, called Te -d, without the addition of structuring agents or chemicals, which after a short ripening period that can be done in small pots can be easily reused in balconies, gardens and orchards. The transition from the linear economy to the circular economy - this represents a real ecological, sustainable and economic revolution, a fundamental step towards an "Internal Circular Economy" with countless environmental and economic advantages. Compoststyle technology processes food waste through bioengineered degradation. There is no need for structuring, therefore the declared management capacity is equal to 100% of food waste, in other words nothing is wasted, everything is transformed. (https://www.

saecgroup.eu/scarti-alimentari-da-spreco-a-risorsa)

Thermophilic microorganisms – fungi

Thermophilic fungi are microscopic fungi, molds, that belong to the kingdom Mycota and have a minimum growth temperature at or above 20°C and a maximum growth temperature that extends up to 60 to 62°C. As the only representatives of eukaryotic organisms that can grow at temperatures above 45°C, thermophilic fungi are valuable experimental systems for investigating the mechanisms that allow growth at moderately high temperature but limit their growth above 60 to 62°C. Although widespread in terrestrial habitats, they have remained underexplored compared to thermophilic species of eubacteria and archaea. However, thermophilic fungi are potential sources of enzymes of scientific and commercial interest. Thermophilic fungi can be cultivated in minimal media with metabolic rates and growth yields comparable to those of mesophilic fungi. Studies of growth kinetics, respiration, mixed substrate utilization, nutrient uptake, and protein breakdown rates have provided some basic information not only about thermophilic fungi but also about filamentous fungi in general. Some species have the ability to grow at room temperature if cultures are initiated with germinated spores or mycelial inoculum or if a nutrient-rich medium is used. Thermophilic fungi have a strong capacity to degrade polysaccharide constituents of biomass. The properties of their enzymes show differences not only between species but also between strains of the same species. Their extracellular enzymes exhibit optimum temperatures for activity that are near or above the organism's optimum growth temperature and are generally more heat stable than those of mesophilic fungi. Some extracellular enzymes from thermophilic fungi are commercially produced, and others have commercial prospects. Among eukaryotic organisms, only a few species of fungi have the ability to grow at temperatures between 45 and 55°C. Such fungi comprise thermophilic and thermotolerant forms, which are arbitrarily distinguished on the basis of their minimum and maximum growth temperature, thermophilic fungi having a minimum growth temperature at or above 20°C and a maximum growth temperature at or above 50°C, and thermotolerant forms have a growth temperature range from below 20 to ~55°C. Thermophily in fungi is not as extreme as in eubacteria or archaea, some species of which are capable of growing near or above 100°C in hot springs, solfatara fields, or hydrothermal vents. Perhaps because of their moderate degree of thermophily and because their habitats are not exotic, thermophilic fungi have not received much publicity and attention. However, given that the vast majority of eukaryotes cannot survive prolonged exposure to temperatures above 40 to 45°C, the ability of about 30 species, out of about 50,000 recorded fungal species, to exceed the upper temperature limit of eukaryotes is a phenomenon that deserves elucidation. Moreover, this group of fungi provides scientists with valuable experimental material for investigating the mechanisms that, while allowing their growth at moderately high temperatures, limit it above 60 to 62°C. Thermophilic fungi are the main components of the microbiota that thrive in compost piles of plant material, piles of agricultural and forestry products and other accumulations of organic matter where the warm, moist and aerobic environment provides the basic conditions for their development. They constitute a heterogeneous physiological group of various genera in Phycomycetes, Ascomycetes, Fungi Imperfecti and Mycelia Sterilia (Maheshwari et al, 2000).

MATERIALS AND METHODS

Presentation of Comstyle® SGC-020 composter

The Composostyle SGC 020 is an excellent companion for family cooking and also for some small commercial enterprises. It can process up to 2 kg of organic waste in just 6-24 hours, reducing its weight and volume by 95%. It does not produce unpleasant odors and 95% of the waste will decompose imperceptibly. In addition, its compact design makes it easy to use and place in limited spaces. The composter also contributes to the reduction of organic waste, an increasingly urgent environmental problem.

The Unique Food Recycler is a new and innovative device that turns food waste into fertilizer in 24 hours. Designed for kitchen use, the Unique Food Recycler Compostyle® reduces food waste by more than two-thirds of

its original volume through a fully automated process. This organic waste self-composting machine can only be used for food waste.

Figure 1. Household composter for 6/8 people

Technical manufacturing specifications:
Model: Sgc 020
Description: Family composting machine for 2 kg food waste
Nominal decomposition capacity: 2 kg/day
Power mode: continuous or intermittent
Nominal voltage: AC 220V/50Hz
Electricity consumption: about 40/60w*h
Product dimensions: L385 x D 430 x H 580
Decomposition method: enzymatic fermentation
Internal application environment or external environment under a rainproof canopy
Operating temperature: Min 5°C - max 50°C.

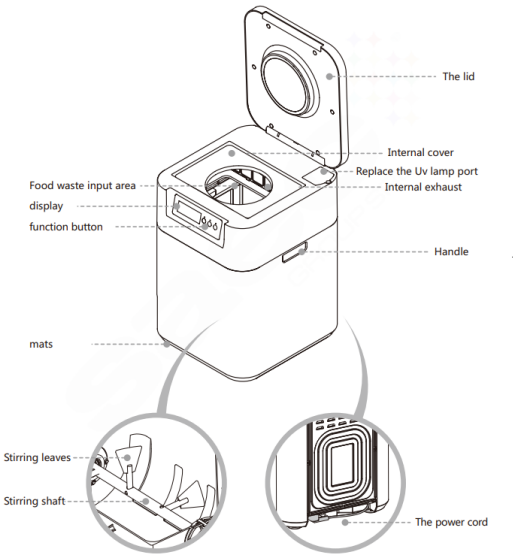

Figure 2. The component parts of the composter

Mode of operation

1.Insert food scraps

2.By rotating the mixing shaft, waste and microorganisms are thoroughly mixed. The control unit heats the inside of the mixing drum to allow sufficient contact between the food waste and microorganisms (air and oxygen), creating an environment most suitable for microbial decomposition.

3.The water content decreases significantly when the device has reached between stages 1 and 2, most of the food waste has been decomposed and the odour has been removed, and the water vapor from gasification will be discharged after purification with deodorizer. (The resulting gases are colourless and odourless, which is harmless to the human body).

4. Using households of 4 people as a reference, after 1-2 months (depending on the amount of input, there will be differences), about 5% of the total food waste will be produced as secondary products. When the by-products are piled high so that the agitator blade cannot be seen (upper limit mark), the by-products must be cleared until the agitator shaft can be seen.

RESULTS AND DISCUSSIONS

At the end of a year, people make their wishes, and at the beginning of a new year or season, people set their mind on achieving new resolutions, such as living healthier, exercising regularly as part of a new lifestyle, reconnecting with nature, traveling and discovering new

places and people to befriend, understanding the way they can contribute to the reduction of the carbon footprint or the use of natural resources and moving to a circular bioeconomy. Making a personal resolution with the slogan "# don't waste food" can be a good idea for everyone, as food loss and waste at all stages of the food supply system needs to be put an end to.

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In figures 3 and 4 you can see photos from the competition that we proposed to students from the Tertiary College for Environmental Protection in USAMV Bucharest from the first year.

Figure 3. Photos from the challenge

The technology of rapid composting of household organic waste is based on the action of microorganisms, bacteria and filamentous fungi (moulds), both those that are naturally found on food waste, but also those that are used by the manufacturing company in the starter kit package, the microbial bioactivators, which are intended to ensure the quick start of the process. These microorganisms can break down the biodegradable material from organic household waste from the cooking activity in a very short time of at least 6 hours. The preparation of vegetable and animal remains from the cooking activity is carried out by chopping them to make the organic matter decomposition process more efficient, the smaller the waste, the faster the bacteria and filamentous fungi have the ability to colonize the organic matter and decompose it. If users do not have the time or availability to break down the food scraps, the microbial degradation process will still take place, but the process will take longer, which is specified in the composter's user manual: the process takes at least 6 hours up to 24 hours. This food waste decomposition technology used in our experiments is a technology that uses microorganisms to break down food waste into organic fertilizer. There are microbes in nature that can efficiently break down food (organic matter), which has been isolated from the soil and put into the product starter. This product creates the environment of microbial biological activity in the mechanical environment of the composter. Food waste can be efficiently fermented and transformed. The micro-organisms used in this product are harmless to the human body, but like any activity involving the use of micro-organisms even without pathogenic potential for humans, it must be handled with care and respecting the minimum necessary hygiene conditions, such as washing hands after the activity is finished.

The stages of the technological process

Stage 1 – collection of food scraps

Food scraps intended for composting are collected in an individual container and placed in the composter using the shovel in the tool kit that accompanies the product. As we stated before, the food scraps are separated, shredded if necessary and then put into the composter only those that are allowed, according to the instructions provided by the manufacturer.

Stage 2 – preparing the composter

When the device is used for the first time, the package with microorganisms is opened, inserted into the composter tank, then 800 ml of

water is added and left to activate the microorganisms for 24 hours, then the food scraps are added.

Figure 4. Food scraps from the kitchen

Stage 3 – starting the composter

After food scraps are added to the machine, no more than the maximum amount indicator line, close the lid and press the start button. The composter starts working according to the pre-set schedule and decomposes plant and animal matter with the help of microorganisms. The rotor with the vanes at the base of the tank should rotate to better homogenize the air, the microorganisms with the food scraps to achieve an optimal process.

Stage 4 – continuous/discontinuous composting

Depending on the amount of food waste that accumulates each day, the composter can operate continuously or intermittently. When the decomposition stage is complete, according to the display on the digital screen, the power can be turned off, to open the lid and remove the compost from the machine. At the bottom of the tank, a minimum amount is left (enough to cover the rotor with its blades, this amount of compost is used as a starter for the next composting process). Food scraps are added, but if they are insufficient to start a new batch it can wait until the next day or the following days. The food scraps are not stored in the composter until a new technological cycle of composting is resumed, but are stored in a special container.

Step 5 – using compost in the garden/potted plants

The compost obtained can be used for the layers of flowers, vegetables, fruit trees in the garden or for those who don't have it, the compost can be used for indoor plants in pots in the house or on the balcony.

Figure 5. Compost obtained by Comstyle technology

CONCLUSIONS

Comstyle technology has the following advantages:

-meets the needs of household users, but also of small entrepreneurs in the field of processing food waste, which represents a valuable resource;

-allows the rapid composting of food waste, which is quickly transformed into compost;

-compost is a valuable product from a qualitative point of view - nutrient substrate for plant growth and development;

-compost is a valuable product from an economic point of view - it is no longer necessary to buy sub-tract for plants from specialty stores;

-uses microorganisms isolated from the non-GMO natural environment, not genetically modified;

-low energy consumption;

-doesn't take up a lot of space;

- does not release unpleasant odors;

- it's quiet.

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THE INFLUENCE OF SPORT COURTS ON THE ENVIRONMENT

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Abstract
In recent years, increased awareness of environmental sustainability has permeated various aspects of human activity, including sports. Amid this shift, the influence of sports courts upon the environment has attracted more and more attention. From the materials used in their construction to the ongoing maintenance practices, sport courts have the potential to leave a significant ecological footprint. Understanding this influence is essential to both stakeholders in the sports industry and environmental advocates alike. This paper explores the multifaceted relationship between sport courts and the environment, focusing on the construction, maintenance, and long-term implications of these structures on our planet. By examining various types of sport courts and their environmental impact, we can identify opportunities for sustainable practices that minimize harm and promote harmony between sports and the natural world.

Key words: *courts, pollution, Romania, sports, tennis.*

INTRODUCTION

The popularity of tennis courts can vary based on several criteria, including historical significance, facility quality, and the type of events. The following are a few of the most widely used types of tennis courts:

1. HARD COURTS:

The most prevalent type of tennis courts in the world is the hard court.
It is composed of concrete or asphalt that has been coated in acrylic substance. Hard courts are used for several important competitions, such as the US Open and the Australian Open

2. CLAYCOURTS:

Clay courts are built of crushed brick, shale, or stone and are slower than hard courts.
The French Open, one of the four Grand Slam tournaments, takes place on clay courts at Roland Garros in Paris, France. Clay courts are also popular in several European and Latin American countries.

3. GRASS COURTS:

Grass courts are made of natural grass that is normally cut short and packed densely. Grass courts are renowned for their fast-playing surface and low bounce.
Wimbledon, the world's oldest tennis tournament, takes place on grass courts at the All England Lawn Tennis and Croquet Club in London, England.

4. ARTIFICIAL GRASS COURTS:

The appearance and playing qualities of natural grass are replicated on artificial grass courts by using synthetic materials.
Recreational facilities and indoor tennis centers frequently use them because they provide a consistent playing surface.

5. CARPET COURTS:

Carpet courts provide a quick playing surface that is comparable to grass courts, and are constructed of textile or synthetic materials.
Carpet courts are more frequently found in indoor tennis facilities these days, although originally they were quite common on the professional circuit.
The popularity of tennis courts and the events that take place on them are frequently correlated with Grand Slam competitions such as Wimbledon, the US Open, the Australian Open, and the French Open greatly influencing the global awareness of particular court surfaces.
In addition, local tastes, maintenance, and accessibility all have an impact on the popularity of tennis courts in certain areas.

MATERIALS AND METHODS

To determine how sports fields can affect the environment, the classification of the fields has

been studied by comparing clay courts with hard courts.

I. Natural courts- clay courts:

Red clay courts are very well-known in both South America and Europe. Clay is the softest material to play tennis on. It is the most forgiving and easiest surface on the body. Both advantages and disadvantages might be discussed when considering natural courts.

1. Better performance: When compared to artificial surfaces, natural surfaces like grass or clay frequently offer a different playing experience. Natural courts, according to many athletes, provide superior traction, enabling more organic movements and improved performance.
2. Tradition: Sports on natural surfaces have a long history dating back hundreds of years. Playing on natural courts has historical relevance and authenticity that is valued by many players and fans, which enhances the attention to this sport.
3. Environmental benefits: In general, natural surfaces are better for the environment than artificial ones. For instance, grass courts support biodiversity, soil health, and oxygen production. Additionally, compared to artificial surfaces, which are usually composed of synthetic materials, they frequently demand less energy and resources for maintenance.
4. Aesthetic value: Natural surfaces frequently have an eye-catching appearance, making them a beautiful backdrop for sporting activities. Particularly grass courts are more desirable and prestigious because of their affiliation with major competitions such as Wimbledon.
5. Variety in playing experience: Various natural surfaces present different kinds of problems and playing qualities. For instance, grass courts are faster and demand that players modify their style of play, whereas clay courts are slower and offer more bounce. This diversity keeps the sport engaging for both participants and viewers by bringing excitement and depth to it.

The combination of tradition, performance, and environmental advantages that natural courts provide makes them appealing for a variety of sports.

Certainly, there are some potential drawbacks of natural courts such as:

1. Maintenance costs: For natural surfaces to remain playable, substantial maintenance is frequently necessary. For instance, grass courts require frequent mowing, watering, fertilizing, and aerating, all of which may be expensive and time-consuming.
2. Weather dependency: When it comes to weather, natural surfaces are more vulnerable than artificial ones. Rain can make clay or grass courts muddy and slick, which can interfere with gameplay and perhaps cause matches to be cancelled or postponed.
3. Limited availability: Particularly in urban places or countries with harsh weather, natural courts can not be as easily accessible as constructed ones. This restriction may limit people's ability to engage in outdoor recreational activities or sports on natural surfaces.
4. Durability: Natural surfaces are prone to deterioration over time, particularly in instances of high traffic or unfavourable weather. For example, uneven or bare sections on grass courts may emerge and need to be repaired or renovated to keep them in good condition.
5. Consistency: Compared to artificial surfaces, natural surfaces cannot provide constant playing conditions. Surface texture, moisture content, and temperature variations can all affect ball bounce and speed, which could have an effect on the performance of the players and the fairness of the competition.
6. Environmental impact: Natural surfaces can be good for the environment. However, they also need to be maintained, which can harm the ecosystem if water, pesticides, and other resources are not used responsibly.
7. Cost of Installation: When opposed to establishing artificial courts, building natural courts, especially those with specific materials like clay, can be more

expensive. This upfront cost could discourage businesses or people from choosing natural surfaces, especially if the budget is tight.

Despite these difficulties, a lot of sports fans still value the distinctive qualities and visual attractiveness of natural courts, outweighing the disadvantages with the rich history and experience they provide.

II. Synthetic courts- Hard courts

Hard tennis courts are one of the most common types of surfaces used for tennis worldwide. Hard tennis courts are typically made of asphalt or concrete, which are then covered with a layer of acrylic or synthetic material. This surface is then painted with multiple coats to create a smooth and uniform playing surface.

There are advantages and disadvantages to these kinds of courts:

Advantages:

1. Durability: Tennis courts made of synthetic materials are renowned for their resilience to weather. They do not break down after heavy use for an extended amount of time.
2. Low maintenance: Synthetic courts require less care than natural surfaces like clay or grass. Because they do not require pesticide treatment, mowing, or watering, they require less effort and upkeep.
3. Consistency: All year round, regardless of the weather, synthetic courts provide reliable playing conditions. Gamers may anticipate consistent bounce and pace, making for a dependable gaming experience.
4. Versatility: Because synthetic courts can be constructed both indoors and outdoors, they are appropriate for a variety of settings and weather conditions. They can be customized to fit particular tastes or brands because they come in a variety of colours and patterns.
5. Accessibility: Players of all ability levels, including recreational and novice players, can use synthetic courts. They lower the chance of injury during play by offering a cozy, easy-on-the-joints surface.

Disadvantages:

1. Initial cost: Synthetic tennis courts may be more expensive to install initially than natural surfaces like clay or asphalt. The initial outlay of funds could discourage certain people or institutions from selecting synthetic alternatives.
2. Heat retention: Synthetic courts have the potential to trap heat, particularly in warm weather or in direct sunlight. High temperatures have the potential to cause discomfort for players and have an impact on gaming when it is hot outside.
3. Environmental concerns: Certain synthetic materials, that are utilized to build tennis courts such as rubber or plastic, may cause environmental problems. The proper disposal of worn-out or outdated synthetic surfaces may provide obstacles to recycling and waste management.
4. Surface hardness: Certain courts may have a tougher surface than natural ones, like clay or grass, depending on the sort of synthetic surface used. Joint injuries may become more likely as a result of this hardness, particularly for the athletes who already have health issues.
5. Surface aging: Exposure to sunshine, moisture, and frequent use can cause synthetic surfaces to deteriorate or lose their original qualities over time. The court may require periodic resurfacing and routine maintenance to extend its lifespan.

In general, synthetic tennis courts are advantageous owing to their longevity, little upkeep, and uniformity; yet there are certain disadvantages associated with their expense, ecological footprint, and surface properties.

A synthetic court should be selected after taking into account a number of aspects, including player preferences, usage trends, budget, and location.

The tennis courts structure represents the first element to be considered when studying the degree of influence on the environment. Most tennis courts are made up of multiple layers:

• formation
• foundation
• regulating base
• wearing surface.

To create a level surface on which to build, the

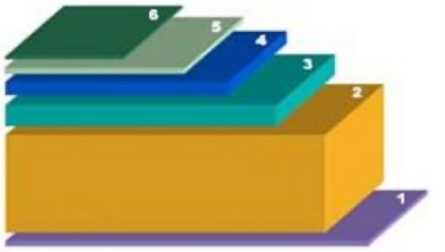
topsoil must be removed to dispose of the organic matter that rots and makes surfaces unstable. The ground is compacted and levelled. We refer to this as the sub-grade.
In many cases, it is not cost-effective to build deep enough to withstand frost damage; in these situations, drainage is essential.
As a result, all surfaces built in areas where there is a chance of ground freezing share the foundation layer also referred to as the sub-base. The foundation is made of aggregate that is resistant to frost damage. Stone grade, or size, should be both large enough to allow water pass through and small enough to facilitate compaction and levelling. Usually, a range of sizes, either mixed or graded, from 14 mm to 28 mm is used.
After being compacted, the depth of the foundation layer varies depending on the local climate and soil type (depth of frost penetration, for example), but it should be about 150 mm below the surface.
To give the surface system a stable platform, the levelling course is laid on top of the foundation layer.

RESULTS AND DISCUSSIONS

To determine the influence of sports fields on the environment, the structure of sports fields was studied and discussed with a series of coaches from tennis, as well as with the managers of the sports clubs: Voinicelu' Club and Tennis Prim Club. The opinions were:
" Clay courts are a friendly alternative for equipment and athletes, but this type of court also has its drawback: in the winter season, when playing on covered lands, the dust produced by slag can produce allergies and affect the performance of athletes." (M.Wesselly, coach)
"*Improper practices used in the construction of sports fields can lead to environmental pollution, surface degradation over time, and subsequently to very high investments to address the issues."* (Tennis Prim Club, director)
"In the case of clay courts, if it is not purchased from specialized places, it may present a risk of radioactivity." (Voinicelu' Club director)
Below we will study the various court surfaces and how can sport fields cause pollution. The construction of these layers differs depending on the surface:
acrylic
artificial grass and artificial clay
carpet
clay
grass

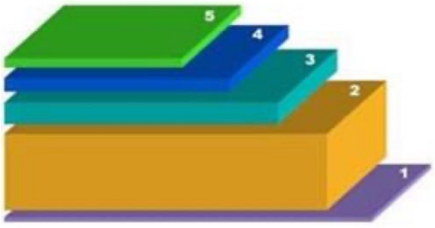
A. Acrylic

Usually, the base is made of asphalt or concrete. To minimize cracking, reinforced concrete should be used. The playing surface is made up of multiple acrylic surface coatings, the quantity of which is adjustable.



1. When stability is needed, on the sub-base, a geotextile membrane must be installed.
2. 150-200 mm compacted depth of foundation
3. 35-40 mm compacted depth of base asphalt with a diameter of 14-20 mm
4. 25-30 mm compacted depth of wearing course asphalt with a diameter of 6 mm
5. Cushion system, if required
6. Coating with aggregate made of acrylic or polyurethane

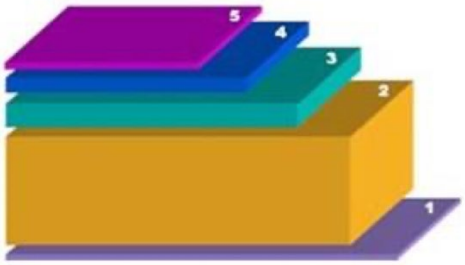
B. Artificial grass and artificial clay



1. Geotextile membrane and drainage system, if required
2. Minimum 150 mm of compacted depth non-frost susceptible carboniferous limestone or granite
3. Compacted depth base course porous asphalt measuring 40 mm
4. 25 mm open-grade porous asphalt with 6 mm in aggregate diameter
5. Sand-filled artificial grass-wearing course

Rolls of artificial grass are provided. To enable drainage, it must be installed outside over a porous base of concrete or asphalt.

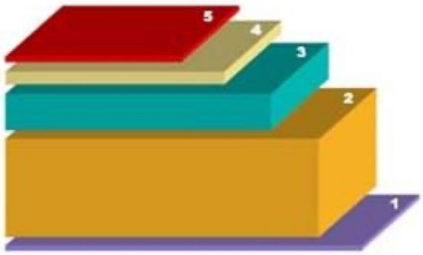
C. Carpet



1. Geotextile membrane
2. 200 mm of compacted depth non-frost susceptible carboniferous limestone or granite
3. Compacted depth base course porous asphalt measuring 40 mm
4. Compacted depth dense asphalt wearing course measuring 25 mm
5. Polymeric carpet or rubber mat

Polymeric surfaces, which are made of rubber bound in polyurethane, can be supplied in prefabricated rolls or cast in place. A level concrete or asphalt substrate is required for these surfaces.

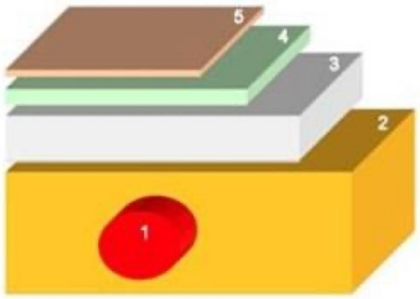
D. Clay



1. Geotextile membrane laid on sub-grade
2. 120-160 mm compacted depth of foundation
3. Graded aggregate measuring 60–100 mm is used to support capillary action
4. 40-50 mm compacted depth of crushed aggregate
5. 3-6 mm of fine crushed aggregate

For above-ground irrigation, clay courts must be constructed with a slope of between 0.25 and 0.35 %.

E. Grass



1. Perforated plastic drainage pipe
2. 6-10 mm of grade permeable backfill
3. 50 mm of a blinding layer of aggregate to separate topsoil from the foundation
4. 100-150 mm of topsoil, composed of clay, silt, and sand
5. 8-12 mm of turf

The soil, drainage, and amount of use and maintenance of the court will all influence the turf grass selection.

Can sports fields cause pollution?

Sports fields can get contaminated in several ways, and the degree of contamination varies depending on the kind of field, maintenance procedures, and environmental circumstances in the area. Sports fields may add to pollution, albeit the amount and kind of pollution varies depending on several variables such as maintenance procedures, utilization trends, and ambient circumstances.

Sports fields may potentially cause pollution in the following ways:

1. **Chemical pollution:**

Herbicides and pesticides: Using pesticides and herbicides on athletic fields to eradicate weeds, bugs, and diseases may result in chemical contamination.

When these chemicals are used excessively or improperly, they may leak into groundwater or runoff into neighbouring bodies of water.

Fertilizers: Fertilizers with phosphate and nitrogen bases, which are frequently used to maintain turf health and encourage grass growth, can contribute to nutrient contamination if they are not administered properly.

Overnutrienting nearby waterways can cause algae blooms and problems with water quality.

2. **Surface Contamination:**

Litter and debris: Sports fields that have trash, plastic bottles, wrappers, and other garbage left on them can become unsightly and even dangerous for the environment.

Litter can enter storm drains by the wind and rain, contaminating nearby bodies of water.

Spills: If spills of motor oil, gasoline, or other hazardous materials are not adequately cleaned up and remediated, they can contaminate the soil on sports fields, and endanger both human health and the environment.

3. Soil erosion:

Poor drainage: Inadequate drainage systems for sports grounds can lead to soil erosion and waterlogging, especially during heavy rainy seasons.

Because it causes sedimentation in nearby bodies of water, eroded soil can deteriorate aquatic habitats and water quality.

Overuse and Compaction: Sports fields that are used extensively, especially in high-traffic locations, may experience soil erosion and compaction.

Because compacted soil has less permeability, there is a greater chance of erosion and flow during periods of precipitation.

4. Air pollution:

Particulate matter and dust: Particularly in metropolitan areas, dust from dry or badly managed sports fields can lead to air pollution.

Air quality can be lowered and respiratory conditions can worsen by particulate matter from surrounding construction sites or agricultural surfaces.

5. Noise pollution:

Loudspeaker systems used during athletic events can cause noise pollution by upsetting the local wildlife and residents. Event scheduling and sound-level management techniques might help lessen these effects.

6. Water pollution:

Water runoff from sports fields can introduce pollutants like pesticides, fertilizers, and silt into storm drains during irrigation or rainfall.

These pollutants can then eventually find their way into natural water bodies and affect water quality.

Sports fields may contribute to pollution, but it is important to keep in mind that this impact can be mitigated with the suitable management strategies.

Sports fields can use strategies including prudent pesticide usage, regular trash cleanups, soil conservation techniques, and effective drainage systems to lessen their environmental effect and promote sustainability.

CONCLUSIONS

To address and avoid pollution in sports grounds, it is essential to implement sustainable management practices, such as adequate waste disposal, integrated pest management, soil conservation measures, and responsible use of fertilizers and pesticides.

Regular care is necessary to stop environmental degradation, preserve the long-term health of sports grounds, and protect the surrounding ecosystems. This entails clearing out trash and monitoring the condition of the water and soil.

ACKNOWLEDGEMENTS

This research work was carried out with the support of Mihai Wesselly, tennis coach, Daniel Dobre, Club Voinicelu's director and Gabriel Munteanu, Tenis Prim Club's director.

The interview has the following conclusions:

" Clay courts are a friendly alternative for equipment and athletes, but this type of court also has its drawback: in the winter season, when playing on covered lands, the dust produced by slag can produce allergies and affect the performance of athletes." (Mihai Wesselly)

"Improper practices used in the construction of sports fields can lead to environmental pollution, surface degradation over time, and subsequently to very high investments to address the issues." (Mihai Munteanu)

"In the case of clay courts, if it is not purchased from specialized places, it may present a risk of radioactivity." (Daniel Dobre)

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THE ENVIRONMENTAL MOVEMENT QUESTIONING SUSTAINABILITY

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Abstract

The concept of sustainability, rooted in the Latin "sustentāre," emphasizes the imperative of preserving resources for future generations. Economically, it denotes activities that can be sustained over time, while ecologically, it focuses on resource use without environmental depletion. Historically, sustainability gained attention in the late 1970s through works by Wes Jackson and Lester Brown, culminating in the 1987 Brundtland Report's definition of sustainable development. This definition stresses meeting present needs without compromising future generations' ability to meet their own. However, debates persist regarding the evaluative criteria for future generations prospects, highlighting the complexity of the concept.
Despite its seemingly clear definition, practical implementation often reveals conflicts between commercial interests and ecological, social, and cultural considerations. This tension underscores sustainability's subtle irony as a term. The intricate nature of sustainability leads to societal skepticism, particularly evident in doubts surrounding phenomena like climate change.

Key words*: climate, people, question mark, sustainable*

INTRODUCTION

The modern environmental movement started in the early 60s. The book that initiated this movement is called "Silent Spring" (1962), written by Rachel Carson, who is considered the "Mother of the Modern Environmental Movement." The book has sold approximately 2 million copies worldwide to date and made a powerful case for the idea that if humankind poisoned nature by using chemical pesticides, nature would, in turn, poison humankind.

MATERIALS AND METHODS

Early Influences and Shifts in the Movement

Although the intention of this movement was well-meaning, another popular book that sold approximately 2 million copies as well is "The Population Bomb" (1968) by Paul R. Ehrlich. This book popularized the neo-Malthusian idea, stating that because of overpopulation, society will collapse in the near future. Ehrlich's ideas strongly influenced the political agenda and policymakers in the early 70s in the US and subconsciously shifted the meaning of the environmental movement from "protecting the environment" to "human impact is inherently bad, immoral, and inevitably self-destructive." From that point on, this new definition infiltrated the minds of people and, unfortunately, became the norm nowadays.

Media and Public Perception

If you look at the news today, everyone is ramping about climate change and how it will make us disappear. The New York Times warns that "across the globe climate change is happening faster than scientists predicted." The cover of Time magazine tells us: "Be worried. Be very worried." The British newspaper, The Guardian, has gone further, updating its style guidelines so reporters must now use the terms "climate emergency," "climate crisis," or "climate breakdown." Global warming should be referred to as "global heating." The newspaper's editor believes "climate change" just isn't scary enough, arguing that it "sounds rather passive and gentle when what scientists are talking about is a catastrophe for humanity." A 2016 poll found that across countries as diverse as the United Arab Emirates and Denmark, a majority of people believe that the world is getting worse, not better. In the United Kingdom and the United States, two of the most prosperous countries on the planet, an astonishing 65 percent of people are pessimistic

about the future (False Alarm, 2020). A 2019 poll found that almost half of the world's population believes climate change likely will end the human race. In the United States, four out of ten people believe global warming will lead to mankind's extinction (False Alarm, 2020).

Reality vs. Exaggeration

Make no mistake, climate change is real, and it is caused predominately by carbon emissions from humans burning fossil fuels, but… (there is always a but) things may not be how they appear. Many climate campaigners go further than the science supports. They implicitly or even explicitly suggest that exaggeration is acceptable because the cause is so important. After a 2019 UN climate science report led to over-the-top claims by activists, one of the scientist authors warned against exaggeration. He wrote: "We risk turning off the public with extremist talk that is not carefully supported by the science." (https://nypost.com/2020/07/11/how-climate-change-alarmists-are-actually-damaging-the-planet/).

Improvements and Positive Trends

WE ARE NOT on the brink of imminent extinction. In fact, quite the opposite. The rhetoric of impending doom belies an absolutely essential point: in almost every way we can measure, life on Earth is better now than it was at any time in history. Since 1900, we have more than doubled our life expectancy. In 1900, the average life span was just thirty-three years; today it is more than seventy-one. Between 1990 and 2015, the percentage of the world practicing open defecation dropped from 30 to 15 percent. Health inequality has diminished significantly. The world is more literate, child labour has been dropping, and we are living in one of the most peaceful times in history.

The planet is getting healthier, too. In the past half-century, we have made substantial cuts in indoor air pollution, previously the biggest environmental killer. In 1990, it caused more than 8 percent of deaths; this has almost halved to 4.7 percent, meaning 1.2 million people survive each year who would have died. Higher agricultural yields and changing attitudes toward the environment have meant rich countries are increasingly preserving forests and reforesting. Since 1990, 2.6 billion more people gained access to improved water sources, bringing the global total to 91 percent. Many of these improvements have come about because we have gotten richer, both as individuals and as nations.

Over the past thirty years, the average global income per person has almost doubled. That has driven massive cuts in poverty. In 1990, nearly four in ten people on the planet were poor. Today, it is less than one in ten. When we are richer, we live better and longer lives. We live with less indoor air pollution. Governments provide more health care, better safety nets, and enact stronger environmental and pollution laws and regulations.

Projections for the Future

Importantly, progress has not ended. The world has been radically transformed for the better in the last century, and it will continue to improve in the century to come. Analysis by experts shows that we are likely to become much, much better off in the future. Researchers working for the UN suggest that by 2100 average incomes will increase perhaps to 450 percent of today's incomes. Life expectancy will continue to increase, to eighty-two years or possibly beyond a hundred years. As countries and individuals get richer, air pollution will reduce even further (Nordhaus, 2018).

Climate change will have an overall negative impact on the world, but it will pale in comparison to all of the positive gains we have seen so far and will continue to see in the century ahead. The best current research shows that the cost of climate change by the end of the century, if we do nothing, will be around 3.6 percent of global GDP. This includes all the negative impacts; not just the increased costs from stronger storms, but also the costs of increased deaths from heat waves and the lost wetlands from rising sea levels. This means that instead of seeing incomes rise to 450 percent by 2100, they might increase "only" to 434 percent. That's clearly a problem. But it's also clearly not a catastrophe. As the UN climate panel put it themselves: "For most economic sectors, the impact of climate change will be small relative to the impacts of other drivers [such as] changes in population, age, income, technology, relative prices, lifestyle, regulation, governance, and many other aspects of socioeconomic development" (IPCC, 2014).

Education and Objectivity

This is what we should teach in schools and universities. We should analyze the problem in a more objective manner without thinking that we are doomed and the end is near, believing everything the media feeds us. Unfortunately, those ideas are very dangerous for young people as they oversimplify the problem and promote adopting the environmentalist stance by creating a false dichotomy suggesting that one must either support the move by believing the narrative of "human impact is inherently bad" or be labelled as a climate change denier that doesn't care about the environment.

Psychological and Sociological Nuances

This has also a psychological nuance and it may be an explanation of why it is so appealing to people, because merely expressing concern for the environment makes one appear morally virtuous. In reality, to understand this subject, one has to put in genuine effort and work that takes years, having to understand the complexities of environmental management and economic sustainability. It comes down to the narcissistic behaviour that everyone possesses; we all want to be morally virtuous, but most of us are not willing to put in the effort and are satisfied by appearing that way by practicing virtue signaling.

Concept of Sustainability

Today, the concept is based on the idea of not crossing certain limits of the Planet. From an etymological point of view, the word sustainable comes from the Latin "sustentāre," which means to sustain. From an economic point of view, this word characterizes an activity that can be sustained and carried out over a long period. If we look at this term from an ecological point of view, sustainability refers to the use of natural resources without exhausting the environment (DEX, 2016).

This concept of sustainability represents a comprehensive way of dealing with environmental problems caused by various activities undertaken by humanity that require serious solutions. The characterization and treatment of sustainability fluctuate according to the concern of the one who defines it. The common point of each definition is the emphasis on environmentally sound activity, respectful of social rules, displaying socially responsible and economically feasible behaviour (UEFISCDI, 2011).

Historical Context

Looking back historically, the term "sustainable" has been noted among those interested in environmental issues, with most definitions supporting some concern. The term was introduced to the general public in the late 1970s through the work of Wes Jackson, writing about agriculture, and in 1980, Lester Brown through "Building a Sustainable Society", and the World Conservation Strategy (Allen, 1980), (UEFISCDI, 2011).

One of the most vehemently debated definitions of sustainable development is that of the UN World Commission on Environment and Development in 1987, headed at the time by the Prime Minister of Norway, Gro Harlem. In the Brundtland Report, or "Our Common Future," sustainable development is defined as "ensuring that development meets the needs of the present without compromising the ability of future generations to meet their own needs." This definition encompasses not only the needs of the present population but also the rational use of natural resources and the environment.

Challenges and Misconceptions

However, although from a theoretical point of view, the definition of the term "sustainable development" is clear, it is difficult to implement it in practice, as the specific concepts on which it is based often conflict with one another. In practice, the expression "sustainable development" is often considered an oxymoron, implying that there is a deep contradiction between commercial priorities and ecological priorities. Today, the way humanity uses natural resources is recognized as a threat to life. The speed of natural resources use is considerably higher than the speed at which they are produced.

For example, a small part of the biomass of microorganisms and plants is sufficient to sustain human life. Still, human activity endangers these sources of supply. This jeopardizes the ecological balance that underpins the economy and production. However, at the same time, it is acknowledged that the development process is strongly conditioned by the existence and continuity of economic growth.

Critical Thinking and Sustainable Development

Sustainable development is a relatively new idea and represents a significant change in our society since the 1970s. Today, the term sustainable development is commonly used, but critical thinking is essential to understand the true meaning of this concept. It is necessary to recognize that "sustainable" is not just a buzzword and understand the complexities of creating genuine sustainable solutions that avoid the unintended negative consequences that often come with oversimplified policies.

Importance of Balanced Perspective

Recognizing the necessity of balancing economic growth with environmental preservation is essential. Oversimplifying the discourse around sustainability can lead to ineffective policies that do not address the root of environmental issues. By acknowledging the complexities and interdependencies between economic activities and environmental health, policies can be better designed to promote long-term sustainability.

RESULTS AND DISCUSSIONS

Case Studies and Practical Applications

To illustrate the practical application of sustainable development, various case studies highlight successful strategies. For example, Sweden's waste management system, which emphasizes recycling and energy recovery, has significantly reduced landfill use. Similarly, Costa Rica's investment in renewable energy sources has made it one of the world's leaders in renewable energy production. These examples show that with thoughtful planning and execution, sustainable development is achievable and beneficial.

The Role of Technology and Innovation

Innovation and technology play crucial roles in advancing sustainability. Advances in renewable energy technologies, such as solar and wind power, have made clean energy more accessible and affordable. Additionally, developments in energy storage and smart grid technologies improve the efficiency and reliability of renewable energy sources. Furthermore, innovations in agriculture, such as precision farming and genetically modified crops, can enhance food security while minimizing environmental impact.

Policy Recommendations

To further promote sustainable development, several policy recommendations can be made:

Invest in Research and Development: Governments should prioritize funding for research and development in sustainable technologies and practices. This can accelerate the adoption of innovative solutions that address environmental challenges.

Promote Education and Awareness: Increasing public awareness and education about sustainability issues is crucial. Schools and universities should incorporate sustainability into their curricula to foster a generation of environmentally conscious citizens.

Implement Incentives for Sustainable Practices: Providing incentives for businesses and individuals to adopt sustainable practices can drive significant change. This includes tax breaks, subsidies for renewable energy installations, and grants for sustainable agriculture projects.

Strengthen International Cooperation: Environmental issues are global in nature, and international cooperation is essential for effective solutions. Countries should work together to share knowledge, resources, and best practices for sustainable development.

CONCLUSIONS

In conclusion, we are far from the brink of extinction, and we should not let ourselves be swayed by doomsday rhetoric. Climate change is real and significant, but humanity has consistently demonstrated the capacity to innovate and adapt. By focusing on objective analysis and critical thinking, we can continue to make meaningful progress toward a sustainable future that balances economic growth with environmental stewardship. This balanced approach should be the cornerstone of education and public policy, ensuring that we remain informed, engaged, and proactive in addressing the challenges ahead.

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REHABILITATION VERSUS MODERNISATION IN THE CASE OF INVESTMENT IN IRIGATION SYSTEMS

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Abstract

Irrigation systems are important objectives, being the basis of production that ensures an entire economic and social chain. In Romania, they were designed in a different economic and social context compared to the present. The design of these systems was carried out for large areas due to the type of land properties, by financing, equipping and operating in a centralized system managed by the state. The modification of the economic system led to the moral and, finally, the technical degradation of these systems, their rehabilitation and modernization being necessary, thus ensuring economic efficiency. The paper considers both aspects related to rehabilitation and modernization in the context of the technological development of watering systems, pumping aggregates, materials for pipes, waterproofing channels and process automation. In practice, through the studies carried out, it becomes necessary to rehabilitate some water components and modernize in the context of climate changes and the pressure generated on water and energy resources.

Key words*: economic efficiency, irrigation systems, modernization, rehabilitation*

INTRODUCTION

This analysis is necessary because a misinterpretation of the terms REABILITATION and MODERNISATION means that necessary investment works are lost in irrigation sites that are in a particularly technically poor situation, even abandoned, existing in many cases only at inventory level.

As a definition , according to the DEX , REHABILITATION refers to the action on restore or reintegrate in an express way the individual (individuals) with his new prestige or reputation but also about restoring in an active state of a function altered as a result of pathological processes and only in slang dictionaries (publicist formulation) we find the definition of REHABILITATION as a repair , the restoration to working order of installations , machines , tools or other objects (mechanisms) and accord into the DEX MODERNIZATION is the actions of adapting to the requirements of the present (a factory , a plant) with modern installations and tool sand to correspond the contemporary state of progress .

In the technical field, REHABILITATION = REPAIR, without modifying the technical-economic indicators, can be done only if the replaced parts or sub – assemblies have the same characteristics as the defective ones, which means that this can be done only by repairing them, automatically maintaining their original characteristics.

These REABILITATION works are included in the budgets for Maintenance and Repair works (M & R) necessary to keep the irrigation system in operation. In practice, it is known that the REHABILITATION of irrigation systems is almost impossible to keep the pumping units, pipes (basic element) with the same characteristics as in the original projects (more than 35 years ago) and therefore REHABILITATION becomes MODERNISATION.

The International Commission on Irrigation and Drainage distinguishes between REHABILITATION which defined as works that ensure the restauration of the development to its original parameters, and MODERNISATION which is defined as works that lead to the improvement of criteria and parameters superior to the previous ones.

MATERIALS AND METHODS

The problems of the irrigation sector in Romania are proposed to be solved by the Irrigation Sector Investment Strategy edited by Fidman Merk in January 2011 for the Ministry of Agriculture and Rural Development in the Irrigation Sector Investment Strategy, 2011 of the Ministry of Agriculture and Rural Development Irrigation Sector Rehabilitation and Reform Project, any current or future investment must start from the request of the water user, with emphasis on empowerment.
Problems in irrigation systems stem from:

a) technical condition of the irrigation infrastructure;
b) low organisational and financial capacity of irrigation systems users;
c) low capacity of user to the modernisation of the systems;
d) irrigation arrangements not adapted to farm typology and user requirements.

Also the objectives pursued in this strategy are:
a) supporting investment in irrigation schemes where farmers have a high potential to use and maintain the systems and to contribute to investments in the scheme.
b) modernisation of the irrigation infrastructure by reducing water loss and energy consumption.
Principles of irrigation investment strategy:
a) The technical-economic viability of irrigation systems, which translates in to the recovery of operating costs and the achievement of a profit from irrigation.
b) User interest, investments are made only at the request of potential beneficiaries. Without the active involvement of users, any investment is not sustainable and a different principle must be excluded.
c) Contribution, refers to the fact that farmers to benefit from investment must have their own contribution in the rehabilitation/ modernisation or creation of new facilities.
d) Economic capacity. Irrigation is a higher step in farm development. Irrigation is not accessible to very farmer, as it is necessary to meet certain conditions of economic capacity (in Fidman Merk's Irrigation Sector Investment Strategy 2, January 2011), organisation, market orientation, financial capacity and technical capacity / expertise.
e) Crops suitable for irrigation. The crop structure on irrigated land must be such as to coverall irrigation-related costs, including maintenance of facilities and contributions to rehabilitation / upgrading and to provide a consistent return to users.
f) Adaptation to demand. Upgrades must respond to user requirements in term of irrigation methods adopted by users.
Irrigation does not only mean systems managed by the National Land Improvement Agency (ANIF system) but support any irrigation systems.
In the following pictures we show the real situation systems that have not worked in the last years (minimum 15 years).

Figure 1. Pumping station (vertical pumps) and degraded wet sump

Figure 2. Building complex of irrigation pumping station, non-existent discharge pipes, section at the discharge basin

Figure 3. Decommissioned equipment from the pumping station

The strategy also aims to support the development and modernisation of local irrigation schemes, new schemes or the fundamental redesign of those ANIF systems that can even be separated or modified. The measures to rehabilitate and modernise irrigation systems are adopted following in depth studies, analyses and measurements carried out with the aim of highlighting current performance, dysfunctions and their causes.

The objectives of the REHABILITATION and/or MODERNISATION activities are threefold:

1)Technical – relating to the intensive and efficient use of soil and water resources.

2)Economic – financial – cost effectiveness of the arrangements.

3)Social – local and regional development according to new needs.

In the rehabilitation and/or modernisation project in the first phase, studies and field analyses are carried out to diagnose the condition of the components of the installations and the results in operation. In this framework, field visits and carried out, discussions are held with farmers and farm staff looking this dysfunctions, needs of the development and their consequences emerge. In this respect it is necessary to carry out and through all the stages of redesign according to the legislation in force. The studies analyses and researches refer to several indicators which in total express the state and need of the whole development and are components in agricultural, economic and environmental terms. These analyses are necessary to start from the request of the water user, with accent on making him responsible and is important no matter how low the costs and no matter how many benefits/subsidies the farmer receives. The efficient irrigation activity can only be carried out if there is an appropriate crop and sufficient profit to maintain and continue farming activities.

The result of these activities is the DESIGN THEME, which is based on the CONCEPTUL NOTE in which the need for service provision is quantified by the need to provide services under current conditions, according to the new crop plans and irrigation facilities used by farmers resulting the flow and pressure required for the rehabilitated systems, so an efficient modernisation. The proposed technical solution is part of the technical – economic scenario or option of the feasibility study, respectively of the documentation for the approval of the intervention works, including the description from a technical, constructive, technological and functional – architectural point of view, of the main works for the basic investment correlated with the technical, quality and performance level resulting from the proposed technical – economic indicators. In the next stage the pre-feasibility study is covered by the calculations made in the design theme and is not mandatory in their habilitation works but the feasibility study is necessary in any investment works because in the design theme there are new supply needs due to climate changes occurred in the last 40 years and even blockages of water in takes where the area concerned has become a protected area.

Because of these change in the areas adjacent to irrigation systems, the documentation for the approval of intervention works is much more detailed and has new approval components.

CONCLUSIONS

Agricultural structures have changed correct term for investments in this strategic area of economic development. For the situation in which the irrigation systems, we consider that the name MODERNISATION and not REHABILITATION is the correct definition of the actions that need to be carried out in the next period in order to eliminate / limit the severe

effects of global warming and automatically the effects resulting from it (soil drought, desertification of agricultural land) .

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ENVIRONMENTAL IMPACT OF THE CONSTRUCTION OF THE SPA DĂMIENEȘTI PUMPING STATION, BACĂU COUNTY

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Abstract

The article aims to analyze the impact of the SPA Dămienești pumping station, Bacău county, together with the rehabilitation of the CR1 and CR2 discharge pipelines, on the environment, through environmental factors and biodiversity, the site being part of the Natura 2000 ROSPA0072 site. The analysis of the effects is carried out both during the execution phase of the works of the investment and during the exploitation phase of the SPA station, through the quantitative and qualitative assessment of these impacts, together with the measures to limit/eliminate the negative effects, according to the legislation in force, in order to obtain the environmental permits, these being limited in the project area.

Key words*: pumping station, environmental impact, rehabilitation.*

INTRODUCTION

The need to rehabilitate and modernise irrigation systems is an effect of the moral and physical wear and tear of existing irrigation systems, characterised by reduced efficiency, physical deterioration, lack of certain equipment and facilities.

The Damienești irrigation scheme is located on the middle course of the Siret River, on the left bank. In the existing situation, the Dămienești SPA supplies water to two plots, SPP1 Bătrânești in an area of 895 ha through the CR1 discharge pipe and SPP2 Dămienești in an area of 1381 ha through the CR2 discharge pipe. In the proposed situation, a new basic pumping station SPA Dămienești will be built, together with the rehabilitation of the discharge pipelines CR1 and CR2.

It will analyse the initial state of the environment, the environmental factors affected by the construction works of the new Damienești SPA and the rehabilitation of CR1 and CR2, the description of the forecasting methods used and the measures proposed to avoid/prevent/reduce or compensate the negative effects, together with the monitoring measures.

The analysis of the environmental factors affected (water, air, soil, noise) is carried out both during the execution phase of the investment project and during the operation phase, through the impact on environmental factors together with the measures to protect these environmental factors.

MATERIALS AND METHODS

The analysis of the impact on environmental factors, due to the implementation of the investment project for the construction of the Damienești SPA pumping station, together with the rehabilitation of the CR1 and CR2 discharge pipelines, was carried out both in the execution and in the operation phase, correlated with the measures to reduce/eliminate the negative effects. An assessment of these influences on environmental factors, both positive and negative, is carried out by means of an estimated score, which can help both the project executor and the beneficiary of the investment to take the necessary measures, according to each situation.

Among the projects where an environmental impact assessment is required, there are also water management projects for agriculture, including irrigation and dewatering projects (Law 292/2018, Annex 2, paragraph 1, letter C).

The environmental impact assessment is carried out by analysing the direct and indirect effects of a project on several factors, including: human

population and health, biodiversity through the protected areas regime, flora and fauna conservation, water, air and soil factors, climate, cultural heritage and landscape (Law 292/2018, art.7, para.2).

The environmental impact assessment cannot take place after the investment has been carried out, as this is necessary to assess the potential effects on environmental factors, especially as the investment takes place in the ROSPA0072 site. Thus, at the time of commissioning of the SPA, the beneficiaries are obliged to take steps to obtain the environmental permit (Methodology for the application of Ministerial Order no. 136/2010, art.5).

RESULTS AND DISCUSSIONS

Initial state of the environment.

The location of the future SPP Dămienești station, with an area of 0.43 ha, is located on the left bank of the Siret river, in the ROSPA0072 perimeter, representing 0.0042% of the total protected area. (Environmental Impact Report, ANIF, page 69). The maintenance of the ecosystem balance is achieved through habitat conservation, achieving the conservation status of bird species. The ROSPA0072 site provides a feeding and resting place for water birds, which migrate in autumn to the Danube and in spring to the north of the country.

In the medium and short term, the environmental factor with the greatest potential to be affected by the proposed investment is water, the Siret surface water (the volume of water taken by the station from the Siret is about 3% of the average daily flow). Qualitative and/or quantitative changes in this environmental factor may have repercussions on the vegetation and fauna of the area.

The proposed investment does not affect the ROSPA0072 site and there are positive assumptions for the integrity of the site.

Environmental factors likely to be affected by the project

The aim will be to minimise the effects on environmental factors, in compliance with the requirements of SR EN ISO 14001:2005, together with the provisions of Emergency Ordinance 195/2005 on environmental protection, based on the principles and strategic elements leading to the sustainable development of society.

Environmental factor water

In the investment phase, water consumption refers to drinking water consumption as well as water consumption for sanitary needs, with a norm of 80l/employee/day, for the staff involved in production (for 25 people daily consumption is 25 x 80/employee/day = 2,000l/day = 2 m3/day). Technological water is not needed at this stage.

During the operating period, the consumption of drinking water as well as that for sanitary needs is ensured for 2 people, those who serve the pumping station (2 x 80/employee/day = 160l/day = 0.16 m3/day). Technological water refers to the volume of water authorised for the irrigation system (average daily volume = 11.7 thousand m3). Technological wastewater is not produced during the operating period, but there is a quantity of domestic wastewater provided through an ecological toilet (quantity of domestic wastewater=0.16mc/day x 0.8=0.128mc/day).

Table 1. Balance of water consumption during construction

Bilanțul consumului de apă în perioada de construcție

Sursa de apă	Consum total apă		Apă prelevată de la surse						Recirculare/ Reutilizare	
			Total		Consum menajer		Consum tehnologic		De la propriu obiectiv	De la alte obiective
	m³/zi	m³/an	m³/zi	m³/an	m³/zi	m³/an	m³/zi	m³/an		
rezervor	1,60	336	1,60	336	1,60	336	0	0	-	-

Bilanțul consumului de apă în perioada de funcționare

Sursa de apă	Consum total apă		Apă prelevată de la surse						Recirculare/ Reutilizare	
			Total		Consum menajer		Consum tehnologic		De la propriu obiectiv	De la alte obiective
	m³/zi	m³/an	m³/zi	m³/an	m³/zi	m³/an	m³/zi	m³/an		
Râul Siret	22,90016 mii	2268,8336 mii	22,90016 mii	2268,8336 mii	0,16	33,6	22,9 mii	2268,8 mii	-	-

The assessment of the impact on the environmental factor water is low, evaluated at -1 (insignificant negative, local, temporary, reversible) in the implementation phase and +1 (significant positive) in the operation phase.

Measures to protect the water environment factor

During the execution of the works as well as during the exploitation period, measures will be

taken to protect surface and groundwater, following measures such as:

- Storage of the materials and raw materials used in specially designed premises so that they are not washed away by water, and at the end of the construction period the premises will be cleared of water
- Selective disposal of waste at the designated site and its transport by a specialised firm
- Periodic emptying of pits used for domestic waste water
- Rainwater will be collected in a controlled manner from roofs and other areas within the SPA and directed to the green space
- The entry and crossing of the Siret river is forbidden to the machines used in the construction of the SPA
- The washing of machinery in the Siret River, oil change on the area affected by the project is prohibited,
- The machines used to make the water intake will be withdrawn in case of flood danger
- Training of personnel in the event of machinery breakdowns or accidental pollution

Environmental factor air

The air quality in the SPA construction area is considered to be good, as there are no significant sources of pollution in the vicinity and the relief ensures a rapid dispersion of possible pollutants emitted by machinery and means of transport.

Table 2. Pollutant emissions from mobile sources during construction

Emisii de poluanți generate de sursele mobile în perioada de construcție

Sursa	Debite masice (g/h)													
	NO_x	CH_4	COV	CO	N_2O	SO_2	Part	Cd	Cu	Cr	Ni	Se	Zn	HAP
								$[10^{-3}]$	$[10^{-3}]$	$[10^{-3}]$	$[10^{-3}]$	$[10^{-3}]$	$[10^{-3}]$	$[10^{-3}]$
Vehicule	273,595	1,60	52,28	219,13	0,772	64,07	27,55	0,066	10,89	0,320	0,452	0,066	6,408	0
Utilaje	2500,81	8,71	362,8	809,68	66,63	512,5	293,6	0,515	87,12	2,562	3,586	0,515	51,24	170,14
Total	2774,40	10,3	415,1	1028,8	67,40	576,5	321,2	0,581	98,01	2,882	4,038	0,581	57,65	170,14

During the investment phase, the main sources of environmental air pollution are dust emissions from the area of roads used by machinery and means of transport, emissions from excavations for pipelines and foundations, exhaust gases resulting from the operation of vehicles and machinery containing a number of pollutants (organic compounds, particles containing heavy metals-Cd, Cu, Cr, Ni, Se, Zn, nitrogen oxides, carbon oxides, sulphur oxides). The use of machinery and means of transport generates noxious substances harmful to the environment and human health. "It is estimated that a diesel consumption of 25 l/h results in the following quantities of pollutants, with the following emission factors/1000 l (kg): Sox 0.222, CO, 0.05, Hydrocarbons ,048, Nox 1.45, Adehide and Ketone 0.12" (www.anpm.ro /documents/14001/501479)

The machines used are internal combustion, technically compliant, with noxious emissions in accordance with operating standards, operating simultaneously a maximum of two machines. We state that the emissions produced by the machinery and transport equipment are within the legal limits, the period of operation is temporary (10 months) during the execution period.

The assessment of the impact on the environmental factor air in the implementation phase is low, evaluated at -1 (insignificant negative, local, temporary, reversible) in the implementation phase and low in the operation phase, at -1 (insignificant negative, local, temporary, reversible).

During operation, air pollution is caused by machinery and pumps in operation.

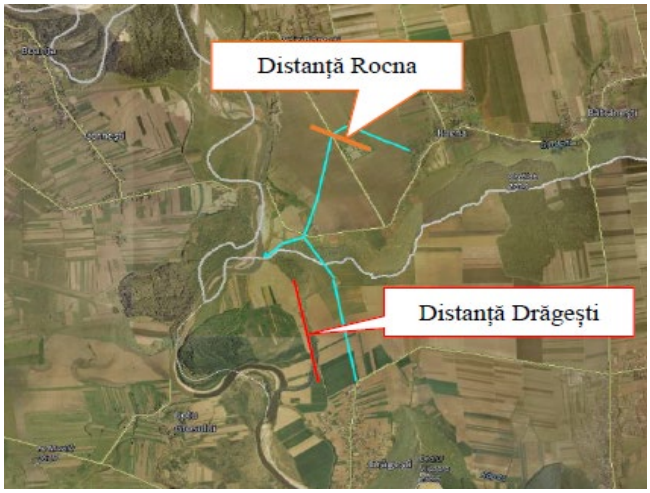
Some impact mitigation measures are necessary:

- Maximum speed to be 30 km/h for the machinery used
- Reducing dust is achieved by cleaning access areas.
- When the wind speed exceeds 3 km/h, the handling of materials containing dust is prohibited.
- Machinery and means of transport must comply with the legal provisions on exhaust emissions

Noise and vibration

During the construction phase, noise pollution is caused by the operation of the machinery and means of transport used to carry out the SPA project investment. This pollution is a function of the operation, its intensity, the type of machinery, the frequency of operations, their positioning in relation to potential natural

barriers that act as screens. Noise limits are regulated and limited by STAS 10009/2017. Occupational protection regulations impose a maximum noise pollution limit of 90 Db(A) - continuous equivalent sound level per working week.
The level of the slag corresponding to the machines used:
"6m concrete mixer3 - Lw=105 Db(A)
Backhoe loader front loader 1,5m3 30t, Lw=115 dB(A)
Trucks 16 m3 - Lw=107 dB(A)
Automacara - Lw=115 dB(A)"
(www.anpm.ro/documents/14011/501479)
The work site is located in the outskirts of Dămienești commune and Icușesti commune, the distances between the ends of CR1 and CR2 from inhabited areas are 650m and 1200m respectively and thus the noise level will not cause discomfort to inhabited areas.



The noise impact assessment is moderate, rated at -2 (significant negative, local, temporary, reversible) in the construction phase and -1 (insignificant negative, local, temporary, reversible) in the operation phase.

Noise and vibration reduction measures

During the execution of the works as well as during operation, measures will be taken to reduce noise and vibrations through measures such as:

- Maximum speed of machinery and means of transport 30 km/h
- Monitoring the operation of machinery, means of transport and pumping units so that they do not malfunction and generate noise and vibration above the values in their technical books
- Stop machinery and means of transport when they are stationary in order to eliminate noise pollution, together with air pollution, and bring these noises within the limits set by Order 119/2014, so as not to adversely affect the environment and habitable areas.
- Use of a maximum of 2 machines on site
- Soundproofing of noise and vibration sources
- Machinery and means of transport whose noise pollution exceeds the permissible noise threshold to be stopped

Soil environment factor

During the construction phase of the investment, there are excavation activities, storage of excavated soil, concrete platforms, etc., all of which produce changes in the structure and shape of the soil:

- The construction of the SPA involves an area of 1,000 square meters of occupied land, transformed from its natural form into a modified form according to the project, with concrete platforms for the location of the container, foundations necessary for the station, green spaces, access roads for vehicles and service personnel, etc.
- The power supply to the SPA station is provided by 12 poles, which will occupy an area of 0.0024 ha, which will affect the soil in the occupied areas.
- The water supply to the SPA involves the construction of a water intake, together with the shore protection, whose surface area totals 320 square metres.
- The rehabilitation of CR1 involves the construction of a 6 m wide ditch, 1,900 m long, on an area of 11,400 sq m, and the rehabilitation of CR2 involves the construction of a 6 m wide ditch, 713 m long, on an area of 4,278 sq m, both of which affect the soil by excavating the ditch, storing the excavated soil, together with the machinery working area.

At this stage, diesel, petrol or other oils used in machinery or means of transport may accidentally leak, but the quantities are so small

that they cannot significantly affect the soil environment.

During the operating period, the soil environment does not change significantly, being affected only by possible accidental spills of petroleum products, oils.

The assessment of the impact on the soil environmental factor is low, rated at -1, in the phase execution and without an evaluation during the exploitation phase, since there are no more activities affecting the soil.

Environmental soil factor protection measures

During the execution of the works as well as during the exploitation period, soil protection measures will be taken, following measures such as:

- Waste is deposited in specially designated areas, not on green spaces or in the area adjacent to the Siret
- No storage of building materials, excavated earth, outside the perimeter of the system
- No fuel, oils, car batteries, tyres, etc. are stored on site.
- The site organisation is the location where machinery and means of transport are stationed
- Use only machinery and means of transport that are in good working order and protect the environment
- Use of a waterproof sheet applied to the ground for the storage of building materials

Biodiversity

The area where the new irrigation system will be implemented is located in the Natura 2000-ROSPA0072 protection area, the Middle Siret Meadow, with an area of 10,329.50 ha.

Proposed surface area for the development of the Damienești SPA.

Compliance with the provisions of the regulations and management plans of protected areas, approved in accordance with the legal provisions, is mandatory, listing a series of activities prohibited to be carried out in the protected area, without mentioning the implementation of an investment with an irrigation system. (OUG195/2005, art. 52, par. 1, 2).

According to the management plan of the site, 47 species of birds have been identified, being their resting and feeding place from the north of the country to the Danube.

The investment project has a neutral impact on bird species (on 35 bird species), an insignificant impact due to the presence of machinery and personnel (on 12 bird species) by reducing the

habitat, but no impact on the population of these species.
A major negative effect on the site, of a temporary nature, is the extraction of sand and gravel by increasing the turbidity of the water downstream of the excavation site for a maximum distance of 300 m, settling naturally.
Agricultural activity, recreational fishing, natural flooding, have negative environmental/micro impacts on the site.
The proposed project has an area of 0.43ha, representing 0.0042% of the protected area. Within these areas, in the rivers/lakes habitat, out of its area of 1594.8ha, the area occupied by the project is 0.32ha (0.002%) and in the grassland habitat, out of its area of 1574.14ha, the area occupied by the project is 0.40ha (0.026%).
Biodiversity impact assessment is differentiated according to its content. Thus for fauna and flora during execution and for the exploitation phase we have a low level of impact, of -1, for the aquatic area, a low level, -1, in the implementation phase and irrelevant in the exploitation
In conclusion, the implementation of the investment project will not affect the conservation status of the 47 species, which are the conservation target of the Natura 2000-ROSPA0072 site, as it does not reduce the habitats of these species, nor does it cause a limitation of their feeding opportunities or mortality.

CONCLUSIONS

The realization of the investment project of the Dămienești SPA station will generate effects on the environment, but these are temporary, determined by the period of realization of the investment, without major influence of environmental factors, both during the execution and exploitation period, determined by the small surface of the working area compared to the surface of the Natura 2000 site - ROSPA0072.
Of all the environmental factors, the environmental factor water has the greatest potential to be negatively affected on the course of the Siret River, as any change in quality and quantity can influence the habitat of the site.
The implementation of the project does not affect the conservation status of the 47 bird species as it does not reduce their habitat or food sources. During the exploitation period the impact on the environmental factor water will not be insignificant if all measures to limit negative effects are respected.
There is no need to apply a timetable for impact mitigation due to the temporary nature of the investment works.
The measures to reduce the impact on environmental factors shall apply throughout the construction and operation of the Dămienești SPA station.

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SECTION 02
WATER RESOURCES MANAGEMENT

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HYDRAULIC DISCHARGERS IN WATER MANAGEMENT SCHEMES

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Abstract

Hydraulic dischargers, including spillways and outlets, are critical in water management schemes for controlling and directing water flow. This paper examines various types of hydraulic dischargers, focusing on their design, applications, and impacts on flood management, irrigation, and environmental protection. Key topics include hydraulic spillways, maximum flow determination, reservoir impacts on flood, and fish passages. Through a comprehensive review, the paper aims to enhance understanding of these structures and their role in modern water management schemes.

Keywords: *Hydraulic spillways, maximum flow determination, reservoir impact on flood, fish passages.*

INTRODUCTION

Efficient water management is crucial for sustainable development, flood prevention, and environmental protection. Hydraulic dischargers, including various types of spillways and outlets, are integral components of water management systems. These structures are designed to control and direct the flow of water from reservoirs, channels, and other storage facilities, ensuring that water is released in a controlled and predictable manner. This helps prevent flooding, ensures reliable irrigation, and maintains urban drainage and wastewater systems. Spillways prevent catastrophic damages for people and structures, ensuring that the dam satisfies the vital needs for water, energy and food (ICOLD, 2020).

Hydraulic dischargers have a long history, with early designs dating back to ancient civilizations that needed to manage water resources for agriculture and urbanization (Chanson, 2018). Over time, the design and functionality of these structures have evolved significantly. Modern hydraulic dischargers incorporate advanced engineering principles and technologies to handle the complexities of contemporary water management challenges (Schleiss et al., 2023).

A comprehensive overview of hydraulic dischargers, focusing on their types, design principles, and applications in water management is crucial, so is necessary to explore various types of hydraulic spillways, including siphon front spillways, side spillways, funnel channels, bottom spillways, and special spillways. Additionally, it will examine the critical role of fish passages in maintaining ecological balance and supporting biodiversity.

A key aspect of hydraulic discharger design is the determination of maximum flow capacity, which is essential to ensure the safety and efficiency of these structures. The methodologies used to calculate maximum flow and the implications of these calculations for the design and operation of hydraulic dischargers is mandatory. Furthermore, the impact of reservoirs on flood propagation is analyzed, highlighting how controlled water release can mitigate downstream flooding and protect communities.

The application of hydraulic dischargers in various water management scenarios is the approach recommended, including flood control, irrigation, urban drainage, and wastewater treatment. Each of these applications requires specific design considerations and operational strategies to meet unique challenges and objectives.

Despite their critical importance, hydraulic dischargers face several challenges. Aging infrastructure, climate change, and environmental impacts pose significant threats to the effectiveness and reliability of these structures. Innovations in smart discharge

systems, sustainable materials, and integrated water management approaches offer promising solutions to address these challenges.

Hydraulic dischargers are indispensable in modern water management, providing essential control over water resources. The enhanced understanding of these structures, offering insights into their design, applications, and future directions in the field of water management improves water management systems and ensure their sustainability for future generations (Tiwari and Sharma, 2015).

Hydraulic Spillways in Water Management Schemes

Hydraulic spillways are critical structures in water management systems, designed to safely convey excess water from reservoirs, dams, or other storage facilities to downstream areas. They play a vital role in preventing overtopping and ensuring the structural integrity of dams. Hydraulic spillways come in various forms, each tailored to specific hydrological and environmental conditions. This section delves into the different types of hydraulic spillways, their design principles, applications, and the factors influencing their selection and performance (Hager et al., 2021).

For the overflow type, the most important is the ogee spillway, which has a controlled weir and an ogee-shaped (S-shaped) profile. Its shape is designed to follow the underside of a horizontal jet of water flowing from a sharp-crested weir (Figure 1). At the design head, the pressure at the ogee crest remains atmospheric. When the water level is lower than the design head, the pressure on the ogee crest becomes positive, creating a backwater effect that reduces discharge. Conversely, when the water level is higher, the pressure on the crest becomes negative, enhancing the backwater effect and increasing the discharge.

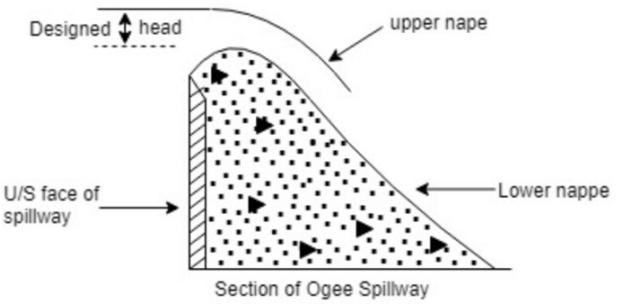

Figure 1 Basic design of an ogee spillway (Chanson, 1996)

Siphon Front Spillways use siphon action to control water flow. A siphon front spillway consists of an inlet, a siphon crest, and an outlet channel (Figure 2). The siphon effect is created when water flows over the crest and forms a vacuum that pulls additional water over the spillway. These spillways are ideal for situations where automatic control of water release is needed without mechanical gates or valves and are commonly used in irrigation canals and smaller reservoirs, that is why it was one of the first spillways build, the first one dating from 1850s (Chanson, 1996).

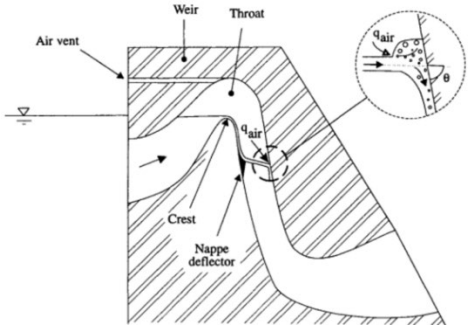

Figure 2 Basic design of a siphon spillway (Chanson, 1996)

Side Spillways are positioned on the sides of reservoirs and are often integrated into the embankment of the dam (Figure 3). Water flows sideways over the spillway crest and down into the discharge channel. Side spillways are used in reservoirs with limited space for a traditional spillway, helping manage overflow without

requiring significant structural changes to the dam.

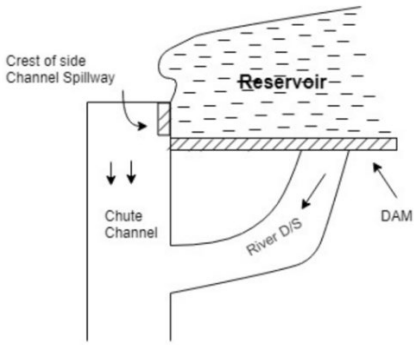

Figure 3 View of a side channel spillway (Chanson, 1996)

Funnel Channels (Figure 4) feature a conical or funnel-shaped entrance that narrows to a smaller outlet channel. This design increases flow velocity and capacity, enabling the spillway to handle large volumes of water efficiently. Funnel channels are suitable for reservoirs in mountainous or hilly terrains where space is limited, and high flow velocities are required.

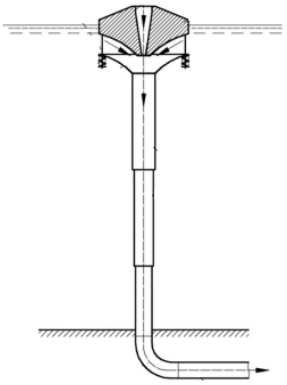

Figure 4 Basic design of a dam funnel spillway (Gasanov and Lipin, 2021)

Bottom Spillways, also known as low-level outlets, release water from the bottom of a reservoir. These structures are designed to manage sediment and maintain water quality by ensuring continuous flow from the lower levels of the reservoir. Bottom spillways are often used in sediment-laden rivers or reservoirs requiring regular sediment management.

Special Spillways, such as labyrinth and stepped spillways, are tailored for specific hydraulic conditions. Labyrinth spillways have a zigzag crest, increasing the length of the spillway and enhancing discharge capacity. Stepped spillways include a series of steps that dissipate energy and reduce flow velocity. These spillways are used in situations where maximizing discharge capacity and energy dissipation is crucial, such as in high-head dams. Effective hydraulic discharger design incorporates several principles to ensure their effectiveness and safety. Ensuring minimal energy loss and optimal flow conditions is essential, as spillways are designed to maximize discharge capacity while controlling flow velocity to prevent downstream erosion. Accurate calculation of the maximum flow capacity is crucial for spillway design, with engineers using hydrological data and modeling to predict peak flow conditions and design spillways that can safely handle these events. Spillways must also be designed to withstand hydraulic forces, environmental stresses, and potential impacts from debris, with material selection and structural reinforcement being key considerations. Minimizing the ecological impact of spillways is important, with fish passages and sediment management systems integrated into spillway designs to support aquatic life and maintain water quality. Additionally, ensuring the structure can handle extreme conditions without failure is crucial for the safety of downstream communities.

Hydraulic dischargers are used in various water management scenarios, including flood control, irrigation, urban drainage, and wastewater treatment. In flood management, spillways control the release of excess water from reservoirs, preventing overtopping and reducing the risk of downstream flooding. In agricultural settings, spillways ensure a reliable supply of water for irrigation by managing reservoir levels and releasing water as needed. Urban areas utilize spillways to manage stormwater runoff and prevent urban flooding, integrating them into drainage systems to handle large volumes of water during heavy rainfall. In wastewater treatment plants, spillways regulate the flow of treated water, ensuring efficient processing and safe discharge into natural water bodies (Chanson, 2004).

Reservoirs equipped with hydraulic spillways significantly influence the propagation of flood. By controlling the release of water during peak flow conditions, spillways can mitigate the impact of flood downstream, protecting infrastructure, reducing erosion, and

safeguarding communities from flood-related damage.

Hydraulic spillways face several challenges, including aging infrastructure, climate change, and environmental impact. Many existing spillways require modernization to meet current safety and efficiency standards, and upgrading aging infrastructure is essential to ensure reliable water management. Increasingly erratic weather patterns and extreme events demand more resilient and adaptable spillway designs, with innovations in hydrological modeling and material science addressing these challenges. Balancing human water needs with ecological preservation is an ongoing challenge, and incorporating fish passages, sediment management systems, and sustainable materials into spillway designs are key innovations.

Determination of Maximum Flows

Hydraulic spillways play a critical role in determining and managing maximum flow rates during periods of high water. The design and calculation of maximum flow capacity are crucial to ensure that spillways can handle peak discharge events without structural failure. Engineers use hydrological data, historical flow records, and advanced modeling techniques to predict extreme flow conditions and design spillways accordingly.

Most large dams are equipped with gated spillways, where the gates are adjusted to regulate the outflow from the reservoir. Additionally, dams may have other outlets to manage water releases for purposes such as irrigation and water supply. The operation of these spillway gates and outlets is governed by the reservoir's condition, demand levels, and the operational policy in place. In gated dams, the outflow from the reservoir can be classified as: a) controlled, b) uncontrolled, or c) partially controlled. When accounting for controlled outflow, the continuity equation can be expressed as:

$$\frac{I_1 + I_2}{2} - \frac{Q_1 + Q_2}{2} - Q_c = \frac{S_2 - S_1}{\Delta t}$$

where Qc is the mean controlled outflow in time Δt (Jain and Singh, 2023).

For instance, the Aswan High Dam in Egypt employs a combination of spillway types to manage flow rates and prevent overtopping during flood events. This approach allows for flexibility and efficiency in handling varying water levels and flow conditions, ensuring the safety and functionality of the dam.

Impact of Reservoirs on Flood

Reservoirs can significantly alter the characteristics of flood downstream. By controlling the release of water through spillways, reservoirs can mitigate the impact of flood, reducing peak flow rates and extending the duration of high flows to minimize damage. An example of this is the Glen Canyon Dam in the United States, which utilizes hydraulic spillways to regulate flow releases and mitigate downstream flood risks. This controlled release of water impacts the Colorado River's flood dynamics, helping to protect downstream communities and ecosystems from flood damage.

Several dams around the world employ various types of hydraulic spillways to regulate water flow and prevent flooding. The Iron Gate Dam on the Danube River, shared by Romania and Serbia, uses different spillway types to manage water flow and mitigate downstream flood risks. The Grand Coulee Dam in the United States combines siphon front spillways and bottom spillways to control the flow of the Columbia River and generate hydroelectric power.

Fish Passages

Environmental considerations are crucial in dam construction, including the facilitation of fish migration. Fish passages are integrated alongside hydraulic spillways to maintain aquatic ecosystems and biodiversity. For example, the Itaipu Dam located on the Paraná River on the border of Brazil and Paraguay incorporates fish passages to allow aquatic species to bypass the dam, ensuring the sustainability of the river's ecosystem

CONCLUSIONS

Hydraulic spillways are indispensable components of dam infrastructure, ensuring efficient water management and mitigating flood risks. By incorporating various types of spillways and considering environmental factors, dams can effectively balance water resource utilization with ecosystem preservation. Continued innovation and careful design are essential to maintain and improve

these critical structures, addressing all kind of challenges. Through comprehensive planning and advanced engineering, hydraulic spillways will continue to play a vital role in safeguarding water resources and supporting sustainable development.

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SECTION 03
CADASTRE

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DETECTION OF ROBINIA PSEUDOACACIA FORESTS IN HUNGARY WITH MAHALANOBIS DISTANCE CALCULATION OF SENTINEL-2 SATELLITE IMAGERY

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Abstract

The focus of the research is on detecting Robinia Pseudoacacia. Robinia Pseudoacacia is an extremely invasive species, yet it provides valuable timber and serves as the primary bee forage in Hungarian apiculture. Currently, 25% of Hungary's forested areas consist of Robinia Pseudoacacia, and this number is continually increasing, making its monitoring crucial from an environmental perspective. To identify Robinia Pseudoacacia from satellite imagery, I used the Mahalanobis distance calculation method. Mahalanobis distance is a statistical method used to measure the distance between multiple variables, taking into account the correlation between variables. The task was executed using Google Earth Engine, which is a cloud-computing geospatial information system. With the help of the results, new images were generated, enabling the delineation of Robinia Pseudoacacia forest areas; however, there is some misclassification to a minor extent. During the study, I compared the analysis conducted with bands in the visible range to the analysis conducted with all spectral bands of Sentinel-2.

Key words*: Flowering, Mahalanobis distance, Remote sensing, Robinia Pseudoacacia, Sentinel-2.*

INTRODUCTION

The research focuses on the identification of Robinia Pseudoacacia forests in Hungary. Robinia Pseudoacacia is a highly invasive plant species, but nevertheless extremely valuable from an economic point of view, due to its high calorific value and high timber quality and is the primary honey producer in the Hungarian honey industry (Farkas et al., 2007). Its invasive spread is being controlled by state and European Union programs, but it is nevertheless expanding year by year. It is currently considered the most widespread tree species in Hungary, statistically occupying nearly 25% of the country's forest area (Vitková et al., 2017). The aim of this research is to map the current extent of Robinia Pseudoacacia using satellite imagery, and later to make the databases available to the public. I did not want to separate the plant species by classification, because during classification, all the objects in the image have to be classified into one of the classes, so I used indexing to solve the problem. The indexing was based on the calculating the spectral Mahalanobis distance for the whole image.

MATERIALS AND METHODS

The Sentinel-2 satellites are part of the constellation of satellites operating under the Copernicus program. The Copernicus program is an initiative of the European Union aimed at observing the Earth, monitoring environmental changes, and supporting sustainable development (Drusch et al., 2012).
The Sesntinel-2 mission will consist of a constellation of two polar orbiting satellites orbiting in the same solar synchronous orbit, 180° out of phase with each other. Its objective is to observe the variability of land surface conditions, and its wide bandwidth (290 km) and long return time (10 days at the equator with one satellite and 5 days with two satellites in cloud-free conditions, which means 2-3 days in mid-latitudes) support the observation of changes in the Earth's surface.
Sentinel-2 carries an optical instrument payload that samples 13 spectral bands: four bands at 10 m, six bands at 20 m and three bands at 60 m

spatial resolution.

They can be very useful in agricultural, environmental, and urban planning projects, as well as in disaster response and crisis management situations. The Sentinel-2 satellites operate continuously, and their data are freely accessible to the public and researchers, enabling the development of numerous applications and a better understanding of the Earth's environment.

The research was carried out by using Google Earth Engine. Google Earth Engine is a powerful cloud-based platform for analyzing and visualizing environmental data at a planetary scale. Leveraging its vast archive of satellite imagery, Google Earth Engine enables users to perform advanced geospatial analyses seamlessly. With easy access to Sentinel-2 imagery within the platform, tasks such as land cover monitoring, vegetation analysis, and environmental change detection can be efficiently executed. Through Google Earth Engine, users can effortlessly harness the wealth of Sentinel-2 data for their projects and research (Tamiminia et al., 2020).

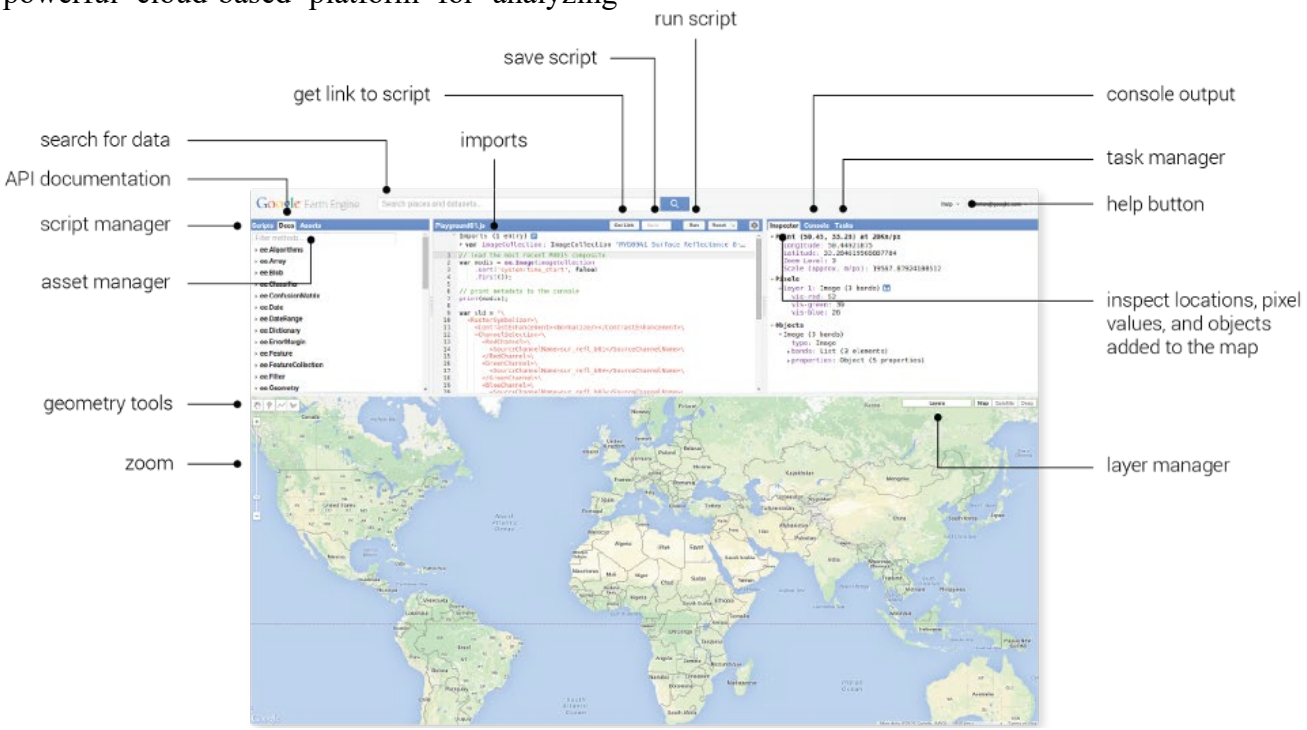

Figure 1. Google Earth Engine interface

The studies carried out in this research were mainly in the visible light range. The visible light range is the part of the electromagnetic spectrum that the human eye can detect, roughly between 400 and 700 nanometres (Austin et al., 2021).

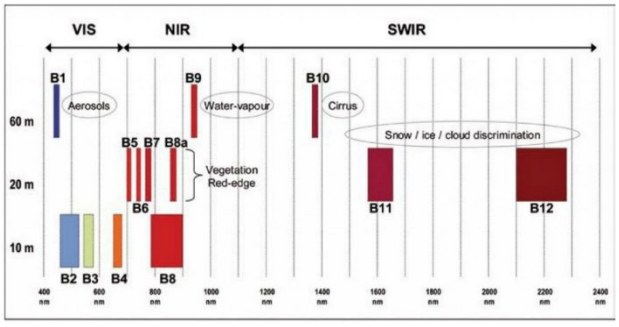

Figure 2. Sentinel-2 multispectral bands

The studies that have been carried out include those using all the bands produced by Sentinel-2. The study areas used for the tests were acacia forests in northern Hungary, located around the villages of Szirák and Vanyarc. The study period covers the flowering in the year 2020.

Figure 3. Flowering Robinia pseudoacacia forest near Szirák

The method used for the tests was the Mahalanobis distance calculation (De Maesschalck et al.,2000). The Mahalanobis distance was calculated by first calculating the covariance matrix of the acacia groves assigned to the study areas. The calculation was first performed in Matlab, which was easier to visualize the task, but Google Earth Engine also has a function for calculating the covariance matrix. The next step was the calculation of the average of the intensity values of the pixels within the study areas per band. To compute the Mahalanobis distance of a pixel, I subtracted the average intensity values per bands from the pixel intensity values, placed the resulting values in a row vector, and multiplied by the inverse of the covariance matrix from the left, and multiplied by the column vector of the difference between the pixel intensity values and the average intensity values from the right. The resulting value is below the root mean square.

$$D^2 = (x - m)^T \cdot C^{-1} \cdot (x - m)$$

Figure 4. Mahalanobis distance formula where: D is the Mahalanobis distance, x is the pixel intensity values in a vector, m is the mean intensity values of the study area in a vector, C is the covariance matrix

$$D^2 = \begin{bmatrix} R - \overline{R} \\ G - \overline{G} \\ B - \overline{B} \end{bmatrix} * \begin{bmatrix} C_{1,1} & C_{1,2} & C_{1,3} \\ C_{2,1} & C_{2,2} & C_{2,3} \\ C_{3,1} & C_{3,2} & C_{3,3} \end{bmatrix}^{-1} * \begin{bmatrix} R - \overline{R} & G - \overline{G} & B - \overline{B} \end{bmatrix}$$

Figure 5. Mahalanobis distance formula for the RGB satellite image

The calculation of the Mahalanobis distance for each pixel has to be performed to get the result, which is an excellent environment provided by Google Earth Engine. However, performing mathematical operations requires a slightly different way of thinking, as images can only perform mathematical operations on images. The solution to this problem is to create a constant image, which means the image takes one value everywhere. I added the constant images created from the computed average image to the original image, so that the constant values appeared as a new bar in the original image. The system was then able to perform the mathematical operations.

There are several methods for programming mathematical operations in Google Earth Engine, of which I used the "expression" method. When using the "expression" method, you can perform the operations with simple operation symbols and variables.

```
var expR = 'b(0)-b(5)';
var XR = image_mean.expression(expR);
var expG = 'b(1)-b(4)';
var XG = image_mean.expression(expG);
var expB = 'b(2)-b(3)';
var XB = image_mean.expression(expB);
```

Figure 6. Example, how to use expression in Google Earth Engine. In this expression I calculate the difference between the original pixel value, and the mean pixel value in the red, green, and blue bands.

In Google Earth Engine, different operations can be performed on different object types. The system distinguishes between Image, ImageCollection, Feature, FeatureCollection, Geometry and Array. The “expression” method is only available for Image operations. The different object types can transform between each other.

Figure 7-8. Image from the standard deviation (left), and the original image (right). The framed part of the image is Robinia pseudoacacia forest.

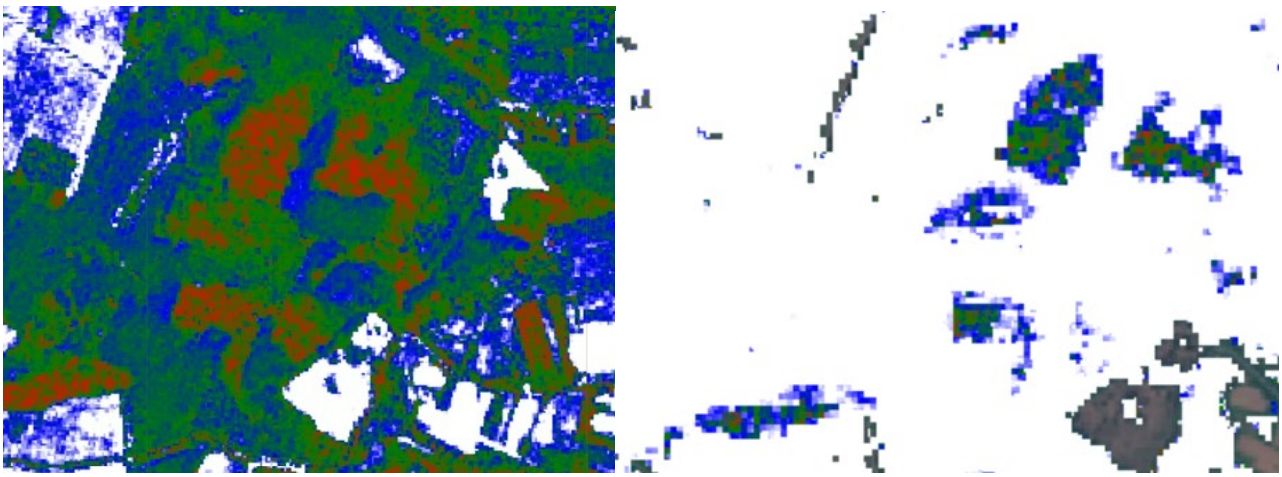

Figure 9-10. Calculating Mahalanobis distances on the original image. The image on the left was created with the inclusion of 3 bands, while the image on the right was created with the inclusion of 13 bands. In the image on the left, the red spots indicate Robinia pseudoacacia forests. From the results, using the 3 visible ranges yielded more satisfactory results than using all 13 Sentinel-2 spectral bands.

During the execution of the task, it emerged that it would be possible to compute the standard deviation for every pixel in the images with the surrounding pixels. The calculation of the standard deviation was performed with a 3x3 moving window, where the central pixel stored the standard deviation of the surrounding pixels. Thus, it was possible to generate a standard deviation value for each pixel, and by substituting these values into the bands of displaying the image, I created a new image. In the resulting image, the locations of the maple forests were much more clearly discernible than in the image made with the original intensity values. However, when I performed the Mahalanobis distance calculation with it, the result seemed less convincing or usable. I performed the operation on both the visible bands and all 13 spectral bands.

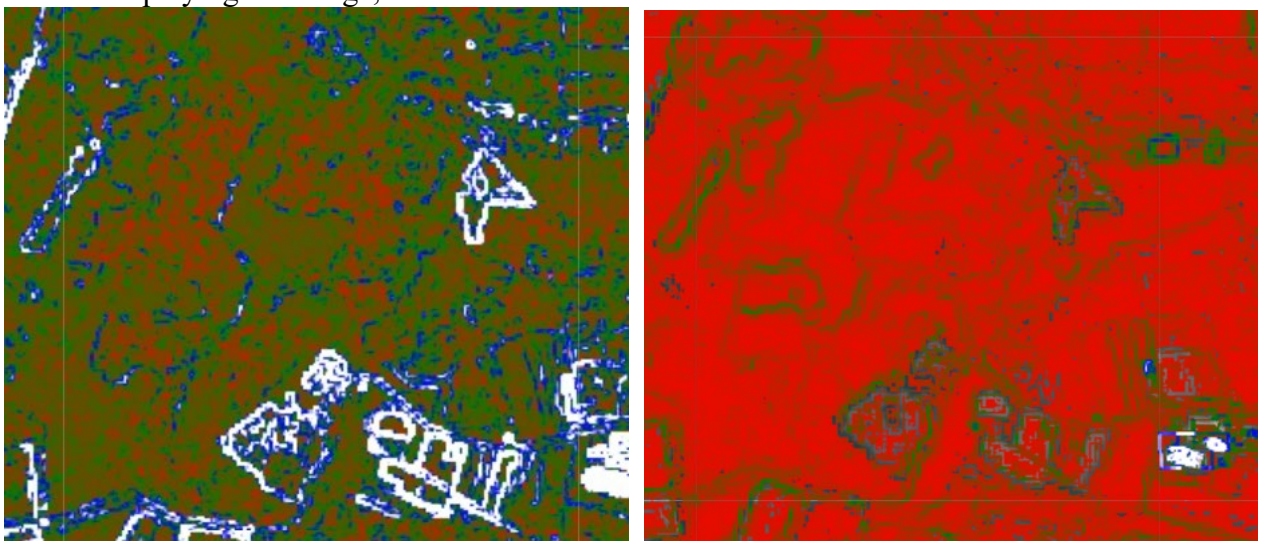

Figure 11-12. Calculating Mahalanobis distances on the standard deviation image. The image on the left was created with the use of 3 bands, while the image on the right was created with the inclusion of 13 bands. The values are difficult to interpret, the images are not clear.

RESULTS AND DISCUSSIONS

At first, the standard deviation images seemed like a good solution because it was clearer to see the location of the Robinia Pseudoacacia forest on them. However, when Mahalanobis distance calculation was applied, unfortunately, the results were less convincing. It can be observed that even when striving for the best results, errors occur during the analysis. In this case,

"false" patches of Robinia Pseudoacacia forests appear on the image.

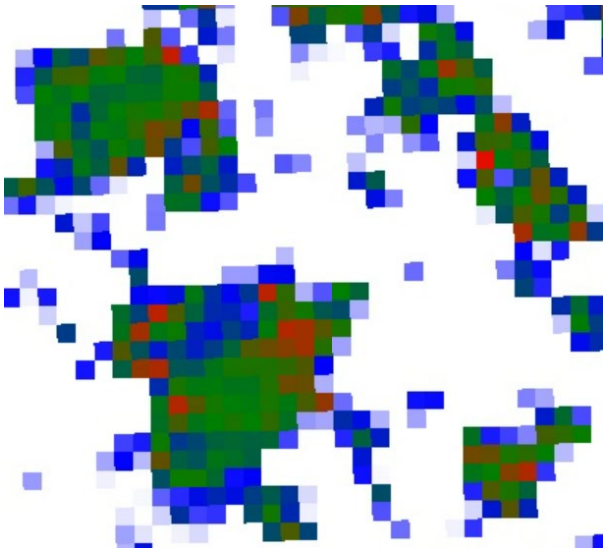

Figure 13. Example for the “false” Robinia Pseudoacia forests (the red pixels).

Comparing the research to a study conducted in Slovenia, I arrived at similar conclusions, the analysis can practically only be carried out during the flowering period because that's when the Robinia Pseudoacacia forest stands out more distinctly from other forests (Somodi et al., 2012). It would be an interesting proposition if satellite imagery were available in the ultraviolet range as well since ultraviolet imaging could better model bee vision. For bees, the visible light spectrum ranges from 300 to 600 nanometers, allowing them to easily detect flowers (Riddle, 2016).

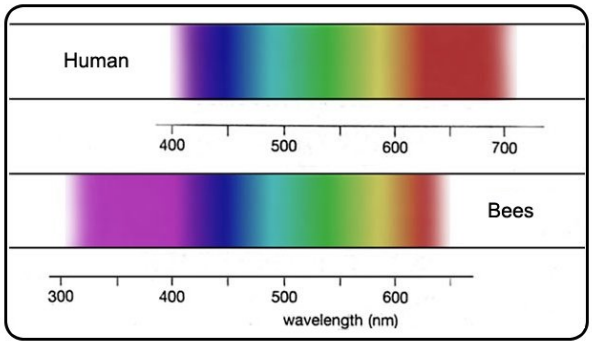

Figure 14: Difference between the human, and bee visible light.

Improving the Mahalanobis distance calculation could further enhance the results. The robust version of the Mahalanobis distance may product much more effective outcomes, and it might be worth considering how to implement this in the Google Earth Engine for possible future developments (Leys et al., 2018).

CONCLUSIONS

A suitable method for detecting the Robinia Pseudoacacia species could involve indexing the pixels using Mahalanobis distance calculation. Indexing sporadically introduces errors but does not significantly affect the analysis. Investigations have revealed that producing unnecessary standard deviation images is redundant as their application does not lead to adequate analysis, and it has also been observed that using too many bands deteriorates the quality of the results. For producing the most appropriate images, it is advisable to utilize the three spectral bands of the visible light spectrum. With proper display settings, it can also be observed that besides the Robinia Pseudoacacia forests, other forests can be filtered out using thresholding with Mahalanobis distance.

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MODERN TECHNIQUES FOR TRACING A BUILDINGS AND COMPLEX BRICK STRUCTURES

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Abstract

The level of automation in the construction industry is currently low and there is a growing need for new manufacturing techniques that can bring more flexibility. This paper presents a modern method for tracing complex structure elements using an optical tool that can bring digital fabrication data to the construction site in a real-time procedure to facilitate the construction of complex brick structures. This tool consists of three customized dual-axis laser pointing devices, a microcontroller and a processor that allow the user to identify the exact location of objects in the real world. In addition, a control subsystem is considered to reduce human errors. The effectiveness of the proposed system has been studied by finding that the errors fall within permissible tolerances. This tool can provide more flexibility for building complex brick structures on site.

Key words*: additive manufacturing, complex brick laser pointer, complex brickwork, digital fabrication, human augmentation.*

INTRODUCTION

In recent decades, software has enabled architects to design many complex things, but building these forms remains a challenge. Although builders on the site or developed digitally, the level of automation has declined. Although concepts have been made to rapid automation in construction, there have been problems. Therefore, people tried to solve things in time.

Studies have shown that in the field of digital fabrication, there can be both human and robot construction. These attempts began in the 1970s through the 1990s, when architects began to work with robotic construction technologies that offered architects great possibilities. These robotic systems can be broadly classified into two categories: stationary robotic systems and mobile robotic systems. Stationary robots are easy to use but too large to operate anywhere, and mobile robots are faster and have the ability to move around the site.

Through human augmentation, man has tried to understand, develop and improve machines and to remove many obstacles in the design and construction of buildings on the site. A number of people have found and proposed ideas in augmented reality (AR) using a special marker for modular surfaces and foam printing on site and others real-time design with VR glasses or laptops. Laser and optical devices, GPS, inertial positioning and camera systems are technologies that are used in the prefabrication, automotive and aerospace industries. These devices can provide quality positioning of building elements, but they are too expensive and complicated, and only a few studies have been carried out on the application of these technologies in the field of free-form construction and possible terrestrial measurements.

MATERIALS AND METHODS

The level of automation in the construction industry is currently at a fairly low level, with a growing need for manufacturing techniques that can bring more flexibility to the field. This idea attempts to introduce an optical tool that can transform digital information from the construction area into a real-time procedure and

start the construction of a complex brick structure. This tool consists of three special laser pointers, a microcontroller and a processor that allow the user to identify the exact location of real-life objects. A sub-control system is also designed to reduce errors. The idea of this study is to replace classical tracing with low-power laser beam projection. This device consists of several hardware components for laser beam projection and corresponding real-time software. To identify the position of an object you need the geometric position in three dimensions. In this way it was considered necessary to apply a simple method based on the successive completion of several steps in order to identify the object in space. There are four ways in which a plane can be determined, namely 3 non-colonial points, a straight and a point, two intersecting lines and two parallel lines. Once this plan has been created, the position of the object can be placed on the identified plane. This can be expressed in an equation of a plan in the desired coordinate system. (Figure 1) defines the parameters by which the position of the object in space can be identified and which underlies the method used in the article. I_t and O_t are the laser quotas and coordinates. p0, p1, p2 are the position of the laser spots, determined by the devices with which the position of the object to be traced is identified in space. These points form an equilateral triangle in the work plane using the method of determining a plane through the three points described above.

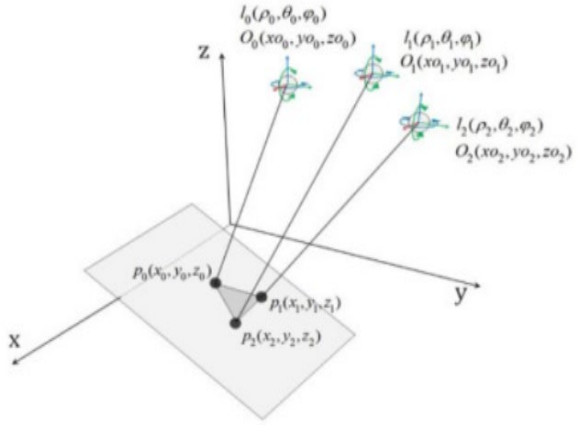

Figure 1. Identification of the work plan with the help of laser spots

Projection device

Concerning the device constituting the projection system it emits laser beams, which form the projection plane in which the coordinates of the object to be located can be drawn. They can be installed on various temporary support systems or even on immediate nearby walls depending on the position of the object to be drawn.

Figure 2. Device that has built-in laser beam with adjustable holder

Figure 3. Components of the device shown

Guidance plan

The control system is a component of the assembly with which the position of each object in the work plan is determined. As a way of working, it determines an equilateral triangle of

predefined dimensions from the laser spots created by those devices, which, with the help of which the position of the components that constitute the construction to be located is located in space (Figure 4).

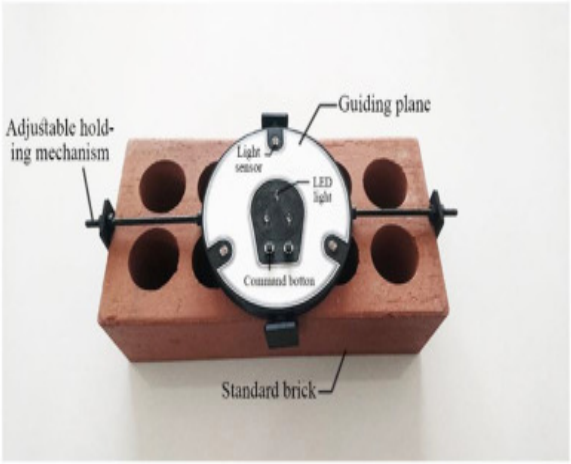

Figure 4. The control system mounted on a brick in which it was identified and the related guidance plan

System architecture

The device has two basic components. The first is hardware and the second is software. The first is made up of classic devices having a certain memory and processing power correlated with the chosen method. And the second is based on a program designed specifically to meet the needs of the working method. Both components are detailed in the following lines (Figure 5):

1. The handheld computer
2. Micro-controller box
3. Laser projection devices
4. Visible light laser beams
5. Control system
6. Guidance plane
7. Visible light sensors

LED control lights

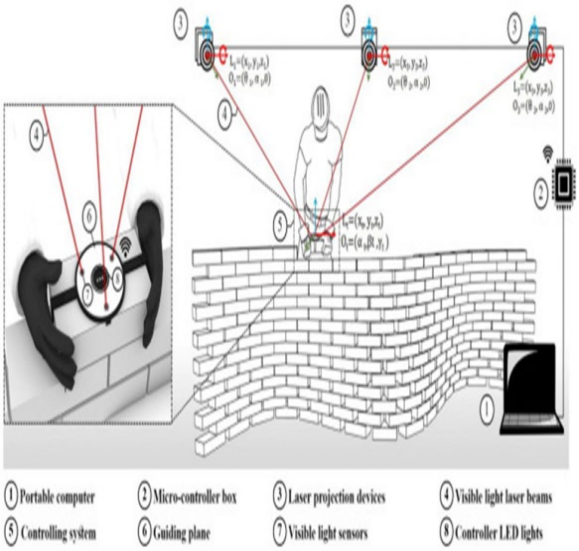

Figure 5. The work device that also contains the hardware component

In order to achieve the objective, a number of building-specific materials are required, such as the necessary adhesive for brick assembly as well as tools specific to the construction field, etc. This is used at each stage after the brick positioning device locates their position in space (Figure 6).

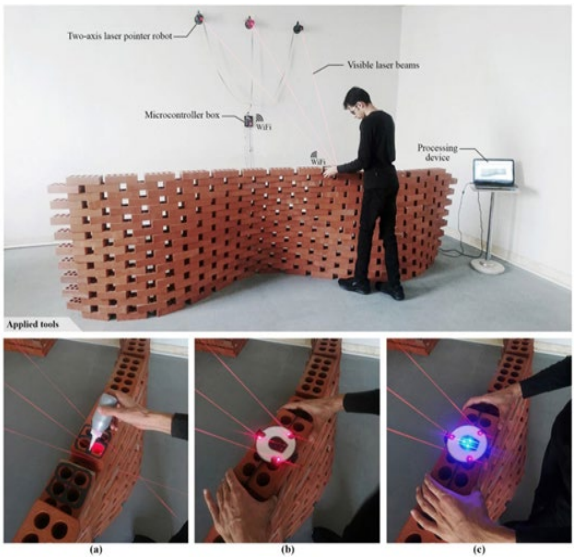

Figure 6. Stages of realization of the wall using the related tools

This system was tested on a construction site where a brick fence was made to enclose a residential complex. The fence configuration also contains irregular shapes and these were drawn with this device. Firstl we tested the device in a room in the complex, with integrated WI-FI, to test the accuracy of the system when tracing and to familiarize ourselves with the working steps and related commands, creating some abstract shapes of brick walls; after this first one-day test, in order to trace those complex elements of the fence, we used the situation plan drawn up by the architect with the designed configuration. Initially the tracing was done classically with the help of the total station and specific attachments; after tracing we found that there are insufficient points for accurately constructing the fence due to its complex shape in certain areas. As a result of the aforementioned, the tracing was redone using the presented technology following the previously described steps.

In order to be able to perform the tracing, a mobile workbench made of wood, in the form of a cupboard, placed on 4 wheels, was created, on which the whole system composed of laser diodes, microcontroller and laptop was mounted; on this assembly a WI-FI router was mounted and also a battery that provides the necessary energy to use the system. With the help of the workbench and the system mounted on it, it was possible to trace the portions of the fence whose configuration is atypical and complex. The tracing was performed vertically and horizontally, in direct correlation with the actual construction, with laser marking of the site being repeated for each brick until the fence was completely built.

RESULTS AND DISCUSSIONS

The tests showed that the lateral error level was 2.5 mm and the orientation error was one degree and the construction time for each module was 27 seconds, therefore the effectiveness of this tool was studied based on 4 similar prototypes (Figure 7). This tool can bring more flexibility for building complex structures on the construction site.

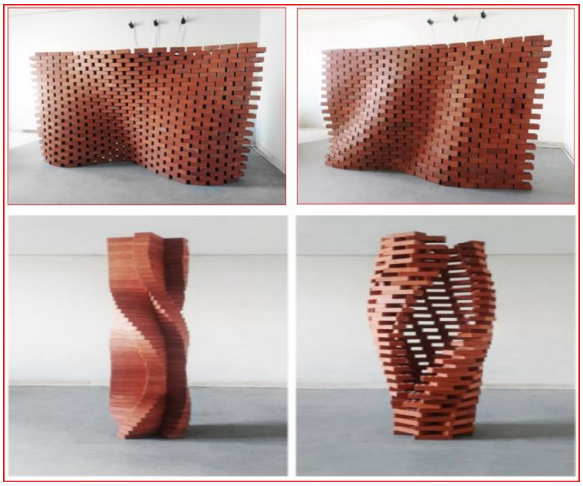

Figure 7. 4 complex structures prototypes

This optical device was designed for complex and slightly artistic brick structures but with its mode of operation and use of geometry it can assist the dimensioning system for positioning walls in land surveying and survey. Technically and practically possible the system and the device can replace the use of the theodolite and distomats for tracing points.

In order for the device to work properly, it is necessary to observe various parameters for the accuracy of the projection system, the optimal distance between the projection system and the target object, and the size of the work plan. The optimal determination of these parameters was made by successive tests positioning themselves at various distances, relatively small, correlated with the accuracy of the projection system and the dimensions of the work plan (Figure 8).

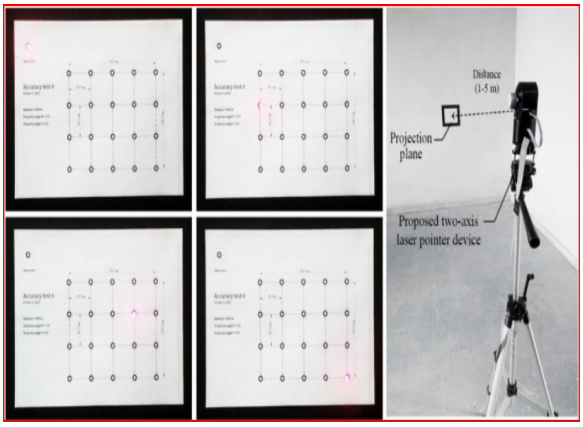

Figure 8. Stage of testing

This analysis presents an optical device that can replace classical tracing for building complicated brick structures that can be used in construction projects. After presenting the proposed device and its information, it is now possible to show the advantages and disadvantages of the proposed method in terms of accuracy, time, money and evaluation.

CONCLUSIONS

The results of the tool are comparable with other systems that have benefited from complex tools, and the results showed some improvements in the construction and placement of bricks on chosen topographic points for future buildings. The presented method can successfully replace conventional plotting, especially for buildings with a complex shape. This working method substantially transforms the way of tracing. In this way, the classical tracing is transformed into a modern working method, being much more accurate and efficient with a number of advantages, among which I mention:

-the system can be deployed in any situation in the field due to its independence, having a battery power source that supplies all components;

- the system can also be used during the night when needed;

- the designed system is a flexible one that solves the problem of tracing the complex shapes of certain special constructions, which can be carried out with difficulty using classical methods.

This paper presents a possible working method for tracing and tracking a complex construction using a intelligent optical device for fabricating complicated brick structures. Some disadvantages of the system can also be mentioned, namely, when working in the field during the daytime with high brightness, the laser spots are difficult to observe, which is why it is recommended that the system should be used at certain times of the day when the brightness is medium or low such as before sunset or when it is cloudy; also the system is not very complex but requires instruction in order to use it correctly.

Considering these and other observations to mention, for the future development of the system, more research and improvements are required. One, the procedure was done manually, which improves automation for a quick time. Secondly, the quality of the parts can be improved along the way. Other types of diodes that utilize waves in the visible spectrum can also be used to attenuate the brightness issue. Last but not least, the method can be extended to other building materials such as BCA, stone blocks, etc.

In conclusion, the system is efficient and accurate but it can be further developed to increase its efficiency and to be used in other fields of activity.

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GEO-CADASTRAL ANALYSIS OF EUROPE: ROMANIA IN COMPARATIVE CONTEXT

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Abstract

This scientific paper examines Romania's position among European Union countries concerning land cadastre, considering aspects such as property ownership, urbanization level, cadastre technology spectrum, land use categories, and the degree of cadastre completion. Through comparative analysis, it elucidates Romania's standing in these domains relative to other EU members. By exploring property ownership structures, urbanization trends, cadastre technologies, and land use classifications, the study provides insights into Romania's cadastre within the EU context.

Key words*: European cadastre, land use, property ownership, Romanian cadastre.*

INTRODUCTION

The importance of cadastre lies in its fundamental role in organizing and managing real estate properties within a society. In the context of the European Union, each member state has its own cadastre system, which reflects specific traditions, norms, and historical evolution. The study of cadastre in EU countries is essential to understand how they manage real estate property, land registration, and property rights. Romania's classification in this context is crucial to assess the level of development and efficiency of its cadastre system compared to other member states. Additionally, cadastre is vital for establishing property rights, facilitating real estate transactions, ensuring legal security, and promoting sustainable economic and social development. Thus, we conducted a comparative study between Romania and the other constituent countries of the European Union to evaluate and compare the efficiency and development of the cadastre system in the European context.

MATERIALS AND METHODS

For the purpose of studying cadastre in European Union countries and classifying Romania among them, three main zones within the EU were selected. The study focused on analyzing basic relevant elements to assess the current state of cadastral systems. Individual states were examined to identify common elements such as forms of property, land use categories, relief features, population demographics, country area, number of geomatics specialists, and notably, the degree of cadastration in each country.

1.FORM OF REAL ESTATE OWNERSHIP

In the European Union, the structure of ownership plays a significant role in defining the characteristics of its member states. Both Central and Eastern European nations and those in the Nordic, Baltic, and Western regions share a commonality in private ownership. However, a notable distinction exists among them: while some countries possess absolute private ownership, others maintain exclusive private ownership. Apart from private ownership, various ownership models are also present: public ownership is prevalent across all EU countries, while cooperative ownership is prominent in the Nordic and Baltic regions, Croatia, Romania, Italy, and Spain. Notably, within the EU, former communist countries such as Poland, Czech Republic, Slovakia, Hungary, Romania, and Bulgaria have transitioned from collective property ownership—where property was managed by the state or state-controlled entities on behalf of the community—to systems

of private property ownership (Real Estate Laws and Regulations).

2. URBANIZATION

Urbanisation affects both urban and rural areas in terms of land registration. In urban areas, population growth and infrastructure development require efficient property and land use management, and cadastre is essential in this process to identify and monitor changes and needs. In rural areas, urbanisation can lead to the transformation of agricultural land into residential or commercial areas, which also requires updates of cadastral information to reflect new land uses and destinations. Cadastre therefore plays a key role in managing urbanisation in both environments, ensuring a balanced and sustainable development of the territory (Urban Development Portfolio in Romania).

3. RANGE OF TECHNOLOGY

Technological advancements have greatly transformed land cadastre systems across European Union (EU) countries, revolutionizing the management, accessibility, and updating of land and property information. These innovations are pivotal in improving efficiency, transparency, and accuracy within cadastre systems, thereby supporting effective land governance and various socioeconomic activities. Among the key technologies applied are Geographic Information Systems (GIS), Remote Sensing, Global Positioning System (GPS), interoperable data systems, mobile and web applications, Artificial Intelligence (AI) and Machine Learning, as well as 3D cadastre and Building Information Modeling (BIM). For example, countries like Germany employ GIS technology through ALKIS, integrating cadastral, topographic, and cartographic data for comprehensive land information. France utilizes high-resolution satellite imagery for cadastral mapping, aiding in land parcel delineation. Meanwhile, Estonia's e-Cadastre system offers online services for land registration, allowing remote access to property information and transactions (Index Mundi, Land use 2018).

4.LAND USE

Land use categories are essential within the European cadastre framework, where they are used to classify and manage properties and lands based on their specific use. Within the European cadastre system, lands are categorized as arable lands, pastures, forests and other wooded lands, roads and railways, water bodies, lands occupied by buildings and yards, as well as unproductive lands. This classification enables authorities to efficiently monitor and manage land use, provide accurate and updated information to property owners and investors, and facilitate sustainable urban and rural development in Europe (Regional Differences in Land Use).

5. DEGREE OF CADASTRATION

In Western Europe, countries such as Belgium, France, Germany, and the Netherlands stand out for their high degree of cadastre, often approaching 100%. This is due to significant investments in modern cadastre and property registration systems. In contrast, in Central and Eastern Europe, the degree of cadastre can vary, with some countries such as the Czech Republic and Slovenia making notable progress, while others such as Bulgaria and Romania still face challenges in this area. In Nordic and Baltic Europe, countries such as Denmark, Finland, and Sweden have advanced cadastre systems, reflecting their commitment to efficiency and transparency in governance (Cadastral Template, Cadastral statistics, 2014).

RESULTS AND DISCUSSIONS

Property ownership is a cornerstone of modern societies, serving as the bedrock for economic transactions and social stability. Within the context of cadastre, the documentation and recognition of property ownership rights play a pivotal role in ensuring legal clarity, facilitating efficient land management, and fostering economic development.

Romania, like many Central and Eastern European countries, transitioned from a communist regime to privatization and property reform post-collapse. This shift encouraged private ownership and restored individual property rights, aligning with the trajectory of nations such as Poland, Czech Republic, Slovakia, and Hungary. However, differences emerge in the management of public properties. While Nordic countries prioritize state-managed public assets for conservation and infrastructure, Romania and its Eastern European counterparts lean towards a more limited public ownership, with the private sector assuming a dominant role

in the economy and property landscape. Consequently, Romania stands apart in its approach to public property management compared to its European counterparts.

In Europe, cadastre systems are vital for property and infrastructure management. Western Europe relies on cadastre for urban development, while Central and Eastern Europe uses it to monitor land-use change. Nordic and Baltic Europe emphasize cadastre for sustainable land management. Understanding these differences offers insights into regional land management needs.

Western Europe is smaller in area than the other regions mentioned, but densely populated with large, developed cities. Due to the high population density and urban development, cadastre in Western Europe is essential for efficient property and infrastructure management, needing constant updating and monitoring in such a dynamic area.

Central and Eastern Europe is larger than Western Europe and has a variable population, with some countries more densely populated than others. Cadastre in Central and Eastern Europe is essential for managing land-use change, such as the transformation of agricultural areas into urban or industrial areas, and for monitoring growing infrastructure, needing to adapt to the different demographic and economic realities of the region.

Nordic and Baltic Europe This region has a moderate surface area and a smaller population compared to Western Europe and Central and Eastern Europe. Cadastral surveying in Nordic and Baltic Europe is of particular importance for the efficient management of land and natural resources and is essential for sustainable planning and environmental protection in a region with a strong focus on sustainability and quality of life (Table 1).

As for **Romania**, it ranks lower than the countries of the three European regions. This is due to less developed urban infrastructure, lower rural-urban migration and a weak economy.

Table 1. The surface of European countries

Western Europe

COUNTRY	km²
Belgium	30,689
France	551,695
Germany	357,022
Luxembourg	2,586
Netherlands	41,543
Austria	83,879
Monaco	2.02
Portugal	92,090
Spain	505,990
Italy	301,340
Malta	316
Cyprus	9,251

Central and Eastern Europe

COUNTRY	km²
Hungary	93,030
Poland	312,696
Slovakia	49,037
Slovenia	20,273
Bulgaria	110,994
Croatia	56,594
Romania	238,397

Nordic and Baltic Europe

COUNTRY	km²
Denmark	42,916
Finland	338,424
Sweden	450,295
Estonia	45,227
Latvia	64,589
Lithuania	65,300

Transitioning from population and surface area, we now delve into aspects related to terrain. Within the diverse landscapes and demographic dynamics of Europe, cadastre systems play a pivotal role.

Western Europe, marked by dense urbanization, relies on cadastre for efficient property and infrastructure management. In Central and Eastern Europe, cadastre aids in monitoring land-use change and growing infrastructure. Nordic and Baltic Europe emphasize cadastre for sustainable land and resource management. Understanding these regional differences in cadastre usage offers insights into the evolving needs of land management amidst urbanization and demographic shifts across Europe (Figures 1 and 2).

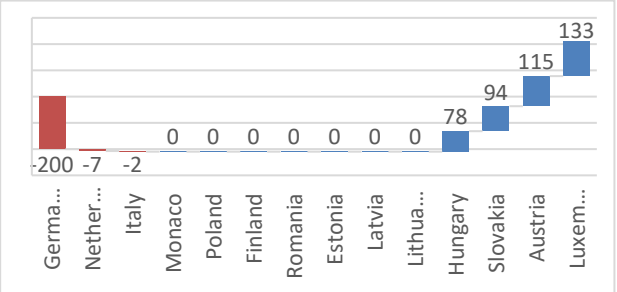

Figure 1. The lowest point in all countries

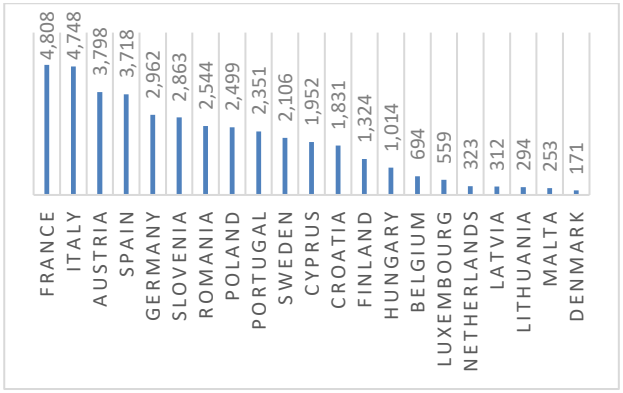

Figure 2. The highest point in all countries

In comparison to the three European regions - Western Europe, Central and Eastern Europe, and Nordic and Baltic Europe - Romania stands out through its distinct geographical, demographic, and cultural characteristics. Beginning with its relief, Romania is defined by the presence of the massive Carpathian Mountain range, traversing the country from north to south, and providing it with a predominantly mountainous and hilly profile. This geography bestows Romania with a wealth of natural landscapes, ranging from snow-capped peaks to deep valleys and dense forests. In contrast, Western Europe is characterized by majestic mountain ranges such as the Alps and Pyrenees, as well as flatter terrain and hills, offering a remarkable geographical diversity. Central and Eastern Europe is distinguished by its varied mix of terrains, encompassing both mountains and hills, as well as plains and plateaus, along with significant rivers like the Danube and Vistula. Meanwhile, Nordic and Baltic Europe predominantly features flat lands such as plains and plateaus, with isolated mountainous regions in countries like Norway and Sweden. Regarding surface area, Romania occupies an intermediate position, having a moderate size compared to Western and Central European regions, but larger than the Nordic and Baltic countries. The population of Romania, situated within an intermediate range compared to the other European regions mentioned, is diverse and multicultural, reflecting its rich history and heritage.

From the point of view of specialists, with a long tradition in the development and implementation of cadastral systems, Western European countries stand out with a significant number of land surveying specialists. Germany, France, and the Netherlands count among the countries with the highest number, totaling over 26,500 specialists, while Portugal stands out with an immense number of over 92,000 land surveying specialists. In Central and Eastern Europe, countries have significantly invested in the modernization and digitalization of cadastral systems following the fall of communist regimes. Romania stands out with over 3,600 land surveying specialists, while Croatia and Bosnia and Herzegovina together contribute nearly 2,000 specialists (Figure 3).

On the other hand, in Nordic and Baltic Europe, countries have a significant number of land surveying specialists, totaling over 5,000 specialists. Sweden, Finland, and Lithuania are among the leaders in the region in this field.

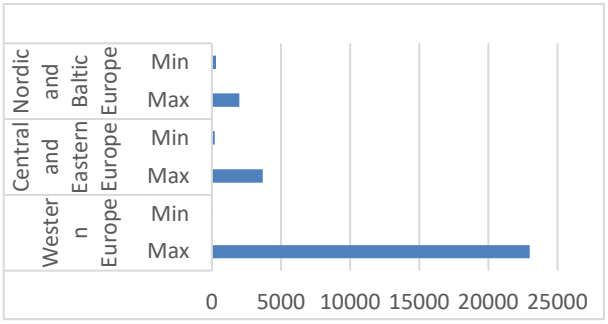

Figure 3. Number of Geomatics Specialists

Taking into account the number of geomatics specialists in each European country, Romania stands out prominently within the context of Central and Eastern Europe. With 3,666 specialists, Romania ranks among the top countries in the region, contributing significantly to the workforce in the field alongside other nations like Croatia and Bosnia and Herzegovina (870 specialists). While Romania's presence in geomatics may not be as extensive as in Western European countries such as Germany (23,000 specialists) or France, its notable number of specialists underscores its importance within the Eastern European region, showcasing a significant commitment to the development and implementation of geospatial technologies.

This study provides a comparative analysis of land use patterns across three distinct regions of Europe: Western, Central and Eastern, and Nordic-Baltic. Each region exhibits unique characteristics in terms of land use, influenced

by geographical, historical, and socio-economic factors.

In Western Europe, a balanced distribution of land use categories is observed. Agriculture covers approximately 13.4% to 55% of the land, while forested areas range from 0.9% to 47%. Other land use categories, including urban and industrial zones, account for approximately 9.1% to 67.8% of the land (Index Mundi, Land use 2018) (Table 2).

Table 2. Land use – Western Europe

	COUNTRY	AGRICULTURE	FOREST	OTHER
		%	%	%
WESTERN EUROPE	Belgium	44.1	22.4	33.5
	France	52.7	29.2	18.1
	Germany	48.0	31.8	20.2
	Luxembourg	50.7	33.5	15.8
	Netherlands	55.1	10.8	34.1
	Austria	38.4	47.2	14.4
	Portugal	39.7	37.8	22.5
	Spain	54.1	36.8	9.1
	Italy	47.1	31.4	21.5
	Malta	32.3	0.9	66.8
	Cyprus	13.4	18.8	67.8

Central and Eastern Europe is predominantly characterized by agricultural land use. Arable land constitutes approximately 22.8% to 63.4% of the region, with forests covering approximately 22.5% to 62.3%. Other land use categories, such as urban and industrial areas, comprise around 6.1% to 41.9% of the land (Regional Differences in Land Use in Hungary, 2018) (Table 3).

Table 3. Land use – Central and Estern Europe

	COUNTRY	AGRICULTURE	FOREST	OTHER
		%	%	%
CENTRAL AND EASTERN EUROPE	Hungary	58.9	22.5	18.6
	Poland	48.2	30.6	21.2
	Slovakia	40.1	40.2	19.7
	Slovenia	22.8	62.3	14.9
	Bulgaria	46.9	36.7	16.4
	Croatia	23.7	34.4	41.9
	Romania	60.7	28.7	10.6
	Bosnia și Herzegovina	42.2	42.8	15
	Cehia	54.0	33	9
	Serbia	57.9	31.6	10.5
	Montenegro	38.2	40.4	21.4
	Greece	63.4	30.5	6.1

In the Nordic-Baltic region, extensive forest coverage is notable. Agriculture accounts for approximately 2.7% to 63.4% of the land, while forests range from 12.9% to 72.9%. Other land use categories, including rural settlements and protected areas, constitute around 16.7% to 69.5% of the land (Index Mundi, Land use 2018) (Table 4).

Table 4. Land use – Nordic and Baltic Europe

	COUNTRY	AGRICULTURE	FOREST	OTHER
		%	%	%
NORDIC AND BALTIC EUROPE	Denmark	63.4	12.9	23.7
	Finland	7.5	72.9	19.6
	Sweden	7.5	68.7	23.8
	Estonia	22.2	52.1	25.7
	Latvia	29.2	54.1	16.7
	Lithuania	44.8	34.6	20.6
	Norway	2.7	27.8	69.5

Romania's prominence in agricultural land use stems from its diverse geography and historical context. The presence of the Carpathian Mountains and the hilly landscape of Transylvania has created varied soil types and climates ideal for cultivating a wide range of crops. Fertile plains, hills, river valleys, and floodplains all contribute to the country's robust agricultural sector (Geography & Travel).

Unlike some other European regions where land serves multiple purposes like agriculture, grazing, and urbanization, Romania's land use is primarily focused on agriculture due to its rich agricultural potential. This emphasis on agriculture is a result of the country's natural resources being well-suited for efficient and profitable farming activities.

As a result, Romania stands out as a leader in agriculture in Central and Eastern Europe, thanks to its unique terrain and historical factors that have shaped its economic and agricultural development.

After extensive research, we were able to obtain an informative percentage of the cadastral area of the European Union member countries, thus providing a comprehensive overview of cadastral extent and detail in Europe (Figure 4) (Figure 5) (Figure 6).

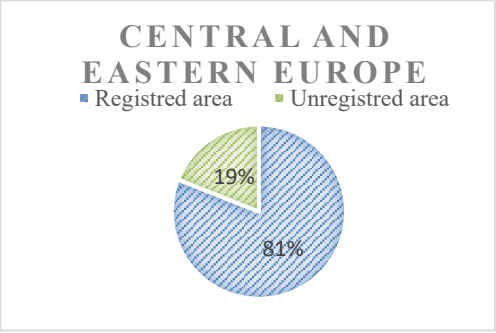

Figure 4. Registration Degree- Central and Eastern Europe

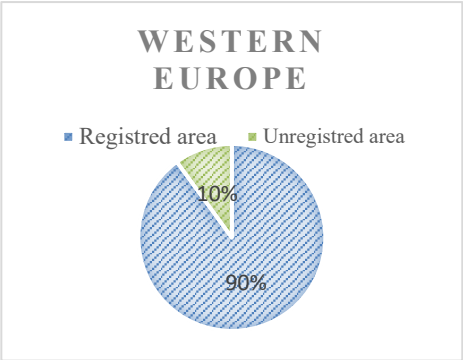

Figure 5. Registration Degree – Western Europe

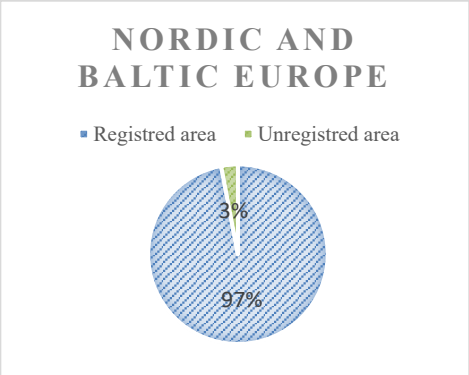

Figure 6. Registration Degree- Nordic and Baltic Europe

As for the percentage of **Romania**'s land area covered by land registers, it is lower than in other EU member countries. This discrepancy can be explained by the different level of economic and technological development between Romania and these other countries. While the latter have benefited from more advanced resources and infrastructure for the cadastral process, Romania has encountered certain obstacles or limited resource allocations in this direction. Thus, the difference in the percentage of area covered by cadastral surveying reflects not only the level of development but also the efforts and priorities invested in this area in each country.

CONCLUSIONS

The detailed analysis of **Romania** compared to the three European regions - Western, Central and Eastern, as well as Nordic and Baltic - reveals significant aspects regarding its status concerning cadastre, surface area and population, relief, number of specialists, and cadastre level. Regarding the cadastre level, Romania ranks between European states, constantly striving to improve in this field. The country's surface area and population are comparable to those of other states in Central and Eastern Europe, while being inferior to those in Western and Nordic-Baltic Europe. Romania's diverse relief presents both advantages and challenges in the cadastre process. The number of cadastre specialists is essential for the efficiency of this process, and although efforts are made in all regions to ensure an adequate number of specialists, some states appear to have an advantage. The cadastre level, as an indicator of the accuracy of cadastre data, is increasing in Romania, but there is still room for improvement. Overall, comparing Romania to the other regions, we observe that our country is in a process of modernization and improvement of its cadastre system, striving to align with European standards, but there are still challenges to overcome to reach the level of efficiency and accuracy of Western and Nordic-Baltic European countries.

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ORTHORECTIFYING ARCHIVE AERIAL PHOTOS WITH OPEN SOURCE SOFTWARES

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Abstract

The aim of our paper is to present a method that enables end-users to simply orthorectify archive aerial images using GDAL, an open-source function library. The used GDAL-command utilizes the Rational Polynomial Camera (RPC) model. It describes relation between ground coordinates and image coordinates as ratios of cubic polynomials.
Interior orientation parameters are calculated using fiducial points of the image and some GCPs were specified to determine exterior orientation parameters. As RPC camera model requires the use of ellipsoidal coordinates, the object space coordinates of our GCPs (that were measured in a projected coordinate system) should be transformed into ellipsoidal ones applying a local transformation. Using these computations, we calculated the RPC coefficients with closed form equations.
Precision of computation using collinearity equations or rational polynomial functions does not differ significantly. The orthophoto was created based on the computed RPC parameters. The accuracy of generated orthophoto meets the requirement of most GIS applications.

Key words*: archive aerial photograph; camera model; GDAL; orthophoto; RPC model.*

INTRODUCTION

Archive aerial photographs ensure a great amount of useful information for researchers (for example, from the fields of archaeology or environmental sciences) If the user would like to obtain information about the exact spatial position of objects of photographs, it is needed to process them and produce orthophotos, surface models or 3D models.
In Hungary, Lechner Knowledge Centre (formerly Institute of Geodesy, Cartography and Remote Sensing), – a background institution of the government – stores and digitizes archive aerial photographs of the past decades.
These photos were declassified after 1989 and now, a great number of them are published on www.fentrol.hu website, providing great help for researchers. Images can be downloaded from the site after a free registration.
The archived images are not orthorectified, only a coarse georeferencing was done acquiring the data provided in the flight plan. (A 2D similarity transformation has been applied for the images.) The position of this georeferenced image is stored in a *.twf world file that is able to describe an affine transformation.
This georeferencing can be corrected by users, by specifying three GCPs on the photo and on the adjacent map. These changes are confirmed by the operators of the website, and then the position will be updated.
The above discussed method is not suitable for precise orthorectification of the images because of the disregard of distortion caused by relief. It results quite poor fit to a ground coordinate system.

MATERIALS AND METHODS

In this chapter we introduce the data sources and the process of orthophoto creation.

The aerial photo

The aerial photo was chosen from a survey that was carried out on 11th of April, 1976, and covered the administrative area of Gyöngyös town (Northern Hungary). It was covered by east-west rows and the altitude of flight was about 1000 a.m.s.l. Each image covers about 1 km^2. The black and white panchromatic photos were taken with a calibrated aerial camera (Wild

RC-8), which means that the exterior and interior orientation parameters can be determined accurately.

Images were recorded to a 230×230 mm film and the contact prints were digitised with a pixel size of 14 μm (i.e. 1814 dpi resolution). It must be noted that it is not identical to the resolution of the original image. The digitized image was oversampled as the mean resolving power of the analogue image is only 44 lines pair per millimetre.

The approximate scale of the image can be computed from the relative flight altitude (h) and the focal length of the camera (c_k) as:

$$S = \frac{h}{c_k} \approx \frac{1}{5317} \quad (1)$$

The scenes in the archive are available in *.tif format. A *.tfw world file attached to each image, which describes the position of the georeferenced image in the EOV, the Uniform National Projection system (of Hungary) (Mugnier, 2017). It must be emphasised that it represents only the approximate position of the image and it can be used only for preliminary value for the further steps (The webpage of fentrol.hu, n.a.).

The image presented in this paper has unique identifier 1976_0029_9095 in the archive and it covers the urban area of the southern part of Gyöngyös town. The size of the scanned image is 17698 × 16880 pixels, and the uncompressed file requires 59.53 MB memory size.

The Digital Elevation Model

As only one image was used for the orthophoto, a digital surface model was needed for the process (Molnar, 2019). We used DDM-10 dataset, that was generated from Warsaw Pact Gauss-Krueger military topographic maps of scale 1:50 000, and the elevation values were obtained by digitising the contour lines and interpolating between them (Mihály, 2005).

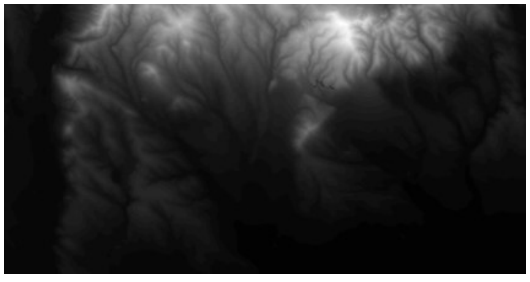

Figure 1. DDM-10 elevation model of the investigated area, shown as a grayscale image

As a result, it represents the topographic terrain surface and can therefore be considered a terrain model.

The elevation data are arranged in a regular grid of 10×10 m. The projection of the model is EOV, elevation data is above the Baltic Sea level, using the EOMA vertical datum, and elevation values are rounded to the nearest metre. There are several margins of error for describing the accuracy of the model depending on the type of the relief. For the investigated area, the values for hilly terrain were relevant. The Mean error is less than 2.5 m, the maximum error for the 90% of the points is less than 5.0 m and the maximum error is less than 7.5 m (Zboray & Siristye, 2004).

Ground Control Points

On the area covered by the aerial photograph, 12 Ground Control Points (GCPs) were selected considering their visibility on the image. Their ground coordinates were measured with RTK GNSS receiver, and their pixel coordinates on the digital image were specified in QGIS software.

As the used GNSS receiver determined coordinates in ETRS89 system, the horizontal coordinates had to be transformed into the EOV system, and heights above ellipsoid had to be transformed into EOMA heights.

For these transformations, horizontal and vertical grid shift type correction were used (Takács & Siki, 2017).

Figure 2. The position of 12 GCPs on the photo. They are used for the computing exterior orientation parameters

Table 1. Coordinates of GCPs.

X (Eastings)	Y (Northings)	Z (height)	u	v
715800.552	269485.589	147.297	464.9	-10659.0
715158.090	269844.880	145.997	4611.9	-2056.9
715696.346	269859.321	150.967	5148.9	-9119.7
715832.619	269722.758	149.977	3490.7	-10954.6
715871.711	270342.277	155.387	11584.1	-11158.1
715274.340	270409.330	151.777	12165.3	-3161.3
715302.550	270693.090	155.417	16063.5	-3318.3
716245.202	270290.139	162.067	11112.6	-16095.8
715444.307	269891.193	148.737	5399.2	-5802.0
715846.318	269927.167	151.687	6122.9	-11032.2
715910.530	270335.100	155.727	11512.0	-11675.9

Interior Orientation

Collinearity equations describe the transformation between object space and image space coordinates. As we use a digitized image, we can measure only pixel coordinates on them, but we need image space coordinates for the further computations.

Fiducial marks of the photogrammetric camera are used to determine the position of the image space coordinate system on the image. Image space coordinates of the fiducial marks were recorded in the calibration report and their pixel coordinates can be measured directly from the digitized image.

The relationship between pixel coordinates and image space coordinates can be described by a 2D affine transformation, as we must consider that film position in the scanner varies at every single image. Furthermore, the relation between the two system is also affected by the deformation of the film and the errors of the scanner (Kraus, 2007).

$$\xi = a_0 + a_1 u + a_2 v$$
$$\eta = b_0 + b_1 u + b_2 v \qquad (2)$$

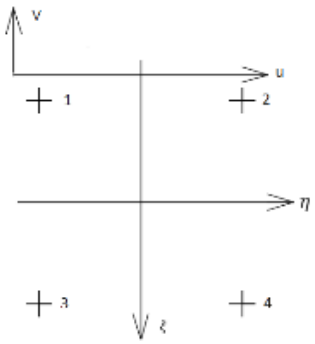

Figure 3. Position of image space coordinate system (ξ, η) and the pixel coordinate system (u, v) of the image. This position of ξ, η axis determined in the calibration report. Position of u, v axis means how QGIS software interprets pixel coordinates.

As the image space coordinates of the 4 fiducial marks were known, we could use them to determine the 6 parameters of the affine transformation, using least-squares adjustment. where u and v are digital image column and line coordinates, ξ and η are camera (image space) coordinates and a_0, a_1, a_2 are the coefficients of the affine transformation.

Determining Exterior Orientation Parameters Using Collinearity Equations

In this section we shortly introduce the methodology used for the calculation of the camera (exposure station) position X_0, Y_0, Z_0 and attitude angle φ, ω, κ determination by space resection. A least squares adjustment was used for obtaining these exterior orientation parameters using GCPs.

In the first step, preliminary parameters of exterior orientation ($X_0^{(0)}$, $Y_0^{(0)}$, $Z_0^{(0)}$, $\varphi^{(0)}$, $\omega^{(0)}$, $\kappa^{(0)}$) were estimated for the image. Preliminary horizontal coordinates ($X_0^{(0)}$, $Y_0^{(0)}$) were the approximate image center coordinates, while $Z_0^{(0)}$ was taken from the flight plan. We used the approximate image orientation to estimate the $\kappa^{(0)}$ (yaw) angle and we choose $\omega^{(0)}$ and $\omega^{(0)}$ as zero, as the image was near vertical.

Using these preliminary angles, we calculated the preliminary R rotation matrix that represent the rotation of the image space coordinate system with respect to the object space. R can be obtained as:

$$\boldsymbol{R} = \boldsymbol{R_\varphi} \cdot \boldsymbol{R_\omega} \cdot \boldsymbol{R_\kappa} \qquad (3)$$

where we used the preliminary values of the exterior orientation angles.

If we know the rotation matrix and the preliminary coordinates for camera position, camera coordinates of the GCPs' can be computed using the collinearity equations.

$$\xi_i^{calc} = -c_k \frac{r_{11}(X_i - X_0^{(0)}) + r_{12}(Y_i - Y_0^{(0)}) + r_{13}(Z_i - Z_0^{(0)})}{r_{31}(X_i - X_0^{(0)}) + r_{32}(Y_i - Y_0^{(0)}) + r_{33}(Z_i - Z_0)^{(0)}} + \xi_0$$

$$\eta_i^{calc} = -c_k \frac{r_{21}(X_i - X_0^{(0)}) + r_{22}(Y_i - Y_0^{(0)}) + r_{23}(Z_i - Z_0)^{(0)}}{r_{31}(X_i - X_0^{(0)}) + r_{32}(Y_i - Y_0^{(0)}) + r_{33}(Z_i - Z_0^{(0)})} + \eta_0 \qquad (4)$$

where ξ_i^{calc}, η_i^{calc} are the calculated image space coordinates of the i-th GCP's, X_i, Y_i and Z_i are the object space coordinates of the i-th GCP, r_{ij}-s are the elements of the **R** rotation matrix, ξ_0, η_0 are the image coordinates of the principal point, taken from the camera calibration report ξ_0=0.0 mm and η_0= -0.003\ mm. The focal length c_k is 152.34 mm. $X_0^{(0)}$, $Y_0^{(0)}$ and $Z_0^{(0)}$ are the

preliminary object space coordinates of the focal point of the camera.

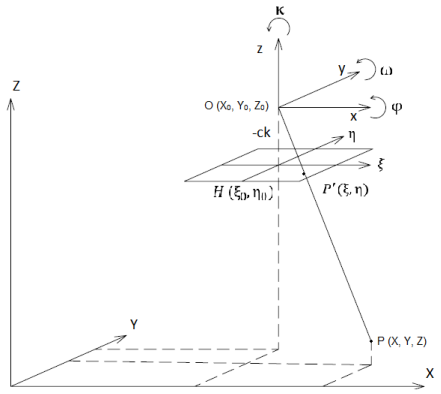

Figure 4. Collinearity equations describe the relationship between ground coordinates and image space (camera) coordinates. OP vector represents ground (object space) coordinates (relative to the focal point of the camera). OP' vector (representing the ξ, η image space coordinates) can be obtained by rotating and reducing OP. Exterior orientation parameters provide a relationship between the two system. We get these parameters using adjustment of GCPs' coordinates.

The condition to be fulfilled is the sum of the squares of the differences of the measured and calculated image space coordinates should be minimal:

$$\sum_{i=1}^{N}\left(\xi_i^{meas}-\xi_i^{calc}\right)^2+\sum_{i=1}^{N}\left(\eta_i^{meas}-\eta_i^{calc}\right)^2 \coloneqq min$$

To fulfil this condition, we applied the nonlinear least squares method.

For this we had to calculate the differences of the measured and the calculated image space coordinates for the GCPs, and arrange them into one single vector l.

We also needed the Jacobians of the equation (4) with respect to the six exterior orientation parameters: the three coordinates of the focal point (X_0, Y_0, Z_0) and the three angles $(\varphi, \omega, \kappa)$ that describe the attitude of the camera (Kraus, 2007). We can form $\boldsymbol{A}$ matrix as:

$$\boldsymbol{A}=\begin{pmatrix} \vdots & & & & & \\ \frac{\partial\xi_i}{\partial X_0} & \frac{\partial\xi_i}{\partial Y_0} & \frac{\partial\xi_i}{\partial Z_0} & \frac{\partial\xi_i}{\partial\varphi_0} & \frac{\partial\xi_i}{\partial\omega_0} & \frac{\partial\xi_i}{\partial\kappa_0} \\ \frac{\partial\eta_i}{\partial X_0} & \frac{\partial\eta_i}{\partial Y_0} & \frac{\partial\eta_i}{\partial Z_0} & \frac{\partial\eta_i}{\partial\varphi_0} & \frac{\partial\eta_i}{\partial\omega_0} & \frac{\partial\eta_i}{\partial\kappa_0} \\ \vdots & & & & & \end{pmatrix}$$

We obtained the A matrix by numeric derivation of equation (4).

With A matrix and l vector we could calculate the corrections for the preliminary parameters:

$$\boldsymbol{x}=(\boldsymbol{A}^T\boldsymbol{A})^{-1}\boldsymbol{A}^T\boldsymbol{l}$$

where x vector consists of the correction of the parameters:

$$\boldsymbol{x}=(\Delta X_0 \quad \Delta Y_0 \quad \Delta Z_0 \quad \Delta\varphi \quad \Delta\omega \quad \Delta\kappa)$$

Adding these corrections to the preliminary parameters and repeating the calculation starting with equation (3), the differences of the measured and calculated image space coordinates of the GCPs decrease We accepted the corrected parameters as estimates of the exterior orientation of the image. Actual values of the exterior orientation are in (Table 2), where angles are in radians.

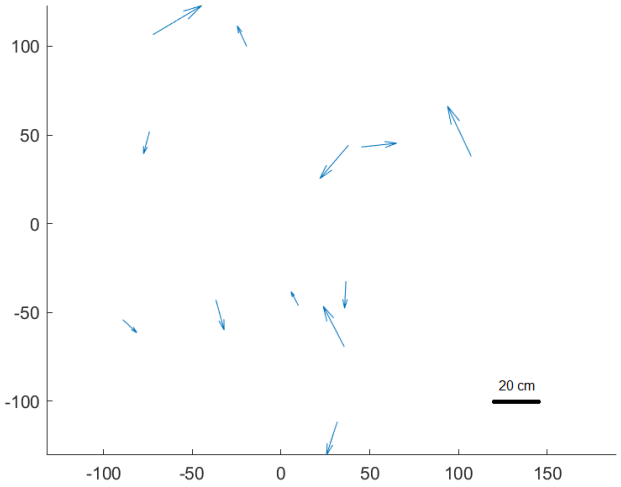

Figure 5. The residual errors of coordinates of the GCPs (the difference between measured and calculated image space coordinates). Error values in image space coordinates are multiplied by the approximate image scale (see equation (1)) to get error values in object space coordinates. Coordinate axes are in mm. (ξ, η)

Table 2. Exterior orientation parameters

X0	715636.701
Y0	270130.443
Z0	977.371
φ	0.01898536
ω	0.02345388
κ	0.04898815

The RPC model

The RPC model is a camera model developed for processing of satellite imagery. Its benefit is that its set of parameters allow orthorectification of an image, while the actual imaging geometry

remains hidden. It is built in many open-source GIS software.

The Rational Polynomial Camera model is an extension of the rigorous collinearity equations (used for frame camera orthocorrection) with terms of higher power of object space coordinates.

The camera model uses rational polynomial functions, hence it also referenced as RPFs, (Rational Polynomial Functions). It is a more generic camera model, that allow for photogrammetric processing without requiring a physical camera model.

This model describes relation between ground ellipsoidal coordinates (latitude, longitude and height) and the image coordinates (line and sample) as ratios of cubic polynomials.

The transformation is represented by the coefficients of the ground (object space) coordinates (they are the RPCs – Rational Polynomial Coefficients).

In order to avoid rounding errors, each input data types are required to be re-scaled (Tong, Liu & Weng, 2010). The normalized ground- and pixel coordinates can be obtained as:

$$l = \frac{v - v_0}{v_{SCALE}}$$
$$s = \frac{u - u_0}{u_{SCALE}}$$
$$P = \frac{\varphi - \varphi_0}{\varphi_{SCALE}}$$
$$L = \frac{\lambda - \lambda_0}{\lambda_{SCALE}}$$
$$H = \frac{Z - Z_0}{Z_{SCALE}}$$

where *l* (line) and *s* (sample) are the normalized pixel coordinates; *P, L* and *H* are the normalized ellipsoid latitude, longitude and height. Offset of the certain parameters are marked with *0* subscript, scale factors are marked with SCALE index.

Based on RPCs, normalized pixel coordinates can be obtained as:

$$l = \frac{N_l(L,P,H)}{D_l(L,P,H)}$$
$$s = \frac{N_s(L,P,H)}{D_s(L,P,H)} \quad (5)$$

where numerators *N* and denominators *D* are both cubic polynomials of normalized ground coordinates. The order of the terms is the following (RPCs in geotiff, n.a.):

$$\begin{matrix} c_1 & c_6LH & c_{11}PLH & c_{16}P^3 \\ c_2L & c_7PH & c_{12}L^3 & c_{17}P \cdot H^2 \\ c_3P & c_8L^2 & c_{13}LP^2 & c_{18}L^2H \\ c_4H & c_9P^2 & c_{14}LH^2 & c_{19}P^2H \\ c_5LP & c_{10}H^2 & c_{15}L^2P & c_{20}H^3 \end{matrix}$$

Here, c_1, … , c_{20} are the coefficients related to the respective polynomials, so (nominators and denominators for line and sample) are described by 4·20=80 coefficients. With the offsets and scale factors (of latitude, longitude, height, line and sample), the RPC model consist of 90 coefficients.

Coordinate Transformation Between EOV and WGS84 System

As RPC model can only handle ellipsoidal coordinates, we need to transform EOV coordinates of GCPs to ETRS89 system (it is the European realization of the WGS84 system, and it is fixed to the European continental plate (Altamimi & Boucher, 2001).

Because of the relatively small area covered by the photograph, the use of accurate projection equations is not necessary. Instead of it, we determined the local transformation parameters between the two system and substitute EOV coordinates to equation (4) as functions of ETRS89 coordinates.

The local transformation parameters can be obtained using numeric derivation. It means that we determine the change of EOV coordinates of a point, while changing the ETRS89 coordinates of this point with a small $+\Delta\varphi$ and $+\Delta\lambda$ value. We can obtain more precious result when we change these coordinates with $+\Delta\varphi$, $-\Delta\varphi$; $+\Delta\lambda$, $-\Delta\lambda$ values too, and compute their mean, respectively (two-sided numerical derivates).

$$\frac{\partial X}{\partial \phi} = \frac{X(\phi + \Delta\phi, \lambda) - X(\phi - \Delta\phi, \lambda)}{2 \cdot \Delta\phi}$$
$$\frac{\partial X}{\partial \lambda} = \frac{X(\phi, \lambda + \Delta\lambda) - X(\phi, \lambda + \Delta\lambda)}{2 \cdot \Delta\lambda}$$
$$\frac{\partial Y}{\partial \phi} = \frac{Y(\phi + \Delta\phi, \lambda) - Y(\phi - \Delta\phi, \lambda)}{2 \cdot \Delta\phi}$$
$$\frac{\partial Y}{\partial \lambda} = \frac{Y(\phi, \lambda + \Delta\lambda) - Y(\phi, \lambda + \Delta\lambda)}{2 \cdot \Delta\lambda} \quad (6)$$

We used the horizontal object space coordinates of the focal point of the camera for this computation, because it is located in the middle

of the assessed area that can minimize errors of the method.

For these computations we needed to accurately transform coordinates between the two system. Takács and Siki (2017) have developed a precise solution for open-source proj library using a 2×2 km resolution correction grid. This solution can be used in various open-source softwares (cs2cs, ogr2ogr, QGIS, etc.). We used it in cs2cs function.

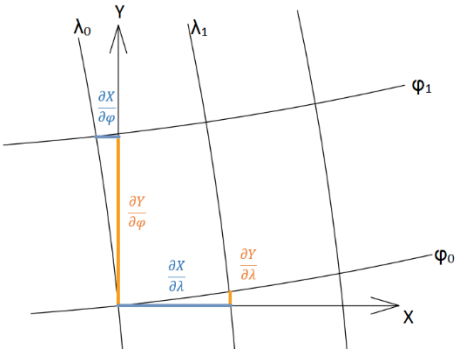

Figure 6. Relationship between the object space reference system and the ellipsoidal coordinates used in RPC model. The local transformation parameters obtained from numeric derivation. For this, coordinate transformation was implemented with a cs2cs command, that utilizes correction grid to ensure high accuracy.

Computing RPC Parameters from Rigorous Sensor Model

It is possible to compute RPC parameters only with the use of GCPs (its advantage that it does not require to know the physical camera model) (Guo & Xiuxiao, 2006). In this case, equations (5) should be applied for the coordinates of the GCPs and RPC parameters can be determined with least-squares adjustment.

The disadvantage of this solution that it totally disregards the camera intrinsics.

In our case, as we know the interior and exterior orientation parameters with high precision, it is more practical to determine RPC parameters as functions of camera interior and exterior parameters (Liu & Tong, 2008). Pixel coordinates should be computed only from the 1st order terms, (as these terms appear in collinearity equations), coefficients and terms containing the 2nd or 3rd power of ellipsoidal latitude, longitude and height should be omitted. In this case, the rational polynomial functions for *l* (line) and *s* (sample) have only first order terms:

$$l = \frac{n_{l_2}L + n_{l_3}P + n_{l_4}H}{d_{l_2}L + d_{l_3}P + d_{l_4}H}$$

$$s = \frac{n_{s_2}L + n_{s_3}P + n_{s_4}H}{d_{s_2}L + d_{s_3}P + d_{s_4}H}$$

In case of collinearity equations, the denominators are equivalent.

Substituting equation (4) (the collinear equations), into equation (2) (defining the affine transformation), we get:

$$\begin{aligned} s = a_0 + a_1\left(\xi_0 - c_k \cdot \frac{R_{11}(X-X_0)+R_{12}(Y-Y_0)+R_{13}(Z-Z_0)}{R_{31}(X-X_0)+R_{32}(Y-Y_0)+R_{33}(Z-Z_0)}\right) + \\ +a_2\left(\eta_0 - c_k \cdot \frac{R_{21}(X-X_0)+R_{22}(Y-Y_0)+R_{23}(Z-Z_0)}{R_{31}(X-X_0)+R_{32}(Y-Y_0)+R_{33}(Z-Z_0)}\right) \\ l = b_0 + b_1\left(\xi_0 - c_k \cdot \frac{R_{11}(X-X_0)+R_{12}(Y-Y_0)+R_{13}(Z-Z_0)}{R_{31}(X-X_0)+R_{32}(Y-Y_0)+R_{33}(Z-Z_0)}\right) + \\ +b_2\left(\eta_0 - c_k \cdot \frac{R_{21}(X-X_0)+R_{22}(Y-Y_0)+R_{23}(Z-Z_0)}{R_{31}(X-X_0)+R_{32}(Y-Y_0)+R_{33}(Z-Z_0)}\right) \end{aligned} \quad (7)$$

Then we substitute into equation (7) the expression of object space coordinates as functions of ellipsoidal coordinates (equation (6):

$$\begin{aligned} X - X_0 &= \frac{\partial X}{\partial \varphi}\cdot(\varphi-\varphi_0) + \frac{\partial X}{\partial \lambda}\cdot(\lambda-\lambda_0) \\ Y - Y_0 &= \frac{\partial Y}{\partial \varphi}\cdot(\varphi-\varphi_0) + \frac{\partial Y}{\partial \lambda}\cdot(\lambda-\lambda_0) \end{aligned} \quad (8)$$

Substituting these back into equation (8), and highlighting the polynomials to the coefficients of (φ-φ0), (λ-λ0) and (Z-Z0) (i.e. *P, L* and *H*), we obtain the RPC coefficients (since they are also coefficients of *P, L* and *H*).

Due to RPCs computed from collinearity equations, ground coordinates are interpreted relative to the focal point (φ0, λ0) of the camera and pixel coordinates relative to the principal point (ξ0, η0) of the image. Therefore, offset values of the ground coordinates must be the latitude, longitude and height of the focal point, and offset of the pixel values are the pixel coordinates of the principal point.

Sign of the line offset changes to its opposite because in QGIS software (where GCPs were specified) line pixel values interpreted as negative values, but gdalwarp uses the other convention. As we did not rescale values, all of the scale factors were set to 1. The RPC parameters obtained with this method are in (Table 4).

Orthorectification Using gdalwarp Program

In this section the procedure of orthophoto generation is discussed.

The user has to specify the input image, the elevation model, the properties of the output file and the RPC parameters used for the orthocorrection.

The gdalwarp command can orthorectify raster data if its metadata is stored in header of the *.tif file. Unfortunately, *.tif header manipulation is not properly works in gdal_translate environment, so instead of it, a virtual raster header file *.vrt was defined for the *.tif image. The *.vrt consists of metadata of the image in XML format, including statistical indicators, georeferencing information, interpretation of bands of the image, grouped into so-called "metadata domains". We could also add new types of metadata (in this case the RPC parameters, called Metadata domain="RPC", as (Table 4) shows. (Vrt - gdal virtual format, n.d.). For further processing, it is important that the image file and its *.vrt file must have the same name.

The used DDM-10 elevation model was clipped and reprojected to WGS84 (practically ETRS89) system using GDAL -command:

- gdalwarp -s_srs EPSG:23700 -t_srs EPSG:4326 DDM-10.tif dem.tif

(because gdalwarp command can only handle elevation models with ellipsoidal coordinates.) Instead of it, SRTM global elevation model dataset can be also used (Farr & Kobrick, 2000). The orthophoto was generated using the following GDAL command:

- gdalwarp -rpc -to "RPC_DEM=dem.tif" -t_srs EPSG:23700 input.vrt output.tif

The -rpc option means that we will produce the orthophoto using RPC parameters. The RPC_DEM switch means that we will use an elevation model. The path of DEM also should be specified. After the -t_srs switch the coordinate system (map projection) of the orthophoto can be specified. Finally the input *.vrt file of the raw image, and the name and extension of the result file should be defined. In this case, the generated orthophoto was a *.tif file in EOV projection (EPSG:23700).

Table 3. Accuracy of the two different types of computation and the generated orthophoto

Root Mean Square (RMS) error of GCPs'	
measured vs. calculated image coordinates using collinearity equations and multiplied by image scale	0.113 m
measured vs. calculated image coordinates using RPC coefficients and multiplied by image scale	0.173 m
measured by RTK GPS vs. measured on the orthophoto	0.960 m

Table 4. The 1976_0029_9095.vrt file that contains the set of coefficients for the orthorectification

```
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  <Metadata>
    <MDI key="TIFFTAG_DOCUMENTNAME">{1C6E48BE-1F08-4CD8-BFD2-6EA3C4C8BE4D}</MDI>
    <MDI key="TIFFTAG_MAXSAMPLEVALUE">255</MDI>
    <MDI key="TIFFTAG_MINSAMPLEVALUE">0</MDI>
    <MDI key="TIFFTAG_RESOLUTIONUNIT">3 (pixels/cm)</MDI>
    <MDI key="TIFFTAG_XRESOLUTION">713.91351</MDI>
    <MDI key="TIFFTAG_YRESOLUTION">713.96979</MDI>
  </Metadata>
<Metadata domain="RPC">
<MDI key="ERR_BIAS">0.000000</MDI>
<MDI key="ERR_RAND">0.000000</MDI>
<MDI key="LINE_OFF">8436.4134</MDI>
<MDI key="SAMP_OFF">8442.3124</MDI>
<MDI key="LAT_OFF">47.7716366637000007</MDI>
<MDI key="LONG_OFF">19.9231569236000006</MDI>
<MDI key="HEIGHT_OFF">977.371</MDI>
<MDI key="LINE_SCALE">1</MDI>
<MDI key="SAMP_SCALE">1</MDI>
<MDI key="LAT_SCALE">1</MDI>
<MDI key="LONG_SCALE">1</MDI>
<MDI key="HEIGHT_SCALE">1</MDI>
<MDI key="LINE_NUM_COEFF">0.0000000000000000 -813498905.0200021266937256 67515173.6506950259208679
254.1037802916758039 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</MDI>
<MDI key="LINE_DEN_COEFF">0.0000000000000000 -1668.6914592352668478 2263.8115948932404535
0.9995448034225362 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</MDI>
<MDI key="SAMP_NUM_COEFF">0.0000000000000000 -45861299.1080696210265160 -1206708817.9251120090484619
207.4472535998895637  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</MDI>
```

```
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0.9995448034225362 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</MDI>
</Metadata>
  <Metadata domain="IMAGE_STRUCTURE">
    <MDI key="COMPRESSION">JPEG</MDI>
    <MDI key="INTERLEAVE">BAND</MDI>
  </Metadata>
  <VRTRasterBand dataType="Byte" band="1" blockYSize="16">
    <ColorInterp>Gray</ColorInterp>
    <SimpleSource>
      <SourceFilename relativeToVRT="1">1976_0029_9095.tif</SourceFilename>
      <SourceBand>1</SourceBand>
      <SourceProperties RasterXSize="17698" RasterYSize="16880" DataType="Byte" BlockXSize="17698"
BlockYSize="16" />
      <SrcRect xOff="0" yOff="0" xSize="17698" ySize="16880" />
      <DstRect xOff="0" yOff="0" xSize="17698" ySize="16880" />
    </SimpleSource>
  </VRTRasterBand>
</VRTDataset>
```

RESULTS AND DISCUSSIONS

(Table 3) shows the residual errors of the adjustment calculated with collinearity equations and the residual errors calculated with the RPC model.

To express the errors in object space coordinates, the obtained error of the adjustment in image space coordinates had to be multiplied by the approximate scale of the image (described at equation (1)).

This table also shows the Root Mean Square (RMS) error of GCPs' derived from the orthophoto. The object space coordinates of GCPs on the orthophoto were measured in QGIS, and were compared with the RTK GPS measurements.

(Table 3) proves, that the accuracy of the transformation based on RPCs does not differ significantly from that computed from collinearity equations.

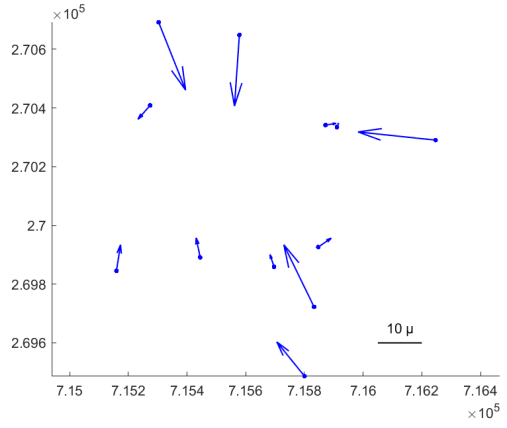

Figure 7. Error vectors of the orthophoto. Vectors represent the difference in coordinates of GCPs measured with RTK GNSS on the field and measured on the orthophoto. The mean error of rectification is 0.96 m that make it suitable for utilizing in GIS applications. Map axes are object space coordinates (EOV projection).

CONCLUSIONS

The mathematical methods we used enables to determine the relationship between pixel and ground coordinates in the images with sufficient accuracy.

(Table 3) shows that there is no significant difference in the accuracy of the two different types of computation.

However, the precision of the orthophoto is considerably lower, but it is still less than one meter, that make it suitable for utilizing in most GIS applications.

This dilution of precision is supposed to be caused by the poor quality of the applied digital elevation model, as discussed above. (It has high errors and also low resolution.) GCPs that are farther away from the image centre mostly have larger errors that also proves this theory.

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ADAPTING SOUTH KOREEAN TRAFFIC, MANAGEMENT STRATEGIES, AI AND GIS INNOVATIONS TO IMPROVE TRAFFIC MANAGEMENT IN BUCHAREST

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Abstract

The paper delves into the pressing issue of traffic management in Bucharest, Romania, which is plagued by congestion, infrastructure deficiencies, and outdated traffic control systems. By harnessing the power of Geographic Information Systems (GIS), Artificial Intelligence (AI), and dynamic traffic management techniques, it proposes a transformative approach to address these challenges. GIS serves as the backbone of the proposed solution, providing spatial analysis capabilities to understand traffic patterns, identify bottlenecks, and optimize road networks. AI complements GIS by offering predictive analytics and decision-making capabilities, enabling traffic management systems to anticipate and adapt to changing conditions in real-time. Dynamic traffic management techniques further enhance the efficacy of the system by continuously monitoring traffic flow and implementing responsive measures such as variable speed limits and adaptive signal timings. This innovative integration of technology promises to revolutionize traffic management in Bucharest, creating a smarter, more efficient system capable of alleviating congestion, enhancing safety, and improving the overall urban mobility experience.

Key words: *AI, Dynamic Traffic Management, GIS, Innovation, Traffic Management.*

INTRODUCTION

Urban traffic congestion presents a formidable challenge in cities worldwide, and Bucharest is no exception. Conventional traffic management strategies struggle to keep up with the escalating demands placed on transportation infrastructure. However, the emergence of advanced technologies such as Geographic Information Systems (GIS), Artificial Intelligence (AI), and smart dynamic traffic management introduces a paradigm shift in traffic management practices. Through the integration of GIS, cities like Bucharest can gain valuable insights into traffic patterns, infrastructure deficiencies, and optimal routing strategies. AI serves as a powerful tool for predictive analytics and real-time decision-making, enabling traffic management systems to

dynamically adapt to changing conditions. Smart dynamic traffic management techniques, including variable speed limits and adaptive signal control, further enhance the efficiency and safety of urban road networks.
By harnessing these innovative technologies, cities can unlock new possibilities for optimizing traffic flow, improving road safety, and enhancing the overall commuting experience for residents and visitors alike.

MATERIALS AND METHODS

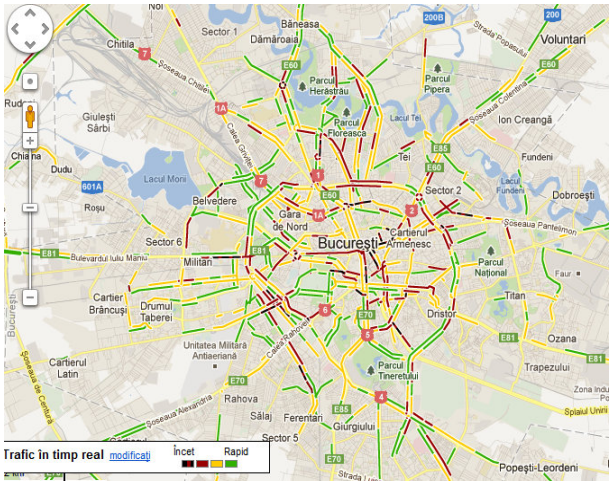
Congestion: Bucharest contends with persistent traffic congestion, a result of its burgeoning population and limited road capacity. During peak hours, major thoroughfares become overwhelmed with vehicles, leading to significant delays and frustration for commuters. The gridlock not only impedes the flow of traffic but also contributes to increased emissions, worsening air quality and environmental health. Addressing congestion requires comprehensive strategies that incorporate measures to manage traffic flow, optimize signal timings, and promote alternative modes of transportation to alleviate pressure on the road network.
Infrastructure: Bucharest's infrastructure struggles to accommodate the city's growing transportation needs. Inadequate road capacity and maintenance deficiencies exacerbate congestion and prolong travel times, particularly during peak hours. The lack of sufficient infrastructure investment hampers efforts to improve traffic flow and enhance the overall commuting experience. Addressing infrastructure shortcomings necessitates strategic planning and investment in road expansion, maintenance, and modernization projects to bolster the city's transportation network and alleviate congestion bottlenecks.
Inefficient Traffic Control: Existing traffic control systems in Bucharest often fail to adapt to changing traffic patterns, resulting in inefficiencies and exacerbating congestion. Static signal timings and outdated control mechanisms contribute to prolonged wait times at intersections and suboptimal traffic flow. Implementing dynamic traffic control systems, powered by advanced technologies such as Artificial Intelligence and real-time data analysis, can enable more responsive and adaptive traffic management strategies. By harnessing these innovations, Bucharest can enhance the efficiency of its traffic control systems and mitigate congestion, ultimately improving the urban mobility experience for residents and visitors alike.

Geographic Information Systems (GIS): GIS plays a crucial role in modern traffic management by providing spatial data and analysis tools to understand and manage traffic patterns effectively. It integrates various data sources, including road networks, traffic flow data, population density, and land use, to create comprehensive maps and visualizations. GIS enables transportation planners to identify congestion hotspots, analyze road usage patterns, and plan infrastructure improvements strategically. By leveraging GIS, cities like Bucharest can optimize traffic routes, identify areas in need of infrastructure upgrades, and allocate resources efficiently to alleviate congestion.
Artificial Intelligence (AI): AI technologies offer immense potential for revolutionizing traffic management systems. AI algorithms can analyze vast amounts of traffic data to predict congestion, optimize traffic signal timings, and even dynamically adjust routes in real-time. Machine learning models can learn from historical traffic patterns to anticipate future traffic conditions and recommend proactive measures to mitigate congestion. By harnessing AI, traffic management authorities can enhance the efficiency of their systems, reduce commute times, and improve overall traffic flow, ultimately leading to a more sustainable and livable urban environment.
Smart Dynamic Traffic Management: Smart dynamic traffic management systems utilize real-time data and advanced algorithms to adjust traffic signals, lane assignments, and routing dynamically. These systems continuously monitor traffic conditions, weather events, accidents, and other factors affecting traffic flow, allowing for rapid response and adaptive control strategies. By dynamically optimizing traffic management decisions, such as adjusting signal timings based on current traffic volumes or rerouting vehicles to alternate routes, smart dynamic systems can minimize congestion,

reduce travel times, and enhance the overall efficiency of the transportation network.

Preparation Techniques

GIS Implementation: Implementing GIS in Bucharest's traffic management involves several key steps. Firstly, gathering relevant spatial data including road networks, traffic flow data, and demographic information. Then, this data is processed and integrated into a GIS platform to create comprehensive maps and visualizations. Traffic patterns can be analyzed to identify congestion hotspots, optimize traffic routes, and plan infrastructure improvements strategically. Additionally, GIS can facilitate data-driven decision-making by providing insights into traffic trends and patterns over time. By leveraging GIS, Bucharest can develop informed strategies to address its traffic challenges effectively and improve overall urban mobility.



AI Integration: Integrating AI into Bucharest's traffic management systems involves deploying advanced algorithms capable of predictive analysis and real-time optimization. AI can analyze large volumes of traffic data to predict congestion, optimize traffic signal timings, and recommend proactive measures to mitigate traffic congestion. Machine learning models can continuously learn from historical traffic patterns to improve the accuracy of traffic predictions and optimize traffic management strategies. By integrating AI, Bucharest can enhance the efficiency of its traffic management systems, reduce congestion, and improve the overall flow of traffic throughout the city.

Smart Dynamic Traffic Management Systems: Implementing smart dynamic traffic management systems in Bucharest involves deploying intelligent traffic signals that adjust based on real-time traffic data. These systems continuously monitor traffic conditions, weather events, accidents, and other factors affecting traffic flow. Based on this information, traffic signals can dynamically adapt to optimize traffic flow, reduce congestion, and improve overall urban mobility. Additionally, smart dynamic traffic management systems can facilitate the coordination of traffic signals along major corridors to improve traffic flow and reduce travel times. By implementing smart dynamic traffic management systems, Bucharest can enhance the efficiency of its transportation network and improve the overall quality of life for its residents.

RESULTS AND DISCUSSIONS

Benefits:

Implementing GIS, AI, and smart dynamic traffic management in Bucharest offers several potential benefits:

Reduced Traffic Congestion: By optimizing traffic flow and dynamically adjusting traffic signals, these technologies can help alleviate congestion on Bucharest's road networks, reducing travel times and improving overall mobility for residents and commuters.

Improved Road Safety: AI-powered systems can analyze traffic data in real-time to identify potential hazards and optimize traffic management strategies to enhance road safety. This includes dynamically adjusting signal timings to reduce the risk of accidents and improve intersection safety.

Enhanced Efficiency: GIS allows for more informed decision-making by providing insights into traffic patterns and infrastructure needs, enabling authorities to allocate resources more effectively. Additionally, smart dynamic traffic management systems can optimize traffic flow, reducing delays and improving the efficiency of the transportation system as a whole.

Challenges:

Despite the potential benefits, implementing these technologies in Bucharest may face several challenges:

Cost: The initial investment required for deploying advanced technologies such as GIS, AI, and smart traffic management systems can be significant. This includes the cost of hardware, software, infrastructure upgrades, and ongoing maintenance expenses.

Skilled Personnel: Effectively leveraging these technologies requires personnel with specialized skills in GIS, AI, and traffic management. Training and retaining skilled professionals may pose a challenge for local authorities, particularly in areas with limited expertise in these fields.

Resistance to Change: Introducing new technologies and changing established traffic management practices may encounter resistance from various stakeholders, including government agencies, transportation authorities, and the public. Addressing concerns and ensuring buy-in from key stakeholders is essential for successful implementation.

Overcoming these challenges will require careful planning, collaboration between stakeholders, and a commitment to investing in the necessary resources and expertise to realize the full potential of GIS, AI, and smart dynamic traffic management in Bucharest.

CONCLUSIONS

In conclusion, the integration of Geographic Information Systems (GIS), Artificial Intelligence (AI), and smart dynamic traffic management presents a transformative opportunity to address the pressing traffic management challenges in Bucharest, Romania. By harnessing these advanced technologies, Bucharest can enhance traffic flow, improve road safety, and optimize the efficiency of its transportation network. However, realizing these benefits requires overcoming challenges such as the initial investment costs, the need for skilled personnel, and potential resistance to change. Through strategic planning, collaboration, and a commitment to innovation, Bucharest can unlock the full potential of GIS, AI, and smart dynamic traffic management to create a smarter, more efficient urban mobility experience for residents and visitors alike.

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MAPPING THE LANDSCAPE: A GIS ANALYSIS OF BORGO SAN LORENZO, ITALY

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Abstract

This paper aims to present a comprehensive Geographic Information System (GIS) analysis of Borgo San Lorenzo, Italy, utilizing mapping techniques to uncover spatial patterns and environmental characteristics of the area. Through meticulous examination (hydrographical, slope, exposures, radiation levels, geomorphology, land use, vegetation typology maps), we identify critical landscape features and evaluate natural resource allocation within the region. The analysis highlights the integration of historical layouts with modern urban expansion, revealing how these elements collectively influence the town's development and environmental sustainability. Our findings demonstrate the utility of GIS in preserving natural landscapes and supporting sustainable growth. This study not only maps the physical landscape of Borgo San Lorenzo but also lays a foundation for future research into its socio-economic and environmental dynamics. The maps, along with detailed visual data, serve as a pivotal tool in our analysis, offering insights into the complex interplay between natural and built environments. This article highlights the role of GIS in enhancing agricultural practices in Borgo San Lorenzo, where detailed cartographic analysis reveals an ideal setting for agricultural activities, driven by its unique terrain, climate, and historical land management.

Key words: *agronomic potential, environmental conservation, Geographic Information System, spatial analysis.*

INTRODUCTION

Surrounded by the peaceful Tuscan hills, Borgo San Lorenzo showcases the quintessential charm of Italy's natural landscapes. The town is situated in the heart of the Mugello valley, a region celebrated for its verdant landscapes, fertile terrains, and an intricate network of rivers and streams that nurture the land. This rich environment has transformed Borgo San Lorenzo into a flourishing agricultural nexus.

Beyond its agricultural vitality, the Mugello region boasts a rich tapestry of natural features, including majestic mountain ranges, rolling hills, dense forests, and vibrant chestnut orchards, complemented by the picturesque beauty of its vineyards. These diverse landscapes underscore the ecological richness and scenic variety of the area, highlighting its unique charm and agricultural significance (Azienda agricola la Matteraia, 2013).

The expansive territory of Mugello, extending from the slopes of the Apennine Mountains to the flatlands along the Sieve River, is an area of considerable agricultural productivity and profound natural and historical significance. Characterized by extensive cultivation of olives, grapes, wheat, and forage crops alongside livestock husbandry encompassing pigs, sheep, and cattle, this region stands as a testament to rich agricultural resources and enduring cultural heritage (Paolucci, 2008).

The area represents a harmonious blend of past and present, where medieval structures coexist with modern amenities, reflecting the town's ability to preserve its historical identity while embracing contemporary life. From a financial perspective, the region thrives on a blend of agricultural activities, artisanal craftsmanship, and tourism.

Borgo San Lorenzo offers a unique landscape for analysis. Its diverse topography, rich historical layers, and the intricate interplay between natural and human-made environments present an intriguing subject for GIS-based studies. Such studies can uncover patterns and relationships within the landscape, offering insights into everything from historical land use and architectural evolution to environmental conservation and urban planning.

Figure 1. Location of Borgo San Lorenzo in Italy.

Figure 2. Location of Borgo San Lorenzo in Tuscany. Source of SVG: CC BY-SA 3.0 de

MATERIALS AND METHODS

For the GIS analysis of Borgo San Lorenzo, several key factors such as altitude, hydrography, slope percentages, solar radiation exposure, geomorphological features, land use patterns, and forest typologies were analysed to determine the area's agricultural potential.

Data from the Italian National Institute for Environmental Protection and Research, supplemented by satellite images and historical climate records, were key to this assessment.

Using GIS software for statistical analysis, we conducted a thorough evaluation of the region's suitability for farming development, providing a detailed insight into the area's rich agricultural landscape. Therefore, the multifaceted character of Borgo San Lorenzo can be meticulously mapped and understood, contributing valuable knowledge to both academic fields and practical applications in landscape management and preservation.

RESULTS AND DISCUSSIONS

For the results and discussions phase, a series of maps were made to serve as a visual synthesis of various environmental and topographical data points of Borgo San Lorenzo. They are instrumental in discerning the spatial patterns and geophysical attributes that inform the region's agricultural potential.

Each map is a testament to the complexity and richness of Borgo San Lorenzo's landscape, providing a basis for discussions on the implications of these factors for current and future land use planning, environmental conservation, and the optimization of agricultural sectors.

The first map (Figure 3) offers an overview of the topographical variance within Borgo San Lorenzo, expressed through a colour gradient corresponding to altitude - from the verdant valleys at 200 meters to the rugged peaks reaching 1000 meters. This elevation spectrum not only informs us about the diverse altitudes present in the region but also allows us to infer the resulting microclimates.

These microclimates, formed by the interaction of elevation and topography, foster distinct environments conducive to diverse agricultural practices, each characterized by its own temperature, humidity, and sun exposure.

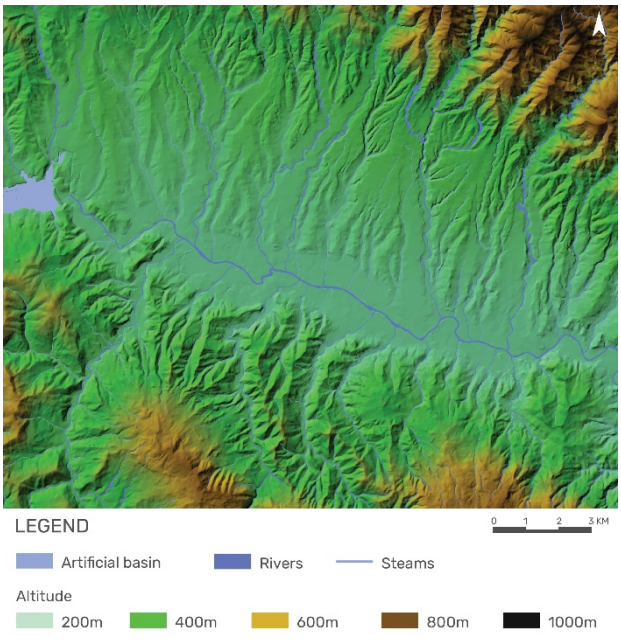

Figure 3. Topographical and hydrographical overview

The following map (Figure 4) focuses on slope analysis, an essential factor in determining the suitability for a variety of agricultural practices. It features a colour spectrum that transitions from light to dark, symbolizing slopes ranging from 0% (flat terrains) to 100% (steep inclines).

This detailed topographical insight is invaluable not just for specific crop cultivation but also for broader agricultural practices that require certain land contours for optimal growth, water management, and soil preservation. Moreover, understanding the slope is essential for implementing effective erosion control measures, optimizing irrigation strategies, planning the placement of infrastructure to support sustainable operations and informed decisions that maximize land use efficiency while minimizing environmental impact.

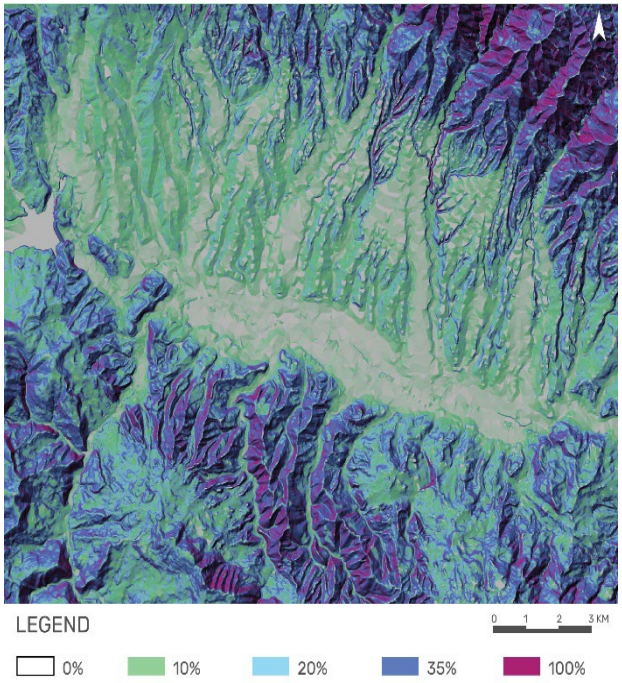

Figure 4. Slope analysis

Mugello's layout is divided into two parts by the Apennine Mountains: the southern Low Mugello (LM) with a wide valley and lower altitude, and the northern High Mugello (HM) with a narrower valley and higher altitude. LM faces west-southwest while HM faces east-northeast. HM is more sheltered from mild western winds but exposed to cold eastern winds, while LM experiences the opposite (Messeri et al., 2023).

The sun exposure map (Figure 5) is a precise analytical representation of terrain orientation within Borgo San Lorenzo, and employs distinct colours to vividly signify the comprehensive range of cardinal and intercardinal directions that the region's land surfaces face.

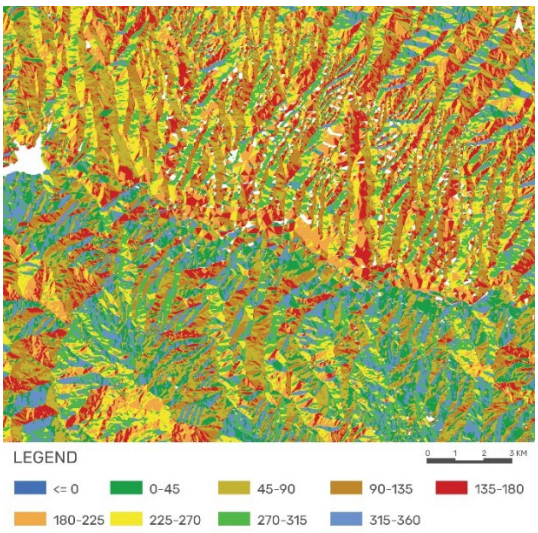

Figure 5. Sun exposure

Starting from flat areas denoted by blue, the palette shifts through greens, yellows, oranges, and reds to indicate the progressive change in orientation from north through east, south, and west, back to north.

These hues reflect the slope aspect from 0 degrees up to 360 degrees, providing a visual cue of the area's topographic diversity. This kind of aspect mapping is instrumental for understanding which parcels of land receive varying amounts of sunlight throughout the year, influencing everything from agricultural zoning (soil temperatures, evaporation rates, vegetative growth patterns) to ecological studies and real estate development.

In Borgo San Lorenzo, summers are short, warm, and clear, while winters are very cold and partly cloudy. Temperatures range from 1°C to 30°C throughout the year, with the warm season lasting from mid-June to early September. July is the hottest month, with temperatures averaging 29°C during the day and 17°C at night (Weather Spark, 2024).

The next map illustrates the annual solar radiation (Figure 6). It is color-coded to show the total yearly solar radiation in watts per square meter per year (W/m²*year), the colours ranging from light yellow for the lowest radiation levels to dark red for the highest.

According to Giacometti & Morosinotto (2013) solar radiation is the primary source of energy for the biosphere, while James (2003) mentions the crucial importance of solar radiation in providing the energy source for photosynthesis.

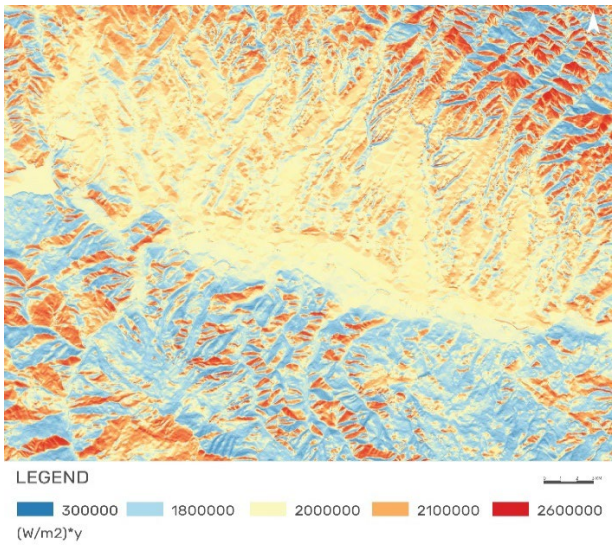

Figure 6. Annual solar radiations

The formula used in order to obtain the result is: RadTot = ((RadAut + RadWin + RadSpr + RadSum)/4)∗365, where RadAut is the autumnal radiation, calculated on the autumn equinox, RadWin is the winter radiation, calculated on the winter solstice, RadSpr is the spring radiation, calculated on the spring equinox, RadSum is the summer radiation, calculated on the summer solstice. The total is divided by 4 (the number of seasons) and multiplied by 365 (the number of days in a year, considering it a bissextile year).

For this topic, it was also illustrated the distribution of solar radiation but divided into different seasons (Figure 7), represented by the four quadrants. The color-coding for this map ranges from light blue for the least amount of seasonal solar radiation to dark red for the most, measured in watts per square meter per day (W/m²*day).

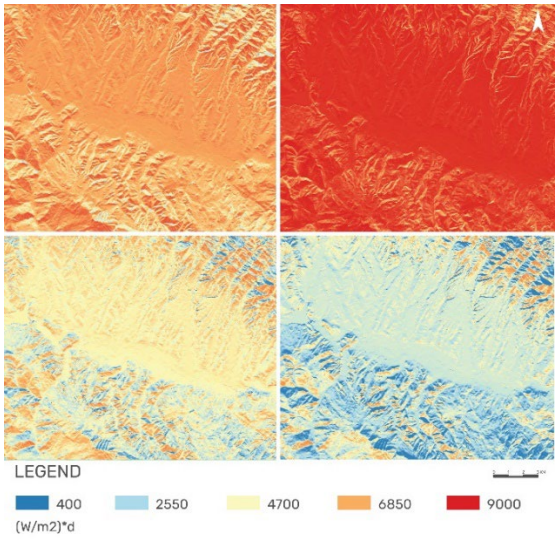

Figure 7. Seasonal solar radiation analysis - Spring, Summer, Autumn, Winter

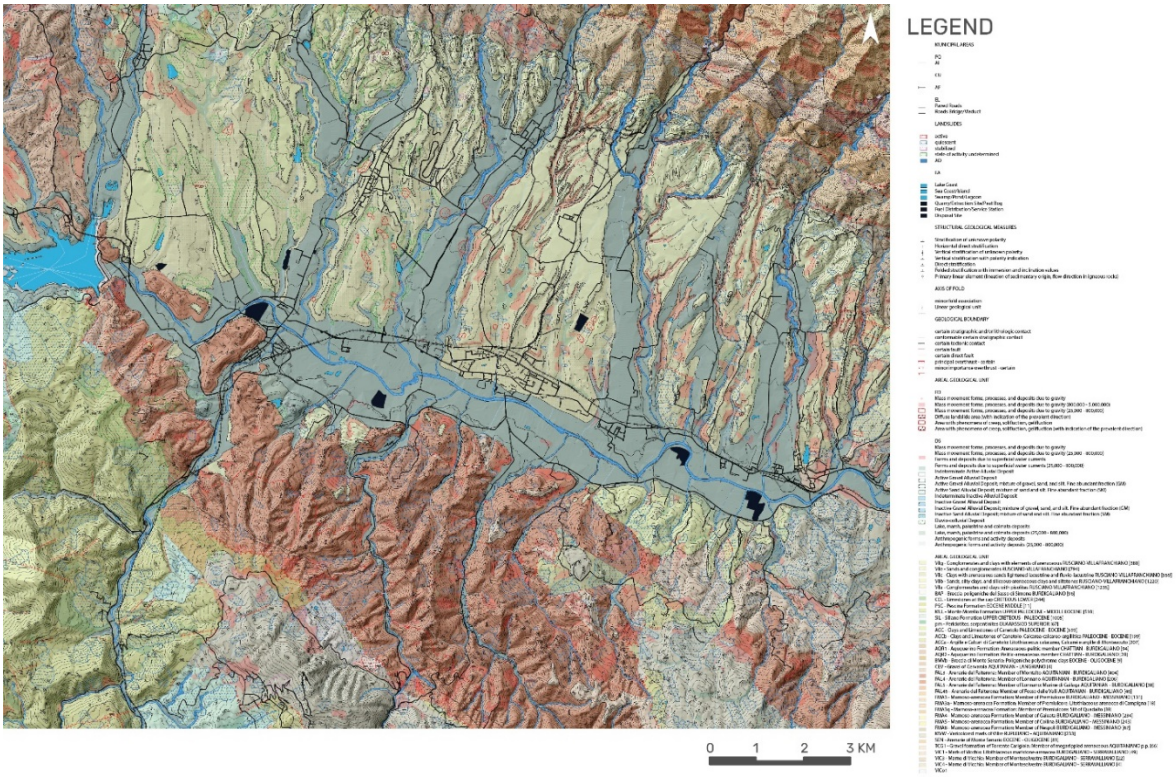

Figure 8. Geological Geomorphological map

The map presented above (Figure 8) is a detailed and complex geological and geomorphological survey of the Borgo San Lorenzo landscape, richly textured with colour to delineate a diverse and extensive range of topographical features, geological formations, and geomorphological structures.
The colour gradients on the map represent different elevation levels, with varying shades indicating the rise and fall of the terrain. The presence of blue hues suggests water bodies such as lakes and rivers, while browner and redder tones indicate higher elevation points or specific geological features like rock formations. Patterns such as stippling, cross-hatching, and other markings are used to depict various geological conditions or land cover, such as vegetation or urban areas (Bortolotti et al., 2010).
The main development axis of the area is formed by the Sieve valley floor, extensively urbanized and characterized by the presence of significant infrastructural connections to the national network (Piano paesaggistico Regione Toscana, Ambito 07 Mugello, 2015).
The forest ecological network of the area is characterized by the extensive coverage of its primary node component, primarily affecting continuous woodlands, especially broadleaf forests (predominantly oak, beech, and chestnut), and coniferous forests in the Alto Mugello region. Other primary forest nodes of lesser extent are located in the northern slopes of Mount Morello, Mount Giovi, and the Consuma area, bordering Casentino. Some of these nodes are part of large regional agroforestry complexes (Giogo-Casaglia) or protected areas and Natura 2000 sites (Piano paesaggistico Regione Toscana, Ambito 07 Mugello, 2015).
The accompanying thematic map (Figure 9) provides a comprehensive overview of the land use and cover patterns observed across the Borgo San Lorenzo area. Within this landscape, agricultural activities play a central role, with cultivated fields and meadows forming prominent features. These agricultural lands are meticulously organized into distinct patterns, demarcated by hedgerows and interspersed with patches of woodland (L'Istituto Superiore per la Protezione e la Ricerca Ambientale, 1991).

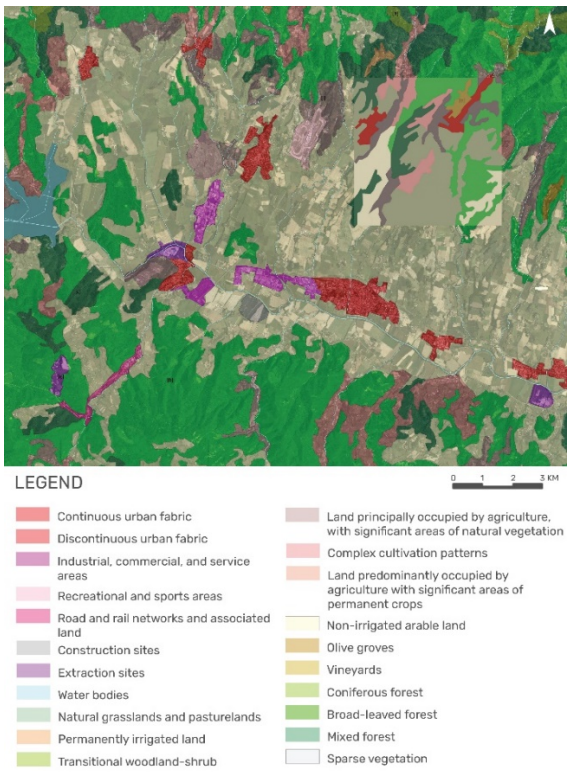

Figure 9. Land use. Source of vectors: CLC - Corine Land Cover

Moreover, the map highlights the importance of assessing these landscapes using physiographic data, including climatic factors and intrinsic soil characteristics, as underscored by previous studies such as that conducted by Wang (1994). Furthermore, it becomes evident that human activities, particularly settlement and land use practices, exert a significant influence on landscape evolution. As such, the map not only serves as a visual representation of the region's land cover but also offers a deeper understanding of the complex interplay between human actions and natural processes in shaping the Borgo San Lorenzo landscape (Boriani, 1999; Bonari et al., 2006).
Within landscape ecology, the intricate relationship between landscapes and agriculture has been extensively explored. This approach provides a systemic and dynamic analysis of interactions between natural processes and socio-economic factors across various scales (Galli et al., 2008).
The land use map is an indispensable aid for research applied in the field of natural and territorial sciences, in programming, in planning and managing various territorial levels, as it allows defining the spatial distribution and the

consistency of natural or anthropic formations that are present in a territory.
The current map underscores the need for strategies that can reconcile the demands of urban expansion with the imperatives of ecological conservation. The green patches, indicative of forests, are not only biodiversity hotspots, but also essential for the well-being of the regional climate and water systems, guiding actions to mitigate environmental impacts. The map thus acts as a key tool in ecological planning, emphasizing sustainable development that honours and preserves the area's natural heritage.

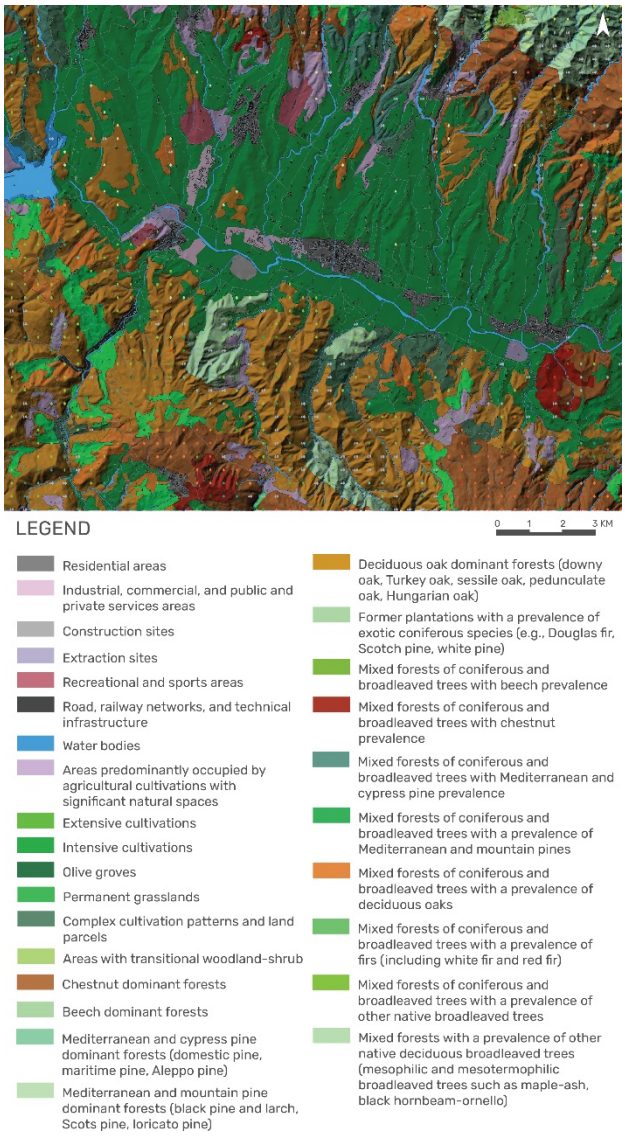

Figure 10. Forest typology

The map presented above (Figure 10) outlines the forest typologies in the Borgo San Lorenzo area, from two primary cartographic sources: the Corine Land Cover (CLC) at the fourth level and the Tuscan Forest Inventory (Inventario Forestale Toscana).
The Corine Land Cover is a program specifically aimed at the surveying and monitoring of territorial characteristics, with particular attention to the requirements for its protection. The Tuscan Forestry Inventory is an archive created between the years 1978-1996 for the purpose of gathering information relevant to the location, extent, and typology of woods, employing a grid for inventory surveying with a step of 400 meters.
A vegetation map is a crucial geographical document that visually represents the distribution of vegetation types within a specific territory. These maps typically employ two classifications: physiognomic maps, which depict vegetation types based on their visual appearance to the naked eye, and phytosociological maps, which illustrate ecological associations among different species. This classification system offers valuable insights into the ecological makeup of a given area and aids in understanding its environmental dynamics.

CONCLUSIONS

In conclusion, this research represents a significant step forward in understanding the landscape dynamics of Borgo San Lorenzo, Italy, through a comprehensive Geographic Information System (GIS) analysis. By employing mapping techniques and examining various spatial and environmental characteristics, the study uncovered critical insights into the region's natural resources, land use patterns, and historical development.
Moving forward, it is imperative to integrate these findings into comprehensive action plans that prioritize the sustainable management and preservation of Borgo San Lorenzo's landscape. The actions outlined in the Piano strutturale, 2005 Statuto del Territorio - Disciplina Strutturale, play a crucial role in achieving this goal. Firstly, by promoting interactions between landscape, historical-cultural values network, agri-food production, and artisanal activities, the plan aims to foster a harmonious relationship between economic development and cultural preservation. Additionally, measures such as safeguarding landscape elements, rural paths,

and local roads, along with protecting truffle-producing areas, contribute to the conservation of biodiversity and ecosystem integrity.

By implementing these action plans, the sustainable development and preservation of Borgo San Lorenzo's landscape for future generations can be ensured. The integration of GIS analysis with strategic planning and community engagement will be vital in achieving this objective. "Mapping the Landscape" serves not only as a research endeavour but also as a call to action for sustainable landscape management practices in Borgo San Lorenzo, Italy.

The findings of this research underscore the invaluable role of GIS in preserving natural landscapes and supporting sustainable growth.

By mapping the physical landscape of Borgo San Lorenzo, the study has not only gained a deeper understanding of its environmental characteristics but also laid a foundation for future research endeavours into its socio-economic and environmental dynamics.

In essence, this research contributes significantly to the body of knowledge surrounding Borgo San Lorenzo's landscape dynamics and emphasizes the importance of integrating GIS into land use planning and environmental management efforts.

By harnessing GIS technology, a deeper comprehension of and preservation of the natural environment can be achieved, simultaneously fostering sustainable growth and agricultural practices in Borgo San Lorenzo, Italy, thereby ensuring a more resilient and prosperous future for generations to come.

ACKNOWLEDGEMENTS

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SECTION 04
FUNDAMENTAL SCIENCES

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FINANCIAL LITERACY FOR YOUTH

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Abstract

Why it matters financial literacy for youth? Because many young people will enter adulthood without the essential financial knowledge and skills they need to make informed choices about their money. Early-adulthood financial decisions can have lifelong consequences, that why equipping young people with the tools to manage their money effectively helps them avoid the cycle of debt and economic insecurity. Without a solid financial foundation, youth are more susceptible to predatory lending and costly errors in managing debts and expenses that can lead to lifelong financial inequity. Financial literacy is the combined knowledge and skills required to make responsible and informed financial decisions that contribute to a sense of financial security and well-being. Knowledge of financial concepts like saving, investing, spending and borrowing is the foundation of financial literacy. In addition, understanding credit management, asset building and how to reduce debt and avoid scams is critical to a healthy financial life. In order to see the level of information of young people regarding finances, we conducted a survey in which one hundred young people participated. In this paper we want to present the results of the ongoing investigation.

Key words*: financial literacy, ongoing investigation, survey.*

INTRODUCTION

The term financial literacy was first coined in 1787 in the USA, when John Adams in a letter to Thomas Jefferson admitted the need for financial literacy for overcoming the confusion and widespread distress in America that had arisen due to ignorance towards credit, circulation and nature of coin (https://www.emerald.com/insight/content/doi/10.1108/IJSE-11-2016-0303/full/pdf?title=financial-literacy-among-youth).

Why it matters financial literacy for youth? Because many young people will enter adulthood without the essential financial knowledge and skills they need to make informed choices about their money. Early-adulthood financial decisions can have lifelong consequences, that why equipping young people with the tools to manage their money effectively helps them avoid the cycle of debt and economic insecurity. Without a solid financial foundation, youth are more susceptible to predatory lending and costly errors in managing debts and expenses that can lead to lifelong financial inequity. Financial literacy is the combined knowledge and skills required to make responsible and informed financial decisions that contribute to a sense of financial security and well-being. Knowledge of financial concepts like saving, investing, spending and borrowing is the foundation of financial literacy. In addition, understanding credit management, asset building and how to reduce debt and avoid scams is critical to a healthy financial life. Financial Illiteracy is an obstacle faced by developing or emerging communities as well as advanced societies throughout the world. Lack of financial education is affecting individuals, girls or boys, families, and communities. It slowly starts to affect the local economy and eventually spreads out to the global level. Attainment and development of wealth management principles and skills are essential to growth at all levels (https://mindtreasures.com/). Financial literacy encompasses the skills, knowledge and tools that people need to take action and make financial decisions that will support their personal goals. The process of acquiring these skills, knowledge and tools is

called financial education and can take several forms, such as classroom education, personal counselling and coaching, technology-based programs and self-study. Financial literacy refers to the management of money, often with an assumption that an individual has access to funds and can decide how to use them. Financial capability includes skills learned through financial literacy but also provides young people with the skills and information needed to access financial institutions, products and markets. Financial literacy is key to helping young people manage money effectively so that they can become financially stable, build assets and achieve their personal goals.

Decisions made in early adulthood can have lasting financial consequences. For instance, today's youth can amass debt quickly, often in the form of school loans or credit card debt. According to a report by the National Endowment for Financial Education, Generation X youth reported an average debt of about $60,000 by their late 20s, and their successors — Millennials — had already reached this point in their mid-20s.

Many young people receive no formal financial instruction. Instead, they learn about money through socialization, such as observing and listening to their parents, caregivers, other adults and peers.

What are the key elements of financial literacy? The website youth.gov identifies five areas of financial literacy and capability that a young person should learn about (https://www.aecf.org/blog/financial-literacy-for-youth):

1. Frauds, scams and predatory lending practices
2. Public and work-related benefits
3. Banking practices
4. Savings and investing strategies
5. Credit use and interest rates

According to UNESCO, "Youth is best understood as a period of transition from the dependence of childhood to adulthood's independence and awareness of our interdependence as members of a community" and age has been considered as the easiest way to define youth by UNESCO which has indicated youth as a person between the age of leaving compulsory education and finding first employment. UN has defined youth as the persons ranging between the age group of 15-24 years, for ensuring statistical consistency in international programmes. For national level programmes, UN has adopted the particular member states' definition of youth. African Youth Charter has considered "Youth" to be person between the ages of 15-35 years (https://www.emerald.com/insight/content/doi/10.1108/IJSE-11-2016-0303/full/pdf?title=financial-literacy-among-youth).

The financial education of young people is a subject that should concern them, that's why we wanted to conduct an opinion poll on a group of students from the USAMV Bucharest to see how important this subject is to them. In order to see the level of information of young people regarding finances, we conducted a survey in which one hundred young people participated. In this paper we want to present the results of the ongoing investigation.

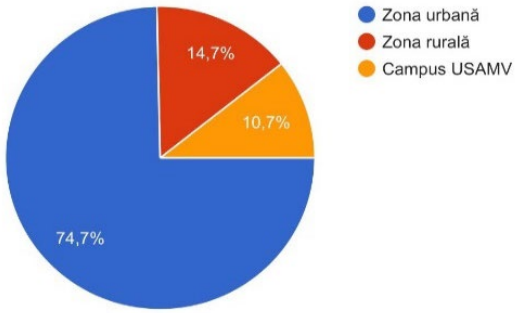
MATERIALS AND METHODS

To create the questionnaire we used Google forms, which allowed us to ask the questions of the participants. The questionnaire had 16 questions:

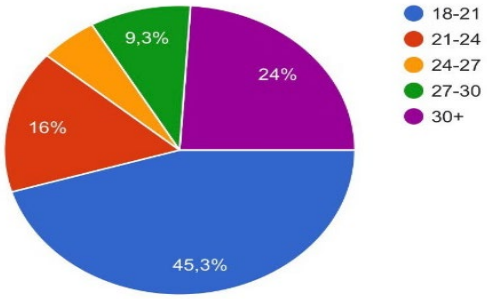
1.Where do you live most of the time?
2.How old are you?
3.Your gender
4.What is the main source of financial information for you?
5.How confident do you feel in managing your own money?
6.Your source of income comes from?
7.How much do you save monthly?
8.What types of investments do you know?
9.Have you ever invested money?
10.The possibility of obtaining a scholarship at school or college stimulates you to learn better?
11.Do you always know what debts you have?
12.The sum of your monthly debts is less than 30% of the value of your total income?
13.Do you pay all your bills in full monthly?
14.What are the main challenges you have with money management and finances?
15.What learning methods or formats do you think would be the most effective for you in terms of financial education? (presentations, group discussions, interactive activities, etc.)
16.The rent or the home loan represents more than 25% of your monthly income?

RESULTS AND DISCUSSIONS

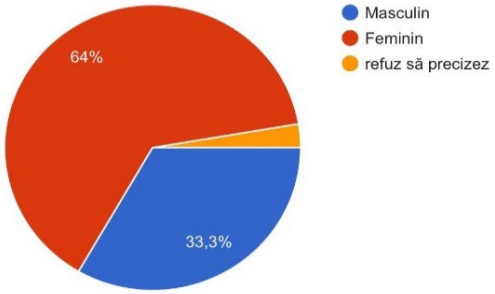
1.Where do you live most of the time?



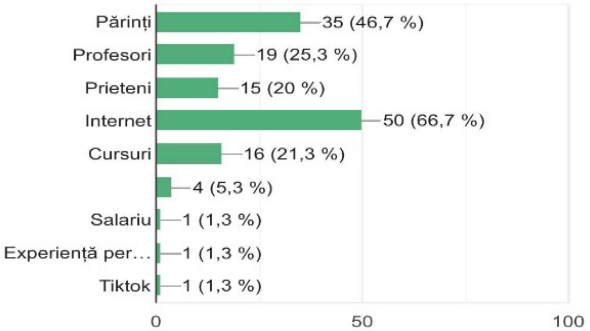
2.How old are you?



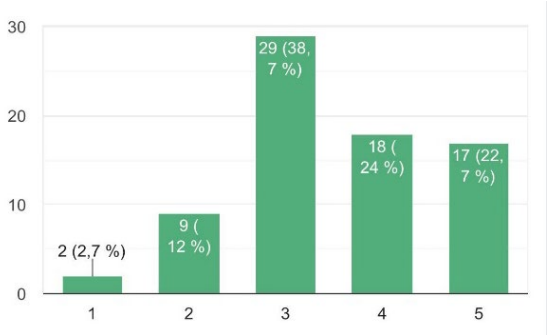
3.Your gender



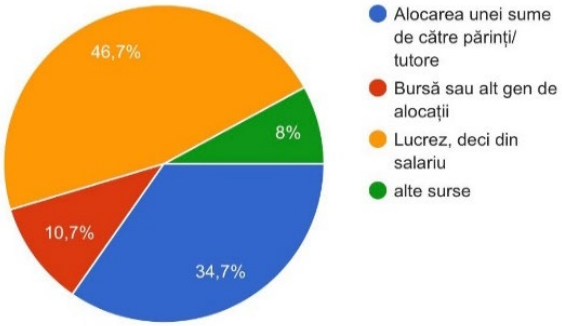
4.What is the main source of financial information for you?



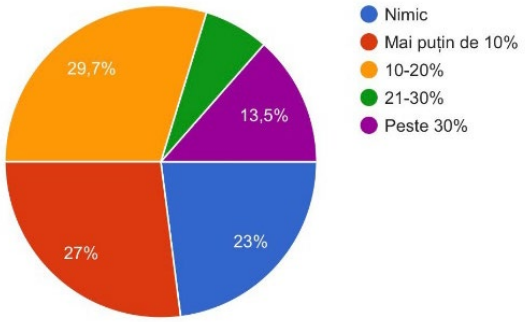
5. How confident do you feel in managing your own money?



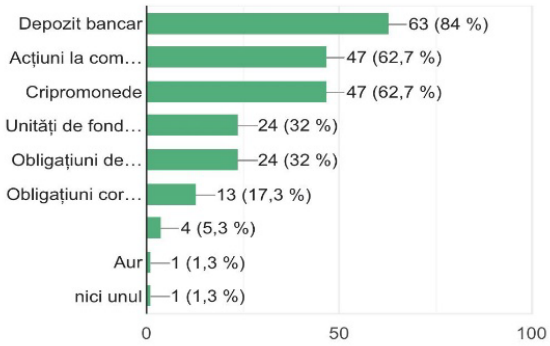
6.Your source of income comes from?



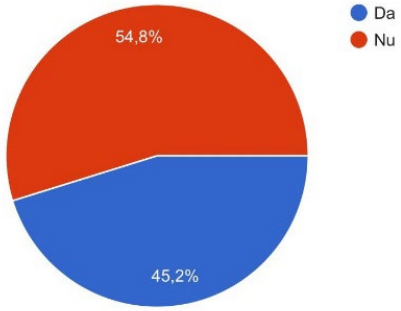
7.How much do you save monthly?



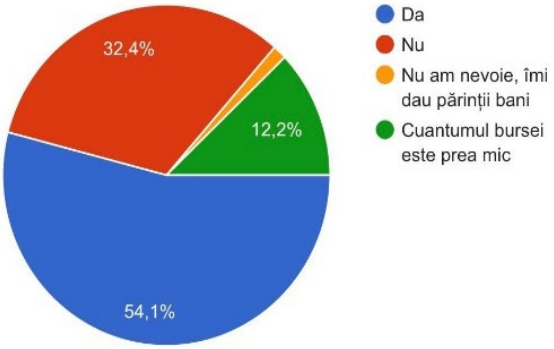
8.What types of investments do you know?



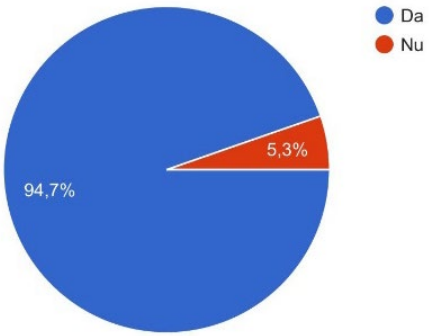
9.Have you ever invested money?



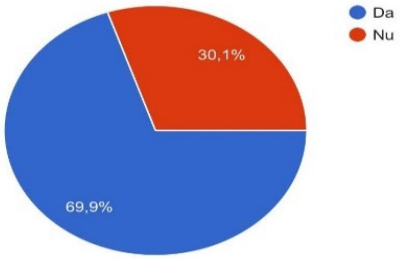
10.The possibility of obtaining a scholarship at school or college stimulates you to learn better?



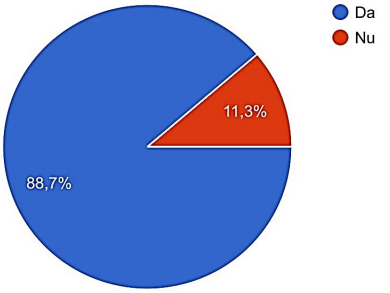
11.Do you always know what debts you have?



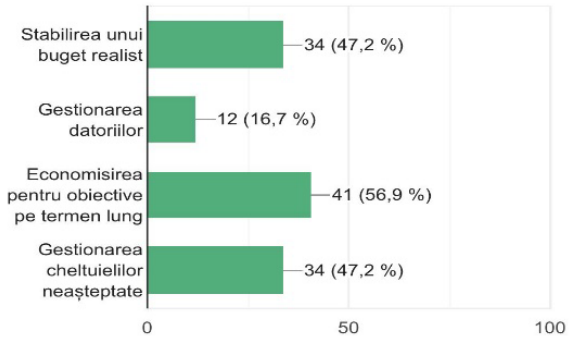
12.The sum of your monthly debts is less than 30% of the value of your total income?



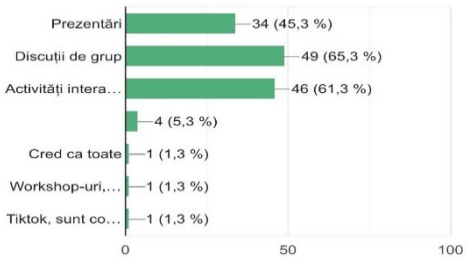
13.Do you pay all your bills in full monthly?



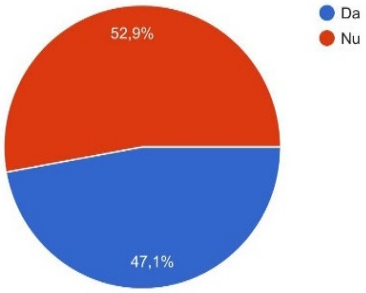
14.What are the main challenges you have with money management and finances?



15.What learning methods or formats do you think would be the most effective for you in terms of financial education? (presentations, group discussions, interactive activities, etc.)



16.The rent or the home loan represents more than 25% of your monthly income?



CONCLUSIONS

The conclusions resulting from the interpretation of the respondents' answers are the following:

1. Where do you live most of the time?
   75 percent of the respondents live in the urban environment, 15 in the rural environment and 10 percent in the USAMVB Campus.
2. How old are you?
   45 percent of respondents are between 18 and 21 years old, 16 percent between 22 and 24 years old, 6 percent between 25 and 27 years old, 9 percent between 28 and 30 years old and 24 percent more than 30 years old.
3. Your gender
   33 percent of respondents are male, 64 percent female and 3 percent do not want to specify their gender.
4. What is the main source of financial information for you?
   For 67 of the respondents, the main source of financial information is the Internet, for 47 percent it's parents, for 25 percent it's teachers, for 21 percent it's courses on financial topics, for 20 percent it's friends, for 1 percent the source is personal experience or the Tiktok application.
5. How confident do you feel in managing your own money?
   Confidence in managing your own money on a scale from 1 to 5, where 1 is not at all and 5 is very confident, for 3 percent of respondents it was 1, for 12 percent it was 2, for 39 percent it was 3, for 24 percent it was 4 and for 23 percent it was 5.
6. Your source of income comes from?
   47 percent of the respondents declared that they work and the source of income is the salary, 35 percent have as a source of income an amount allocated by parents or guardians, 11 percent have as a source of income a scholarship or other type of allowance and 8 percent other sources.
7. How much do you save monthly?
   30 percent of the respondents declared that they save between 10% and 20% of their income, 27 percent save less than 10% of their income, 23 percent do not save, 14 percent save more than 30% of their income and 6 percent save between 21 % and 30%.
8. What types of investments do you know?
   Regarding the knowledge of the types of investments, 84 percent of the respondents declared that they know about bank deposits, 63 percent about shares in companies and cryptocurrencies, 32 percent about mutual funds and bonds, 17 percent about bonds, 1 percent about gold and 1 percent does not know any type of investments.
9. Have you ever invested money?
   Regarding the investment of money, 45 percent of the respondents declared that they invested money, while 55 percent did not invest money.
10. The possibility of obtaining a scholarship at school or college stimulates you to learn better?
    The possibility of obtaining a scholarship stimulates 54 percent of the respondents to learn better, 32 percent said that it does not stimulate them, 12 percent said that the amount of the scholarship is too small and 2 percent stated that the money received from their parents is sufficient.
11. Do you always know what debts you have?
    95 percent of the respondents declared that they always know what debts they have, while 5 percent said that they do not know.

12. The sum of your monthly debts is less than 30% of the value of your total income?

70 percent of the respondents declared that the sum of their monthly debts is less than 30% of the value of the income, while 30 percent said no.

13. Do you pay all your bills in full monthly?

89 percent of the respondents declared that they pay their monthly bills in full, while 11 percent said that they do not.

14. What are the main challenges you have with money management and finances?

57 of the respondents stated that saving for long-term goals is a challenge related to managing money and personal finances, 47 percent that establishing a realistic budget and managing expenses is a challenge related to managing money and personal finances and 17 percent that managing debts represent a challenge in relation to the management of money and personal finances.

15. What learning methods or formats do you think would be the most effective for you in terms of financial education? (presentations, group discussions, interactive activities, etc.)

65 of the respondents declared that the effective learning methods for their financial education are group discussions, 61 percent interactive activities, 45 percent workshop-type presentations, and the rest for all the proposed options.

16. The rent or the home loan represents more than 25% of your monthly income?

53 of the respondents declared that the rent or the interest on the home loan does not represent less than 25% of the monthly income, and 47 percent said yes.

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SERIES WITH COMPUTABLE SUM

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Abstract

In mathematics, a series is a sum with an infinite number of terms. Its terms can be either numbers, or functions. A series is called convergent if the sequence of partial sums is convergent (i.e. it has a finite limit). It is easier to study the nature or convergence of a series, because there exist many criteria, but computing the sum of the series may be very difficult or impossible. From a practical perspective, this is not a problem most of the times, as the sum can by approximated if we can find its convergence "speed". In this article we study some series whose sum can be computed exactly.

Key words*: computable sum, convergence, series.*

INTRODUCTION

The notion of series

In mathematics, a series is a sum with an infinite number of terms. We are interested if such a sum can be correctly defined, that is if it has a limit, and, if possible, to calculate it. A series with a finite sum is called convergent. However, it is easier to study the convergence of a sum, because there exist several criteria for that, than to calculate its sum. Sometimes it is very difficult, or even impossible to compute the sum of a series, but most of the times this is not a practical issue, as it can be approximated.

Definition 1. (Colojoară, 1983) Let $(x_n)_{n\geq 1}$ be a sequence of real numbers. A series is a sum with an infinite number of terms of the form

$$x_1 + x_2 + \cdots + x_n + \cdots$$

which can be written

$$\sum_{n=1}^{\infty} x_n \ or \sum_{n\geq 1} x_n$$

Remark 1.

$$\sum_{n\geq 1} x_n \neq \lim_{n\to\infty} x_n$$

Remark 2. x_n is called the general term of the series. A series may start from any natural index k, and we write

$$x_k + x_{k+1} + \cdots + x_n + \cdots = \sum_{n=k}^{\infty} x_n = \sum_{n\geq k} x_n$$

The convergence and the sum of a series

We denote $S_n = x_k + x_2 + \cdots + x_n$ the partial sum of order n of a series

$$\sum_{n\geq k} x_n$$

Remark 3. A sequence of real numbers (a_n) is called convergent to a number $L \in \mathbb{R}$ if

$$\lim_{n\to\infty} x_n = L$$

Definition 2. The series $\sum x_n$ is convergent if and only if the sequence (S_n) e convergent, more exactly

$$\sum x_n = a \overset{def}{\Longleftrightarrow} \lim_{n\to\infty} S_n = a$$

The number a is called the sum of the series.

Remark 4. The starting rank of a series does not affect its convergence, but it influences the value of the sum.

A theorem of Weierstrass states that a monotonous sequence (i.e. increasing or decreasing) and bounded is convergent. Therefore:

The nature (convergence) of a series with positive terms

$$\begin{cases} convergent\ (if\ bounded): \sum x_n = a \in \mathbb{R} \\ divergent\ (if\ unbounded): \sum x_n = \infty \end{cases}$$

Definition 3. The series $\sum x_n$ is called absolutely convergent if $\sum |x_n|$ is convergent.

Remark 5. It is easy to see that an absolutely convergent series is also convergent.

Definition 4. If (a_n) is a sequence of real numbers and $a \in \mathbb{R}$, then by a power series we mean a series of the form

$$\sum_{n\geq 0} a_n(x-a)^n$$

The domain of convergence of power series is given by the following

Theorem 1. (Boboc, 1999) The interval of convergence of the series

$$\sum_{n\geq 0} a_n(x-a)^n$$

is $I_C \supseteq (a-\rho, a+\rho)$

where $\rho = \overline{\lim_{n\to\infty}} \frac{|a_n|}{|a_{n+1}|}$

is called the radius of convergence.

MATERIALS AND METHODS

The general technique for computing the sum of a series

The main idea for computing the sum of a series

$$\sum_{n\geq 1} x_n$$

is to consider the partial sum

$$S_n = \sum_{k=1}^{n} x_k = x_1 + x_2 + \cdots + x_n$$

Then

$$\sum_{n\geq 1} x_n = \lim_{n\to\infty} S_n$$

Example 1. (Martin, 2008) Find the sum of the series

$$\sum_{n\geq 1} \ln\left(\frac{n+1}{n}\right)$$

Solution. The partial sum is

$$S_n = \sum_{k=1}^{n} \ln\left(\frac{k+1}{k}\right)$$

$$= \ln\left(\frac{2}{1}\right) + \ln\left(\frac{3}{2}\right) + \ldots + \ln\left(\frac{n}{n-1}\right) + \ln\left(\frac{n+1}{n}\right)$$

$$= \ln\left(\frac{2}{1}\cdot\frac{3}{2}\cdot\ldots\cdot\frac{n}{n-1}\cdot\frac{n+1}{n}\right)$$

$$= \ln(n+1) \to \infty$$

Thus,

$$\sum_{n\geq 1} \ln\left(\frac{n+1}{n}\right) = \infty\ (divergent)$$

Classical series

There are two important series that can be used in the comparison tests:

1) The generalized harmonic series:

$$\sum_{n\geq 1} \frac{1}{n^\alpha} = 1 + \frac{1}{2^\alpha} + \frac{1}{3^\alpha} + \cdots$$

$$is\ \begin{cases} conv, & \alpha > 1 \\ div, & \alpha \leq 1 \end{cases}$$

Example 2.

$$\sum_{n\geq 1} \frac{1}{n^2} = 1 + \frac{1}{2^2} + \frac{1}{3^2} + \cdots = \frac{\pi^2}{6}$$

is convergent because $\alpha = 2 > 1$.

Remark 6. The fact that its sum is $\frac{\pi^2}{6}$ can be proved, for example, with advanced techniques of trigonometry and complex analysis or by Bernoulli numbers. This shows that a series' sum is sometimes hard or even impossible to calculate.

Example 3.

$$\sum_{n\geq 1} \frac{1}{n} = \sum_{n\geq 1} \frac{1}{n^1} = 1 + \frac{1}{2} + \frac{1}{3} + \cdots = \infty$$

is divergent because $\alpha = 1 \leq 1$.

Remark 7. The divergence of this series seems a little bit for a beginner, as its general term becomes smaller and smaller $\left(\frac{1}{n} \to 0\right)$.

2) The geometric series:

$$\sum_{n\geq 0} a^n = 1 + a + a^2 + \cdots$$

$$is\ \begin{cases} conv = \dfrac{1}{1-a}, & for\ |a| < 1 \\ div, & for\ |a| \geq 1 \end{cases} \qquad (1)$$

Example 4.

$$\sum_{n\geq 0}\frac{1}{3^n}=\sum_{n\geq 0}\left(\frac{1}{3}\right)^n$$

is convergent because $a=\frac{1}{3}<1$, and its sum is

$$\sum_{n\geq 0}\left(\frac{1}{3}\right)^n=\frac{1}{1-a}=\frac{1}{1-\frac{1}{3}}=\frac{1}{\frac{2}{3}}=\frac{3}{2}$$

Taylor series

Taylor series were first introduced by the English mathematician Brook Taylor in 1715. Every elementary function can be locally approximated (i.e. written as a Taylor series) around the point a by a sum of its derivatives of the form

$$f(x)=\sum_{n\geq 0}\frac{f^{(n)}(a)}{n!}(x-a)^n$$

where $x\in(a-\varepsilon,a+\varepsilon),\ \varepsilon>0$ (2)

A Taylor series at the point $a=0$ is also called a Maclaurin series, after the Scottish mathematician Collin Maclaurin who made use of them in the 18th century:

$$f(x)=\sum_{n\geq 0}\frac{f^{(n)}(0)}{n!}x^n,\qquad x\in(-\varepsilon,\varepsilon)\qquad(3)$$

These are Taylor (Maclaurin) series for some common functions:

$$e^x=\sum_{n\geq 0}\frac{x^n}{n!}=1+x+\frac{x^2}{2!}+\frac{x^3}{3!}+\cdots$$

$$,\quad x\in\mathbb{R}\qquad(4)$$

$$\sin x=\sum_{n\geq 0}\frac{(-1)^n x^{2n+1}}{(2n+1)!}$$

$$=x-\frac{x^3}{3!}+\frac{x^5}{5!}-\frac{x^7}{7!}\ldots,\quad x\in\mathbb{R}\qquad(5)$$

$$\cos x=\sum_{n\geq 0}\frac{(-1)^n x^{2n}}{(2n)!}$$

$$=1-\frac{x^2}{2!}+\frac{x^4}{4!}-\frac{x^6}{6!}\ldots,\quad x\in\mathbb{R}\qquad(6)$$

$$\operatorname{arctg} x=\sum_{n\geq 0}\frac{(-1)^n x^{2n+1}}{2n+1}$$

$$=x-\frac{x^3}{3}+\frac{x^5}{5}-\frac{x^7}{7}+\cdots,\ |x|\leq 1\qquad(7)$$

$$\ln(1+x)=\sum_{n\geq 0}\frac{(-1)^n x^{n+1}}{n+1}$$

$$=x-\frac{x^2}{2}+\frac{x^3}{3}-\frac{x^4}{4}+\cdots,\quad x\in(-1,1]\qquad(8)$$

The Taylor series are a special case of power series. Regarding the derivation or integration of power series we have the following

Theorem 2. (Nicolescu et al., 1971) Let

$$f(x)=\sum_{n\geq 0}a_n(x-a)^n$$

be a power series with the radius of convergence $\rho>0$. Then the series converges absolutely and uniformly on every compact interval $[\alpha,\beta]\subseteq I_C$. So

a) f is derivable and

$$f'(x)=\sum_{n\geq 0}na_n(x-a)^{n-1}$$

b) f is integrable and

$$\int f(x)dx=\sum_{n\geq 0}\frac{a_n}{n+1}(x-a)^{n+1}$$

The series of the derivative and of the primitive have the same radius of convergence ρ.

RESULTS AND DISCUSSIONS

First will give some examples using the general idea of summation. In general, when we want to compute a sum, we try to write its general term as a difference, so that we can simplify terms. A sum written in this way is called a "telescopic sum".

Example 5.

$$\sum_{n\geq 1}\frac{1}{n(n+1)}$$

Solution. First, we notice that $\frac{1}{k(k+1)}=\frac{k+1-k}{k(k+1)}=\frac{k+1}{k(k+1)}-\frac{k}{k(k+1)}=\frac{1}{k}-\frac{1}{k+1}$.

Therefore

$$S_n=\sum_{k=1}^{n}\frac{1}{k(k+1)}$$

$$=\frac{1}{1\cdot 2}+\frac{1}{2\cdot 3}+\cdots+\frac{1}{(n-1)\cdot n}+\frac{1}{n\cdot(n+1)}$$

$$=\frac{1}{1}-\frac{1}{2}+\frac{1}{2}-\frac{1}{3}+\cdots+\frac{1}{n-1}-\frac{1}{n}+\frac{1}{n}$$

$$-\frac{1}{n+1}$$

$$= 1 - \frac{1}{n+1} \to 1$$

As a result:

$$\sum_{n\geq 1} \frac{1}{n(n+1)} = 1$$

Example 6.

$$\sum_{n\geq 1} \frac{1}{n(n+1)(n+2)}$$

Solution. First, we notice that

$$\frac{1}{k(k+1)(k+2)} = \frac{1}{2} \cdot \frac{k+2-k}{k(k+1)(k+2)}$$
$$= \frac{1}{2}\left(\frac{k+2}{k(k+1)(k+2)} - \frac{k}{k(k+1)(k+2)}\right)$$
$$= \frac{1}{2}\left(\frac{1}{k(k+1)} - \frac{1}{(k+1)(k+2)}\right)$$

Therefore

$$S_n = \frac{1}{2}\sum_{k=1}^{n}\left(\frac{1}{k(k+1)} - \frac{1}{(k+1)(k+2)}\right)$$
$$= \frac{1}{2}\left(\frac{1}{1\cdot 2} - \frac{1}{2\cdot 3} + \frac{1}{2\cdot 3} - \frac{1}{3\cdot 4} + \frac{1}{(n-1)n} - \frac{1}{n(n+1)} + \frac{1}{n(n+1)} - \frac{1}{(n+1)(n+2)}\right)$$
$$= \frac{1}{2}\left(\frac{1}{1\cdot 2} - \underbrace{\frac{1}{(n+1)(n+2)}}_{\downarrow\ 0}\right) \to \frac{1}{2}\cdot\frac{1}{2} = \frac{1}{4}$$

As a result:

$$\sum_{n\geq 1} \frac{1}{n(n+1)(n+2)} = \frac{1}{4}$$

Remark 8. Another idee would have been to use the decompositions into simple fractions

$$\frac{1}{x(x+1)(x+2)} = \frac{A}{X} + \frac{B}{X+1} + \frac{C}{X+2}$$

but it would be harder to work in this manner.

Example 7. Generalization

$$\sum_{n\geq 1} \frac{1}{n(n+1)\ldots(n+p)} = \frac{1}{p!\cdot p} \qquad (9)$$

Proof. (Nițu, 2024) We artificially create at the numerator the difference between the maximum and minimum factors of the denominator:

$$\frac{1}{k(k+1)\ldots(k+p)} = \frac{1}{p}\cdot\frac{k+p-k}{k(k+1)\ldots(k+p)}$$
$$= \frac{1}{p}\left(\frac{1}{k(k+1)\ldots(k+p-1)} - \frac{1}{(k+1)(k+2)\ldots(k+p)}\right) \qquad (10)$$

The continuation, as in Example 6, is left to the reader.

Calculations using the geometric series

Example 8.

$$\frac{1}{2} + \frac{1}{2^2} + \frac{1}{2^3} \ldots = \sum_{n\geq 1}\left(\frac{1}{2^n}\right) = \sum_{n\geq 0}\left(\frac{1}{2^n}\right) - 1 = \frac{1}{1-\frac{1}{2}} - 1 = 2 - 1 = 1 \qquad (11)$$

Remark 9. Zeno's arrow paradox in philosophy

Zeno of Elea (490-430 b.Ch.) was a pre-Socratic Greek philosopher.

In the arrow paradox (Nițu, 2024), Zeno states that for motion to occur, an object must change its position. He gives an example of an arrow in flight. He states that at instant of time, the arrow is neither moving to where it is, nor to where it is not. It cannot move to where it is not, because no time elapses for it to move there; it cannot move to where it is, because it is already there. In other words, at every instant of time there is no motion occurring. If everything is motionless at every instant, and time is entirely composed of instants, then motion is impossible.

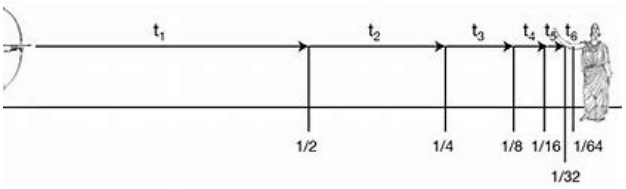

Figure 1. Zeno's paradox

In fact, this paradox shows that time is infinitely divisible, and can be better understood with the above series:

$$\frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \ldots = 1$$

which explains that, when adding all the segments, the arrow reaches its target.

Example 9.

$$\sum_{n\geq 1}\frac{n^2}{3^n}$$

Solution. (Nițu, 2024) From (1) we have

$$\sum_{n\geq 0}a^n = 1+a+a^2+\cdots = \frac{1}{1-a}\ ,$$

$$\forall a\in(-1,1)$$

By denoting $x=a\in(-1,1)$ we obtain:

$$\sum_{n\geq 0}x^n = 1+x+x^2+x^3+x^4\ldots$$

$$=\frac{1}{1-x}=f(x),\qquad \forall\, x\in(-1,1) \quad (12)$$

Using Theorem 2, by deriving:

$$\sum_{n\geq 0}nx^{n-1} = 1+2x+3x^2+4x^3+\cdots$$

$$=\frac{1}{(1-x)^2}=f'(x),\qquad \forall\, x\in(-1,1) \quad (13)$$

Deriving one more time, one has:

$$\sum_{n\geq 0}n(n-1)x^{n-2} = 2+6x+12x^2+\cdots$$

$$=\frac{2}{(1-x)^3}=f''(x),\forall\, x\in(-1,1) \quad (14)$$

Taking $x=\frac{1}{3}\in(-1,1)$ in (13):

$$\sum_{n\geq 0}\frac{n}{3^{n-1}}=\frac{1}{\left(1-\frac{1}{3}\right)^2}=\frac{1}{\frac{4}{9}}=\frac{9}{4}\ \ |\cdot\frac{1}{3}$$

Thus

$$\sum_{n\geq 0}\frac{n}{3^n}=\frac{3}{4} \quad (15)$$

Taking $x=\frac{1}{3}\in(-1,1)$ in (14):

$$\sum_{n\geq 0}\frac{n(n-1)}{3^{n-2}}=\frac{2}{\left(1-\frac{1}{3}\right)^3}=\frac{2}{\frac{8}{27}}=2\cdot\frac{27}{8}$$

$$=\frac{27}{4}\ \ |\cdot\frac{1}{9}$$

we obtain

$$\sum_{n\geq 0}\frac{n(n-1)}{3^n}=\frac{1}{12} \quad (16)$$

So

$$\frac{1}{12}=\sum_{n\geq 0}\frac{n(n-1)}{3^n}$$

$$=\sum_{n\geq 0}\frac{n^2}{3^n}-\sum_{n\geq 0}\frac{n}{3^n}=\sum_{n\geq 0}\frac{n^2}{3^n}-\frac{3}{4}$$

It results

$$\sum_{n\geq 0}\frac{n^2}{3^n}=\frac{3}{4}+\frac{1}{12}=\frac{10}{12}=\frac{5}{6}$$

Series using the Taylor development of e^x

Example 10.

$$1+\frac{1}{1!}+\frac{1}{2!}+\cdots=$$

$$\sum_{n\geq 0}\frac{1^n}{n!}=e^1=e$$

Example 11.

$$1+\frac{3}{1!}+\frac{3^3}{2!}+\frac{3^5}{3!}\ldots=$$

$$\sum_{n\geq 1}\frac{3^{2n-1}}{n!}=\frac{1}{3}\sum_{n\geq 1}\frac{3^{2n}}{n!}=\sum_{n\geq 1}\frac{(3^2)^n}{n!}$$

$$=\frac{1}{3}\left(\sum_{n\geq 0}\frac{9^n}{n!}-1\right)=\frac{e^9-1}{3}$$

Sometimes the series may look difficult but it has a nice sum, as in the following

Example 12.

$$1+\frac{\ln 2024}{1!}+\frac{\ln^2 2024}{2!}+\frac{\ln^3 2024}{3!}\ldots=$$

$$\sum_{n\geq 0}\frac{\ln^n 2024}{n!}=e^{\ln 2024}=2024$$

Other examples using Taylor series

Example 13.

$$1-\frac{1}{3!}+\frac{1}{5!}-\frac{1}{7!}\ldots=$$

$$\sum_{n\geq 0}\frac{(-1)^n 1^{2n+1}}{(2n+1)!}=\sin 1\approx 0{,}841$$

Remark 10. Here $\sin 1=\sin(1\,rad)$. A series with the sum $\sin 1^o=\sin\left(\frac{\pi}{180}\,rad\right)\approx 0{,}017$ is

$$\sum_{n\geq 0}\frac{(-1)^n\left(\frac{\pi}{180}\right)^{2n+1}}{(2n+1)!}=\sin\left(\frac{\pi}{180}\,rad\right)$$

$$=\sin 1^o$$

Example 14.

$$\sum_{n\geq 0}\frac{(-1)^n\pi^{2n+1}}{(2n+1)!}=\sin\pi=0$$

Example 15.

$$1-\frac{1}{2!}+\frac{1}{4!}-\frac{1}{6!}\ldots$$

$$\sum_{n\geq 0}\frac{(-1)^n 1^{2n}}{(2n)!}=\cos 1$$

Example 16.

$$1-\frac{1}{3}+\frac{1}{5}-\frac{1}{7}+\cdots$$

$$\sum_{n\geq 0}\frac{(-1)^n 1^{2n+1}}{2n+1}=\operatorname{arctg} 1=\frac{\pi}{4}$$

From here we obtain one of most beautiful representation of the number π (even though not the fastest converging):

$$\pi=4\left(1-\frac{1}{3}+\frac{1}{5}-\frac{1}{7}+\cdots\right)$$

Example 17.

$$1-\frac{1}{2}+\frac{1}{3}-\frac{1}{4}+\cdots=$$

$$\sum_{n\geq 0}\frac{(-1)^n 1^{n+1}}{n+1}=\ln(1+1)=\ln 2$$

Example 18.

$$\left(\sqrt{e}-1\right)-\frac{\left(\sqrt{e}-1\right)^2}{2}+\frac{\left(\sqrt{e}-1\right)^3}{3}-\frac{\left(\sqrt{e}-1\right)^4}{4}+\cdots=$$

$$\sum_{n\geq 0}\frac{(-1)^n\left(\sqrt{e}-1\right)^{n+1}}{n+1}=\ln\left(1+\sqrt{e}-1\right)$$

$$=\ln\sqrt{e}=\ln\left(e^{\frac{1}{2}}\right)=\frac{1}{2}\ln e=\frac{1}{2}$$

SOME PRACTICAL APPLICATIONS OF SERIES

Taylor series

Taking a sufficient number of terms, one may approximate any common function at a point with the desired number of decimals.

Taylor series are the main tool for approximating the values of elementary functions on any scientific calculator, although there are some extra methods of improving the precision.

Fourier series

They were first used at the beginning of the 19th century by Joseph Fourier in order to find solutions to the heat equation.

They have applications in physics, signal processing, image processing, conversion of special data into frequency data etc.

An usual Fourier series is a representation of a periodic function $f(x)$ on $[-\pi,\pi]$ as a series of sines and cosines (Nițu C.C., 2024)):

$$f(x)=\frac{1}{2}a_0+\sum_{n\geq 1}a_n\cos nx+\sum_{n\geq 1}b_n\cos nx$$

The coefficients have the following formulas:

$$a_0=\int_{-\infty}^{\infty}f(x)dx$$

$$a_n=\frac{1}{\pi}\int_{-\pi}^{\pi}f(x)\cos nx\,dx$$

$$b_n=\frac{1}{\pi}\int_{-\pi}^{\pi}f(x)\sin nx\,dx$$

CONCLUSIONS

Series play an important role in or outside mathematics and they are closely related to the overall advances of science and humanity.

Although the convergence of a series is easier to study, the sum of a series is sometimes hard to find, but it might be approximated.

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APPLICATIONS OF MATHEMATICS IN FORESTRY

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Abstract

This research introduces a method for managing forestry operations by implementing an automated system to calculate the volume of logs using Maple software. This approach integrates data collection with modern software tools to enhance accuracy and efficiency in estimating timber volume. Despite challenges like training needs and initial setup costs this strategy represents an advancement, in leveraging technology and mathematical applications within forestry, environmental management and conservation efforts.

Key words*: felled log volume, rules, symbolic algebra software.*

INTRODUCTION

In this paper, we aim to optimize and automate the method for calculating the volume of a felled log using a mathematically oriented programming environment. We have chosen Maple software, produced by Maplesoft, as the programming environment for developing an automatic calculation algorithm.

Forestry involves the management and preservation of forests to meet society's often multiple needs, including use of forest resources, habitat conservation and ecological equilibrium maintenance. This area encompasses the cultivation and administration of forest systems ranging from timber production to protection and enhancement. The notion of forest exploitation defines, in fact, the two sides of the activities specific for enhancing the value of the wood mass: the transformation of the marked trees into parts with certain characteristics and their transfer to places accessible to users. This activity can be defined in two ways, namely: the productive side - by structure and characteristics the production process; the scientific side - through the theoretical knowledge through which it is regulated carrying out this process (Ciubotaru, 2007).

These intricate ecosystems provide homes for a range of plant and animal species contributing to the preservation of biodiversity. Moreover forests are indispensable for existence by providing resources like wood regulating climate purifying water and air well as controlling soil erosion (Şimonca, 2022). Furthermore, forests are essential for human life, offering resources such as wood, climate regulation, water and air purification, and soil erosion control. Calculating timber mass is crucial for managing forests. Monitoring their resources. This process involves determining the volume of wood in an area for purposes such as sustainable management practices assessing carbon stocks conserving biodiversity and planning economically (Vlaşin, 2022).

Mathematics also plays a role, in forestry applications; in our research study it is utilized to comprehend and sustainably manage forest resources. Throughout the course of history the utilization of principles, in forestry has diversified. Mathematics has the tools and methodologies for conducting research formulating plans and making decisions within the forestry industry (Matei, 2023). These principles are instrumental in building models that depict the growth and evolution of trees over time by considering factors such as age, weather conditions, soil composition and forest management practices. These factors play a role

in estimating wood volume assessing forest vitality and predicting developments in forest ecosystems. By applying theories and methods foresters are able to optimize the utilization of forest resources while taking into account objectives and limitations. The application of mathematics is crucial for ensuring management of forests by aiding in the development and implementation of policies that promote conservation and sustainable utilization of forest resources (Matei, 2006). The forestry sector heavily relies on assessment and management of timber resources to operate effectively. One key aspect is calculating timber mass which helps determine the quantity of wood that can be harvested from a given forest area or logging site.

These formulas were derived from the geometry assumption that also implicitly assumes no taper and sweep were present, rarely true in reality, and that the logs are circular in cross-section; thus, the log volumes can be calculated as they are for geometric solids (Barclay et al., 2015) Various techniques exist for computing timber volume, within forestry operations based on goals related to resource evaluation and management:

- Simplified cylindrical method; this technique computes log volume as if it were a cylinder. This approach may seem straightforward. It could potentially overstate the volume as it does not consider the irregular shapes of logs (Şimonca, 2022).
- Conical method: Considers the log as a frustum of a cone, allowing for a more accurate volume estimate for logs that taper at one end.
- Huber's method: Similar to the simplified cylindrical method but uses the average diameter at the log's ends to calculate the cross-sectional area (Şimonca, 2022).
- Smalian's method: Calculates volume by multiplying the log's length by the average area of the cross-sections at the ends. It is useful for highly irregular logs and provides an accurate estimate when diameter differences are significant (Şimonca, 2022).
- Doyle's method: A specific method used mainly in North America, which provides an estimate of the wood volume in board feet, favouring the wood buyer as it tends to underestimate the actual volume.
- Forest inventory approach; Involves conducting an assessment of forest resources including measuring tree diameters and heights in a systematic representation of the forest. By utilizing data obtained during this inventory process one can estimate wood volume within an area.
- Technology-based methods: LIDAR (Light Detection and Ranging) are utilized to gather information about forest structures and volumes. This technique employs sensors mounted on aircraft or ground vehicles to measure distances and create three maps of the forest. By utilizing LIDAR data accurate calculations of the forests volume and other characteristics can be achieved.

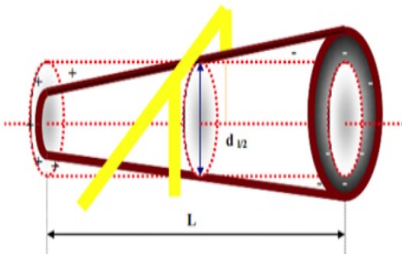

Figure 1. Huber's method (source: https://www.forestdesign.ro)

Various methods are employed in forestry to determine log volume with the selection depending on the study's goals and the availability of resources and technology, at present, the majority of timber measurements are taken manually (Moskalik et al., 2022).

As we know Huber's method uses the average diameter at the log's ends to calculate the cross-area (Figure 1), we propose to enhance this method by measuring in multiple points Huber's digitizing, using the internet and personal computers (Figure 2).

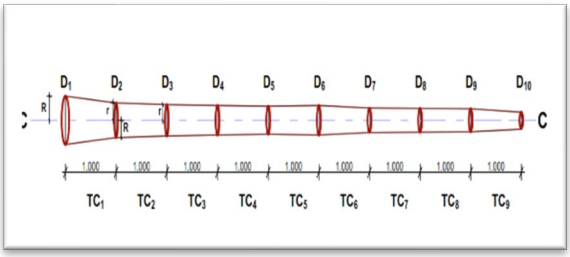

Figure 2. Collecting raw data

The objective of this study is to streamline and automate the process of determining log volumes through a driven programming environment. We have opted for Maple software and Google Sheets as the platform, for creating an automated calculation algorithm.

MATERIALS AND METHODS

The measurement of round wood is probably one of the most important elements of the wood supply chain, the main reason of the importance of wood measurement is the economic impact, as wood cubage is one of the essential elements of wood value (Berendt et al., 2021).

In terms of materials and methodology Maple is an algebra system that performs mathematical computations and visualizations. Widely used in industrial settings this software aids in solving, analyzing and visualizing models. It boasts a programming language that enables users to create custom functions execute algorithms and manipulate different types of data. This software also has a programming language for scripting purposes allowing users to automate tasks and enhance the software's capabilities. Furthermore, it can be seamlessly integrated with tools and programming languages, like MATLAB, Excel and Python to provide a working environment. (https://www.maplesoft.com/company/about/).

In this programming environment, we create a procedure that automatically calculates the volume of felled logs. A procedure is a user-defined function, a block of code that performs a specific task or calculates a specific value. Procedures allow for code reuse, making programs more modular.

A procedure is defined using the keyword "proc" followed by any input parameters between parentheses and the block of code between "begin" and "end". The procedure's result is the last evaluated expression or can be explicitly specified using the "return" instruction. Procedures can accept zero or more parameters. These parameters can be of any type, including numbers, symbols, lists, sets, or even other procedures. In a procedure, variables can be local (defined inside the procedure and accessible only there) or global (defined outside the procedure and accessible anywhere in the document). Procedures can be recursive, meaning they can call themselves to solve sub-problems of a larger problem in a recursive manner (Pop, 2023). Procedures are a fundamental tool in Maple, allowing users to create custom and efficient code for solving specific problems.

The automatic calculation procedure for felled logs that we developed is based on the conical method. This method approach to approximate the volume of irregularly shaped objects like logs is to model each segment as a frustum of a cone (a conical section) and then sum the volumes of these sections. The formula for the volume of a frustum of a cone is:

$$V = \frac{h\pi}{3}(R^2 + Rr + r^2) \qquad (1)$$

where:

- V - the volume of the frustum,
- h - the height (or length) of the frustum (in this case, 1 meter),
- R - the radius of one end of the frustum,
- r - the radius of the other end of the frustum.

The study was developed in Romania, Cluj County, near the town of Cluj Napoca, within the Făget Forest.

Figure 3. The area where the research was conducted (source: Google Earths engine)

The trapezoidal rule is based on integral calculus, but the work is carried out by first-year students who are in process to assimilate this information. As it is known the integration process in based on passing to the limit of a Riemann sum.

As a first step, we collect data from the field, measuring the logs (Figure 4).

Figure 4. Collecting Data

After these data was entered in Google Sheets (Figure 5), were downloaded to the computer where the procedure is located. Subsequently, these results obtained from the collected data will be imported into the software, and the procedure that we created will be called to perform the calculations automatically (Figures 6, 7).

Cod Buștean măsurat	Distanța între măsurători (m)	Intervale Măsurate (m)									
		1	2	3	4	5	6	7	8	9	10
1	1	0,57	0,41	0,37	0,35	0,33	0,35	0,29	0,28	0,27	0,20
2	1	0,65	0,63	0,56	0,53	0,46	0,39	0,34	0,33	0,32	0,28
3	1	0,72	0,70	0,63	0,60	0,53	0,46	0,41	0,40	0,39	0,35
4	1	0,79	0,77	0,70	0,67	0,60	0,53	0,48	0,47	0,46	0,42
5	1	0,86	0,84	0,77	0,74	0,67	0,60	0,55	0,54	0,53	0,49
6	1	0,84	0,82	0,75	0,72	0,65	0,58	0,53	0,52		
7	1	0,82	0,80	0,73	0,70	0,63	0,56	0,51	0,50		
8	1	0,80	0,78	0,71	0,68	0,61	0,54	0,49	0,48		
9	1	0,78	0,76	0,69	0,66	0,59	0,52	0,47	0,46		
10	1	0,76	0,74	0,67	0,64	0,57	0,50	0,45	0,44		
11	1	0,74	0,72	0,65	0,62	0,55	0,48	0,43	0,42		
12	1	0,72	0,70	0,63	0,60	0,53	0,46	0,41	0,40		
13	1	0,70	0,68	0,61	0,58	0,51	0,44	0,39	0,38		
14	1	0,68	0,66	0,59	0,56	0,49	0,42	0,37	0,36		
15	1	0,66	0,64	0,57	0,54	0,47	0,40	0,35	0,34		
16	1	0,73	0,71	0,64	0,61	0,54	0,47	0,42	0,41		
17	1	0,80	0,78	0,71	0,68	0,61	0,54				
18	1	0,87	0,85	0,78	0,75	0,68	0,61				
19	1	0,84	0,82	0,75	0,72	0,65	0,58				
20	1	0,81	0,79	0,72	0,69	0,62	0,55				
21	1	0,78	0,76	0,69	0,66	0,59	0,52				
22	1	0,75	0,73	0,66	0,63	0,56	0,49				
23	1	0,72	0,70	0,63	0,60	0,53	0,46				
24	1	0,49	0,47	0,40	0,37						
25	1	0,26	0,24	0,17	0,14						
26	1	0,23	0,21	0,14	0,11						
27	1	0,20	0,18	0,11	0,08						
28	1	0,19	0,17	0,10	0,07						
29	1	0,18	0,16	0,09	0,06						
30	1	0,17	0,15	0,08	0,05						

Figure 5. Recording and sorting data from the field

In this study we took measurements of 30 felled trees (Figure 5).

```
# Importăm  lista de măsurători de diametru și lungimea bușteanului
# se preia lista cu date (masurari de diametre la fiecare metru)
  DiametreBustean := [0.57, 0.41, 0.37, 0.35, 0.33, 0.35, 0.29, 0.28, 0.27, 0.20];
# Lungimea totală a busteanului în metri
  Lungime_Buștean := 9 m;
# Afișăm rezultatul
 VolumTotal := VolumBuștean(DiametreBuștean, LungimeBuștean) mc;
```

Figure 6. Procedure Input

```
DiametreBustean := [0.57, 0.41, 0.37, 0.35, 0.33, 0.35, 0.29, 0.28, 0.27, 0.20
Lungime_Buștean := 9 m
VolumTotal := VolumBuștean(DiametreBuștean, LungimeBuștean) mc
```

Figure 7. Procedure Output

Following the completion of the calculations via the procedure, the outcomes were uploaded to Google Sheets to ensure accessibility for all individuals with access to the Drive workspace. Below, you will find a workflow diagram depicting the entire process (Figure 8).

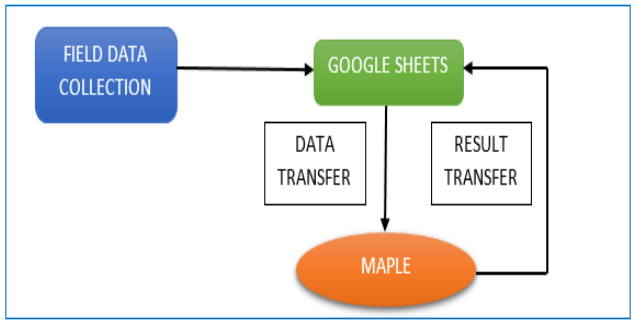

Figure 8. Workflow Diagram

RESULTS AND DISCUSSIONS

This approach not only simplifies and streamlines the process of calculating the volume of timber but also enhances the accuracy and efficiency of forestry operations, due to the procedure's flexibility, which allows for a reduction (or increase) in the measurement distance, this leads to an increase in accuracy. By utilizing software capabilities and automating this approach we can obtain timber volume which is crucial, for forest management and economic planning. The implementation of this technique showcases the potential of integrating software and custom programming in forestry. It opens the way for enhanced research opportunities to conduct analyses of forest resources with accuracy. Furthermore, it highlights the importance of tools in sciences by showcasing their role in promoting effective and sustainable management practices.

Cod Bustean măsurat	Volum Buştean (mc)
1	0.49 mc
2	0.85 mc
3	1.11 mc
4	1.42 mc
5	1.76 mc
6	1.47 mc
7	1.39 mc
8	1.30 mc
9	1.23 mc
10	1.15 mc
11	1.08 mc
12	1.01 mc
13	0.94 mc
14	0.87 mc
15	0.81 mc
16	1.04 mc
17	1.12 mc
18	1.36 mc
19	1.26 mc
20	1.16 mc
21	1.06 mc
22	0.97 mc
23	0.59 mc
24	0.29 mc
25	0.06 mc
26	0.05 mc
27	0.03 mc
28	0.03 mc
29	0.02 mc
30	0.02 mc

Figure 9. Results obtained from the collected data

Integrating field data collection with Google Sheets and processing it using Maple software has optimized efficiency by reducing data analysis time. This automation minimizes errors in calculations ensuring data results (Figure 9). Accurately estimating timber volume is essential, for forestry management practices as it enables planned logging activities that minimize environmental impact while maximizing productivity.

The utilization of models and automation technologies can assist in achieving these goals. This research suggests avenues, for exploration including investigating alternative mathematical models that could enhance the precision of timber volume estimations in real time. Furthermore, incorporating sensing technologies, such as drones equipped with LIDAR capabilities could improve the data collection process by providing detailed and comprehensive information on forest resources. Although the outcomes show promise implementing automated procedures also brings challenges, such as the necessity to train personnel in utilizing Maple software and ensuring the accuracy of field data collection. Additionally setting up and integrating software and hardware systems may require investment.

CONCLUSIONS

In summary employing mathematics through software tools like Maple in forestry not transforms how we approach timber volume calculations but also sets a precedent for integrating technology and mathematics into management and conservation strategies. This fusion is crucial for tackling the issues in forestry and safeguarding the sustainable utilization of our forests, for future generations.

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COMPREHENSIVE REVIEW ON AUTOPHAGIC MECHANISMS AND IMPLICATIONS IN DISEASES OF THE CENTURY

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Abstract

To extend human life expectancy, we must penetrate the mysteries of cellular programs that lead to aging and understand how their malfunction guides us down the paths of senescence and decline. In many degenerative diseases linked to aging, the specific and immediate causes of the disease, such as protein aggregation, arise from the disruption of processes that maintain balance in healthy aging, like autophagy and proteostasis. The cellular process known as autophagy, or cellular self-digestion, is involved in the degradation of proteins and organelles and has a startling number of links to human physiology and illness. For example, microbial infections, cancer, dementia, and ageing itself are all associated with autophagic failure. Autophagy may be involved in the conditions listed above because it has recently been shown to be capable of removing defective cellular structures in addition to producing amino acids for continuous protein synthesis and substrates for energy production during starvation. Surprisingly, autophagy can lead to cell death even though its main function is to protect the cell. Comprehending autophagy might eventually permit scientists and healthcare providers to utilise the mechanism to improve human well-being. The aim of this review is to provide an updated examination of the mechanisms of autophagy, with a focus on its role in protein metabolism and maintaining intracellular homeostasis.

Key words*: ageing and longevity, autophagy, regulatory process.*

INTRODUCTION

The term autophagy was introduced in 1963 at Rockefeller University by the Belgian scientist Christian de Duve (1917-2013), who examined and explained the mechanisms involved in cellular endocytosis, being awarded with Nobel Prize for Physiology and Medicine in 1974. Literally, autophagy means "self-eating", while certain authors may refer to it as "auto-cannibalism". The process of autophagy has recently gained increased attention, following intensive subsequent research by Japanese cell biologist Yoshinori Ōsumi, who also received the Nobel Prize for Medicine in 2016.

Autophagy is differentiated from proteasome-mediated degradation by its ability to remove whole intracellular organelles it can also remove aggregated protein complexes of large or non-selectively targeted substances. As a kind of cellular "self-feeding", autophagy is the cellular process via which cells break down and recycle their internal components. Parts of the cytoplasm are trapped in cytosolic vesicles called autophagosomes, which have a double membrane. The autophagosome's contents are transported to the lysosome, where they undergo degradation and recycling, re-entering the cytosol as amino acids. All eukaryotes engage in autophagy, which can be controlled in response to different nutritional shortages and becomes critical for survival in particular circumstances. Additionally, autophagy plays a significant role in preventing certain types of neurodegenerative diseases and cancer, as well as in eliminating invasive pathogens (Mizushima et al., 2008).

To maintain intracellular homeostasis, protein synthesis and degradation must be balanced; specific environmental signals are translated by various regulatory mechanisms into adaptive responses for growth and development to maintain this balance. When it comes to deterioration, these reactions could be crucial for survival in a variety of stressful situations or for adjusting to particular nutrients (Longo and Anderson, 2022). Autophagy is also upregulated when cells prepare for structural reorganisation, like that which occurs during developmental transitions, or to eliminate detrimental cytoplasmic elements, like those formed after oxidative stress, infection, or protein aggregation buildup. Nutritional status,

hormonal variables, and other indicators like as temperature, oxygen concentrations, and cell density, all play a role in modulating autophagy. Adenosine monophosphate-activated protein kinase (AMPK), Protein Kinase B (Akt), Sirtuin 1 (SIRT1), and Mechanistic Target of Rapamycin Complex 1 (mTOR-1) are just a few of the signalling molecules that gracefully regulate the dynamic process of autophagy (Armstrong and Boggs, 2023). TOR is a key regulatory protein that, during the induction stage, controls the activity of a complex involving the Atg1 kinase. However, the specific target of Atg1 remains unknown. Autophagy is typically thought to be non-specific; nevertheless, certain types of autophagy use proteins that bind and adjust, such Atg 11. It is unclear how Atg 11 ties the load to the autophagosome, a vesicle that sequesters. The process of forming the autophagosome is intricate, and the source of the donor membrane as well as the mechanism of vesicle creation are unknown. Well-characterized lysosomal / vacuolar proteases are necessary for the ultimate disintegration of the sequestered cargo; the functions of lipases, however, remain unclear, and it is not elucidated yet how the lysosome/vacuole membrane is kept intact throughout degradation (Longo and Anderson, 2022).

It may appear unlikely at first that cellular self-feeding might have any advantages. In its most basic form, autophagy reflects the adaptation of a single cell to starvation: in the absence of food in the environment, a cell must use some of its own reserves to sustain itself until conditions improve. For example, in organs such as the liver, autophagy is triggered every day or even every few hours to sustain metabolic processes that produce energy and amino acids via catabolism.

Even if there are in the recent period numerous studies investigating the molecular cascade that governs and executes autophagy, however, many uncertainties remain, despite the considerable progress in understanding the molecular basis of autophagy and identifying the proteins involved in its regulation.

The aim of this review is the revision of up-to-date information regarding the mechanism of autophagy, focusing on its role in protein metabolism and intracellular homeostasis.

MATERIALS AND METHODS

Existing studies related to the mechanism of autophagy, its role in protein metabolism and intracellular homeostasis were gathered to discuss the currently available results. The literature research was carried out in the Scopus database, using initially the keyword "**autophagy**". Then, the research was restricted to scientific papers focused on the molecular mechanism, using the keywords "**autophagy**" + molecular mechanisms + intracellular homeostasis The list of the publications was screened based on the title, authors, and year, and the rest of the studies was excluded. After identifying and screening, 8 research articles were selected.

RESULTS AND DISCUSSIONS

As stated before, autophagy is a fundamental cellular process responsible for degrading and recycling intracellular components, playing a critical role in maintaining cellular homeostasis, responding to stress, and regulating various physiological functions such as metabolism, immunity, and aging.

Autophagy classification

Autophagy can be classified based on several criteria, namely the molecular mechanisms involved, the specificity of selectivity, and the cellular organelles or structures that are degraded and recycled.

i) Pathways of cellular maintenance and degradation

Autophagy can be non-selective or selective depending on the specificity with which cellular components are selected and degraded.

Non-selective autophagy involves the general degradation of cellular components, while selective autophagy targets specific cellular organelles or structures, such as mitochondria, protein aggregates, or pathogens. Non-selective autophagy occurs when a cell degrades its cellular components in a general manner, without regard to their specificity or state. It is a more general process of recycling cellular components and helps maintain cellular homeostasis by eliminating damaged organelles

or denatured proteins. An example of non-selective autophagy would be when a cell needs additional energy or when it faces a stressful environment, such as famine or oxidative stress. In these situations, non-selective autophagy can be activated to degrade and recycle portions of the cytoplasm and cellular organelles, thereby releasing basic molecules and essential nutrients to maintain cell function. It is as the cell is cleaning out unwanted deposits to ensure proper functioning.

In contrast, selective autophagy is a process in which the cell selectively degrades certain cellular components. In addition to the non-selective recycling of nutrients, autophagy degrades specific cargoes such as lipids (lipophagy), pathogens (xenophagy), protein aggregates (aggrephagy / proteophagy), the endoplasmic reticulum (reticulophagy / ER-phagy), mitochondria (mitophagy), peroxisomes (pexophagy), the nucleus (nucleophagy), and even lysosomes themselves (lysophagy).

This process is regulated by certain proteins and specific receptors and helps eliminate cellular components that pose a risk to cellular integrity and function. Selective autophagy in mammals is mediated by a number of receptors, such as toll interacting protein (TOLLIP), sequestosome1 (SQSTM1), neighbour NBR1 (breast cancer type 1), optineurin (OPTN), FUN14 domain containing 1 (FUNDC1), prohibitin 2 (PHB2), reticulophagy regulator 1 (RETREG1), calcium-binding and coiled-coil domain 2 (CALCOCO2), and nuclear FMR1 interacting protein 1 (Meijer and Codogno, 2006).

Thus, selective autophagy is a more specific and targeted process, while non-selective autophagy is more general and involves the general recycling of cellular components. Both types of autophagy are essential for maintaining proper cellular health and function.

ii) Molecular mechanism

Based on the molecular mechanisms involved in the formation process and degradation of autophagosomes, autophagy can be classified in microautophagy, macroautophagy, and chaperone-Mediated Autophagy (CMA), which differ in their mechanisms and functions (Figure 1). While CMA selectively destroys only soluble proteins, micro- and macroautophagy can engulf huge structures using both selective and non-selective methods processes (Mizushima et al., 2008).

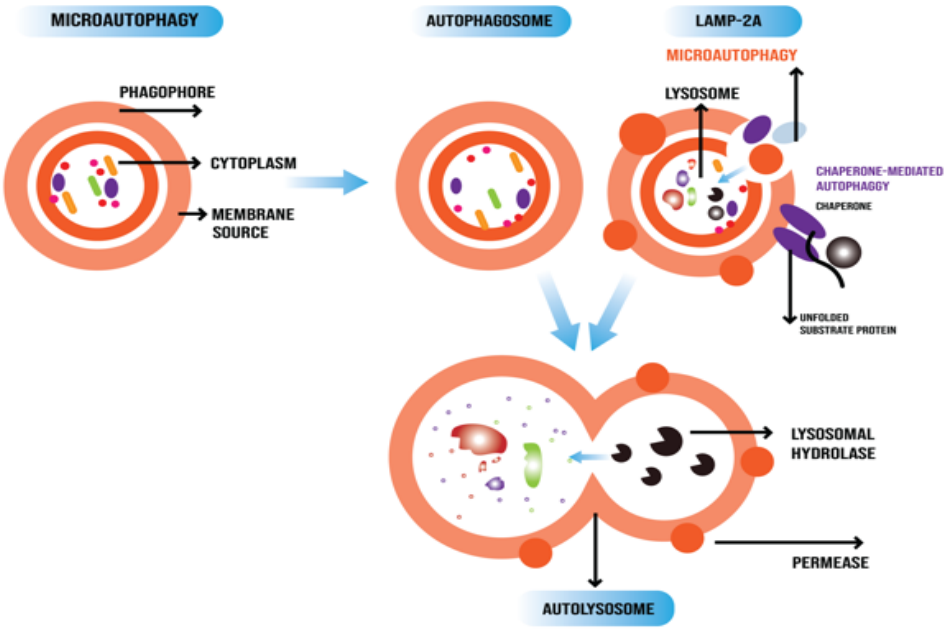

Figure 1. Different types of autophagy

Mechanism, microautophagy, involves septating or invaginating the lysosomal/vacuolar membrane in order to sequester cytoplasm. The most common kind of autophagy, called macroautophagy, is characterised by the production of double-membraned cytosolic vesicles that encapsulate parts of the cytoplasm (Figure 1). The sequestering vesicles known as

autophagosomes during macroautophagy are not produced from the lysosomal/vacuolar membrane (Klionsky and Emr, 2000). An inner vesicle known as an autophagic body is delivered into the degradation compartment lumen by the union of the finished autophagosome with a vacuole or lysosome. The cargo of the vesicular membrane can eventually degrade and be recycled into amino acids and other compounds due to the membrane's subsequent breakdown. In contrast to the other two processes, chaperone-mediated autophagy is a secondary reaction to starvation that requires the direct translocation of specific proteins across the lysosomal membrane. There isn't a recognised yeast counterpart for this process yet (Mizushima et al., 2008).

Mechanisms that trigger autophagy

Nutritional Stress. Cellular starvation or nutritional deficiencies can trigger autophagy to provide essential nutrients to cells and maintain energy homeostasis. Nutritional stress can significantly impact the autophagy process in cells. When the body is subjected to poor or excessive nutrition, the autophagy system is activated to compensate. In conditions of starvation, autophagy can provide essential nutrients by breaking down cellular organs and proteins to maintain homeostasis and ensure cell survival. On the other hand, in conditions of excessive nutrition, excessive activation of autophagy can be linked to various metabolic and inflammatory conditions. Therefore, a proper balance of autophagy in response to nutritional stress is essential for maintaining cellular health and body function (Longo and Anderson, 2022).

Oxidative stress. An increase in the level of reactive oxygen species (ROS) in cells can activate autophagy. This helps remove cellular components damaged or affected by oxidative stress.

DNA damage. Autophagy can be triggered in response to injuries or damage at the DNA level, thus contributing to the maintenance of genomic integrity.

Infections and inflammation. The presence of infections or inflammation in cells can activate autophagy to eliminate pathogens and limit excessive inflammatory responses.

Endoplasmic stress. Dysfunctions at the level of the rough endoplasmic reticulum (a cell component responsible for protein synthesis) can trigger autophagy to manage cellular stress.

Mitochondrial stress. Damage at the mitochondrial level can activate autophagy to remove damaged mitochondria, a process known as mitophagy.

Regulatory Mechanisms

Various processes can regulate autophagy.

Microautophagy is a mechanism in which lysosomes actively consume cytosolic components by invaginating their membrane. Similar processes in fungi selectively degrade organelles, but the function of microautophagy in higher eukaryotes is unknown. Macroautophagy is another type of autophagy that engulfs cellular cargo within a double-membrane vesicle known as an autophagosome. The autophagosome then unites with lysosomes, where the contents are destroyed and recycled. Sequestration can be selective, focusing on payloads like organelles or invasive microorganisms, or non-specific, involving the engulfment of bulk cytoplasm (Shabkhizan et al., 2023). The phagophore expands to form the autophagosome, yet it is unclear where the membrane originated. Hydrolases are produced when the autophagosome fuses with a lysosome or an endosome (not shown). Membrane permeases facilitate the release of the resultant macromolecules back into the cytosol when the inner membrane of the autophagosome is lysed by the autolysosome and breaks down its contents. Chaperone-mediated autophagy (CMA) is a process in which the integral membrane receptor LAMP-2A (Lysosome-associated membrane protein type 2A) and the cytosolic and lysosomal chaperone protein hsc70 work together to directly translocate unfolded substrate proteins across the lysosomal membrane (Mizushima et al., 2008).

Severe degradation is crucial to autophagic activity, but it brings some danger because unchecked cytoplasmic degradation can be fatal. However, basal autophagy levels are necessary to preserve regular cellular homeostasis. Because of this, it's critical that autophagy be strictly controlled (Figure 2), triggered when needed, but otherwise kept at a low level. Many facets of the control of autophagy have been discussed in recent reviews, despite the lack of a comprehensive picture.

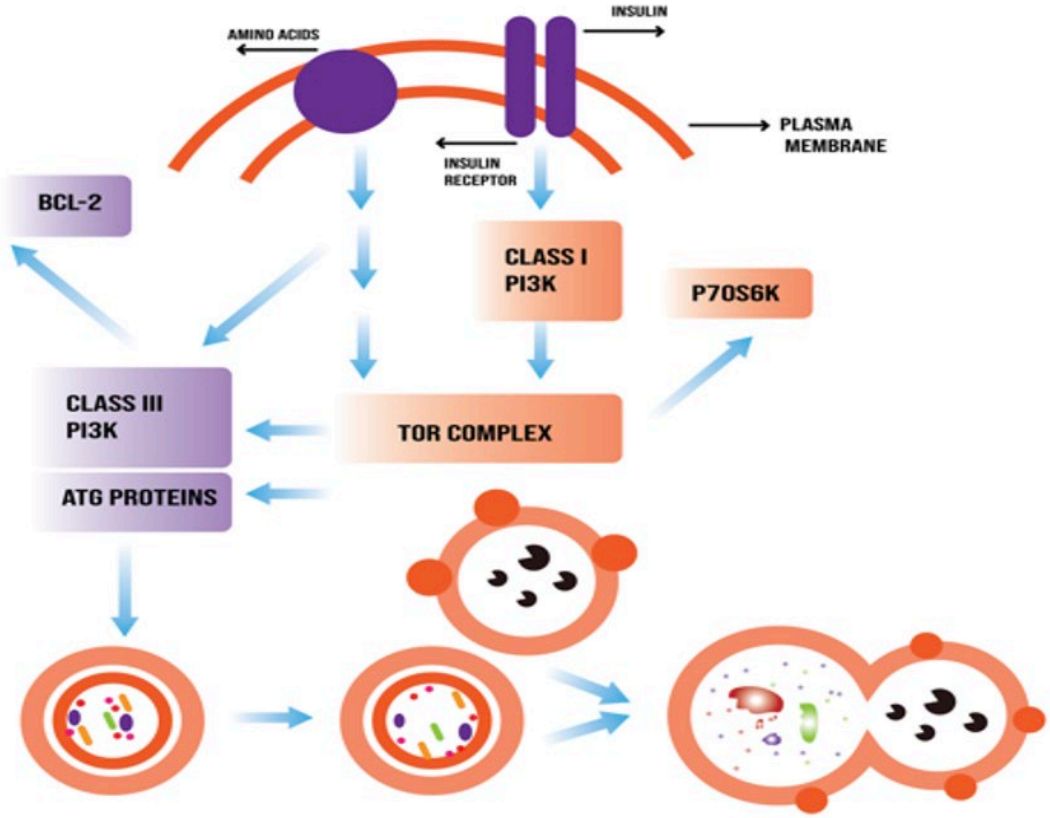

Figure 2. A shortened framework for autophagy regulation:

At the most basic level, macroautophagy is triggered by microbial pathogens, hormones, and nutrition, among other environmental cues. Although the exact mechanism is uncertain, Class I PI3K and TOR are the best-characterized regulatory route; they act to prevent autophagy. You need a Class III PI3K in order to activate autophagy. Feedback loops probably play a role in regulating TOR activity in order to prevent either excessive or inadequate autophagy. For instance, the TOR substrate p70S6 kinase may function to inhibit TOR activity, maintaining baseline autophagy levels that are essential for homeostasis. The green and pink proteins, respectively, stimulate and prevent autophagy. Dashed lines show potential consequences on regulations (Mizushima et al., 2008).

Autophagy in survival and death cells.

In situations, such as microbial infection, efficiency of nutrients and growth factors, and illnesses marked by the buildup of protein aggregates, have been shown to highlight autophagy's pro-survival role at both the cellular and organism levels. Although this pro-survival role is usually thought of as adaptive, it might not be the case in cancer. A prevalent characteristic of the tumour microenvironment is metabolic stress, which is also induced in cells by most of chemotherapy drugs. Therefore, whether autophagy-based survival should be inhibited under certain circumstances, to encourage tumour cell death, is a topic that is being thoroughly researched (DiLoreto and Murphy, 2015).

Complex interactions occur between the autophagy process, which is mostly involved in cell survival, and the apoptosis pathway, which always results in cell death. The two routes have common components, are regulated by similar circumstances, and each has the ability to control and alter the other's activity. Autophagy

is induced by many signals that were firstly investigated in relation to apoptosis activation, while autophagy is inhibited by signals that block apoptosis. Pro-apoptotic factors, including BH3-only proteins, break this inhibitory connection and trigger autophagy. Anti-apoptotic proteins, like those in the Bcl-2 family, inhibit Beclin proteins. The finding that Atg5 can be cleaved by calpain to produce a pro-apoptotic component that participates in the intrinsic mechanism of mitochondrial death provides another connection between autophagy and apoptosis. These are just a few examples, as our understanding of the intricate chemical relationship between autophagy and apoptosis is still developing. Nonetheless, it appears likely that several features tissue homeostasis, and disease pathogenesis are governed by the methodical control of "self-digestion" through autophagy and "self-killing" through apoptosis (Mizushima et al., 2008).

Adaptive and innate immunity

Like cellular organelles, the removal of intracellular organisms presents a steric barrier for cellular breakdown mechanisms, one that autophagy is ideally suited to meet. The process known as xenophagy involves the selective transport of microbes to lysosomes using similar autophagic machinery that is utilised to capture certain cellular components. Autophagy has a likely broader function in antimicrobial defence in mammals (and possibly other metazoan animals) than only eliminating infections directly. Autophagy plays a part in both preserving lymphocyte homeostasis and supplying the innate and adaptive immune systems' antigenic material from microbes. Targets of xenophagy include newly synthesised virions when they leave the nucleus through the cytoplasm, parasites and bacteria living inside vacuoles, phagosomes, or the cytosol harbouring pathogens, and external bacteria that infiltrate intracellularly. The xenophagy's cell biology is not as well understood as that of conventional autophagy. Although the molecular components needed for both processes are comparable, it is still unclear if the biogenesis of the membranes that engulf microorganisms differs or is similar from that of classical autophagosomes. The autophagic process's ability to absorb microorganisms larger than its own organelles is demonstrated by the fact that LC3-positive compartments containing pathogens can be significantly larger than classical autophagosomes formed entirely of cellular constituents. This ability shows the distinct autophagosome formation mechanism (Figure 1). Little is known about the process by which bacteria (or the membrane compartments hosting microbes) are chosen for autophagy, even though xenophagy seems to be essentially a selective type of autophagy.

Beyond its direct involvement in the removal of pathogens, autophagy has the ability to mediate the trafficking steps required for both innate and adaptive immunity as well as to have cytoprotective effects in infected cells. Autophagy is required in some RNA viral infections for the viral nucleic acids to reach the endosomal TLR7 receptor and activate type I interferon signalling. Certain endogenously synthesised viral antigens are also presented on the class II Major Histocompatibility Complex (MHC) by means of autophagic machinery. In addition to its role in both adaptive and innate immunity, the autophagic process is also stimulated by several innate and adaptive immune mediators that are involved in the management of intracellular pathogens (Mizushima et al., 2008).

Aging and longevity.

Even if there are no mutations that lead to pathogenic cells, such as mutant proteins prone to aggregation, the buildup of damaged proteins and organelles is a common characteristic of all ageing cells (Figure 3). Differentiated cells that do not divide, such as neurons and cardiomyocytes, are particularly vulnerable to these deposits of altered components because their typical aging-related functional decline usually occurs earlier than in other types of cells.

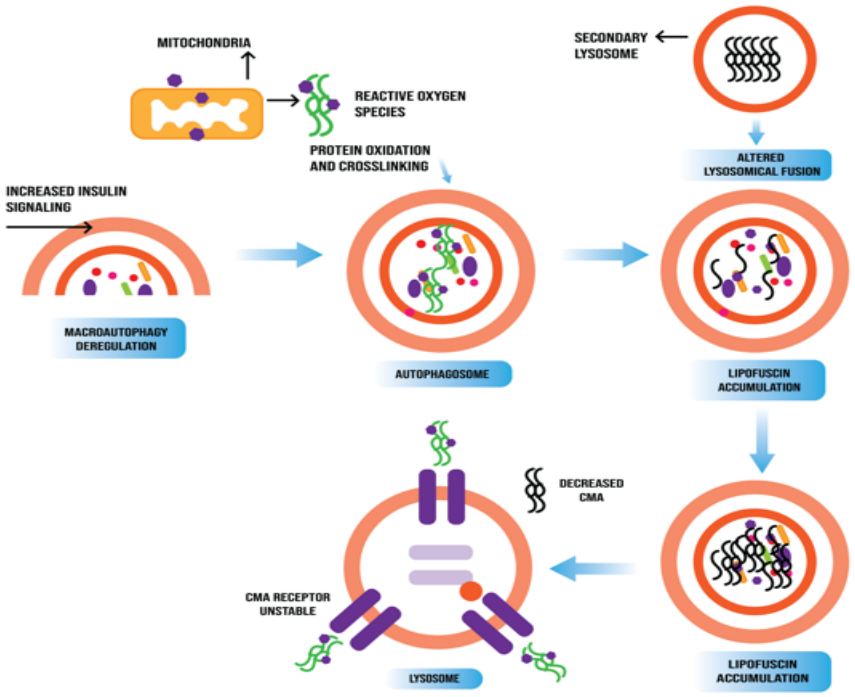

Figure 3. Autophagy and aging

Both macroautophagy and CMA (chaperone-mediated autophagy) activities decrease with age. The dramatic changes observed in the phenotypes of recently created genetically modified mice, where autophagy function is impaired, suggest that a gradual decline in autophagic activity as organisms age could play a significant role in the functional decline observed in aging organisms (Longo and Anderson, 2022).

In contrast, caloric restriction, the only known intervention for slowing aging, appears to increase autophagy induction, presumably due to reduced insulin levels, which hinder autophagy (Figure 3). Current initiatives to avoid or reverse the loss in age-related macroautophagy focus on replicating the positive effect of caloric restriction using anti-lipolytic medications (which simulate the sense of hunger caused by caloric restriction) (DiLoreto and Murphy, 2015).

In nearly all tissues of aging species, ranging from nematode worms to mammals, defective lysosomal function has been observed. Additionally, the activities of macroautophagy and chaperone-mediated autophagy (CMA) decrease with age. Age-related functional loss in macroautophagy is partly explained by problems with its regulation and execution. Older organisms lose the ability to regulate macroautophagy through elevated blood glucagon levels (i.e., between meals). This may be because the insulin receptor's basal activity is constantly boosted responding to the ageing cells' increased levels of reactive oxygen species concentration.

Furthermore, the build-up of lipofuscin, an undigested substance, within autolysosomes and other secondary lysosomes hinders their capacity to combine with autophagosomes and break down their cargo. The CMA receptor becomes unstable as we age because of modifications to the lysosomal membrane. The lower CMA activity in older organisms is caused by an age-dependent drop in this receptor's levels. Some expected effects of the aging-related decrease in autophagy include a weak stress response, an ineffective way of eliminating damaged components, and a possible way of causing disease (Mizushima et al., 2008).

Regulatory process of the autophagy

Sirtuins, a special class of enzymes, are essential for many vital cellular functions, including

survival, metabolism, division, aging, programmed cell death (apoptosis), and DNA repair. These enzymes are activated by nicotinamide adenine dinucleotide (NAD+), a coenzyme involved in redox reactions at the cellular level. There are seven types of sirtuins in mammals (SIRT 1-7), grouped into four distinct classes, SIRT1-3, which are involved in deacetylation, belong to Class I. SIRT1 shuttles between the nucleus and the cytoplasm, SIRT2 resides in the cytoplasm, while SIRT3 is found in both the nucleus and the mitochondria. SIRT4, which predominantly functions as an ADP-ribosyl transferase in the mitochondria, belongs to Class II. SIRT5 and SIRT6, on the other hand, belong to Class III and provide a variety of roles. SIRT5 is located in the mitochondria and serves as a deacetylase, demalonylase, and desuccinylase. SIRT6 is located in the nucleus and regulates nuclear ADP-ribosylation and deacetylation. Finally, Class IV includes SIRT7, a deacetylase that plays a role in the nucleus' RNA polymerase I transcription machinery (Kim et al., 2022). Among these, sirtuin 1 (SIRT1) is the largest and the most extensively studied, playing a crucial role in various cellular processes. SIRT1 is composed of 11 exons and 33,715 base pairs, located on chromosome 10q21.3 (Kim et al., 2022).

SIRT1 regulates autophagy. SIRT1 influences this complex process at multiple levels, interacting not only with proteins directly involved in autophagy (known as ATGs) but also with various regulators that coordinate different phases of autophagy: initiation, expansion, maturation, fusion with lysosomes, and final degradation.

SIRT1 controls stability when autophagy starts (Figure 4). Through inactivating the brain-enriched Ras homolog (Rheb), which triggers mechanistic Target of Rapamycin Complex 1 (mTORC1), Tuberous Sclerosis Complex 2 (TSC2) will inhibit the mTORC1 signalling pathway. When Rheb binds to GTP, it activates mTORC1, and GAP (the TSC2 GTP activating protein) promotes GTP hydrolysis. TSC2's enhanced stability will decrease mTOR signalling and start the autophagy process when it improves GTP hydrolysis to inactivate Rheb. The deacetylase activity of SIRT1 prevents the ubiquitin-mediated destruction of the TSC2 complex, maintaining its stability in the absence of nutrition.

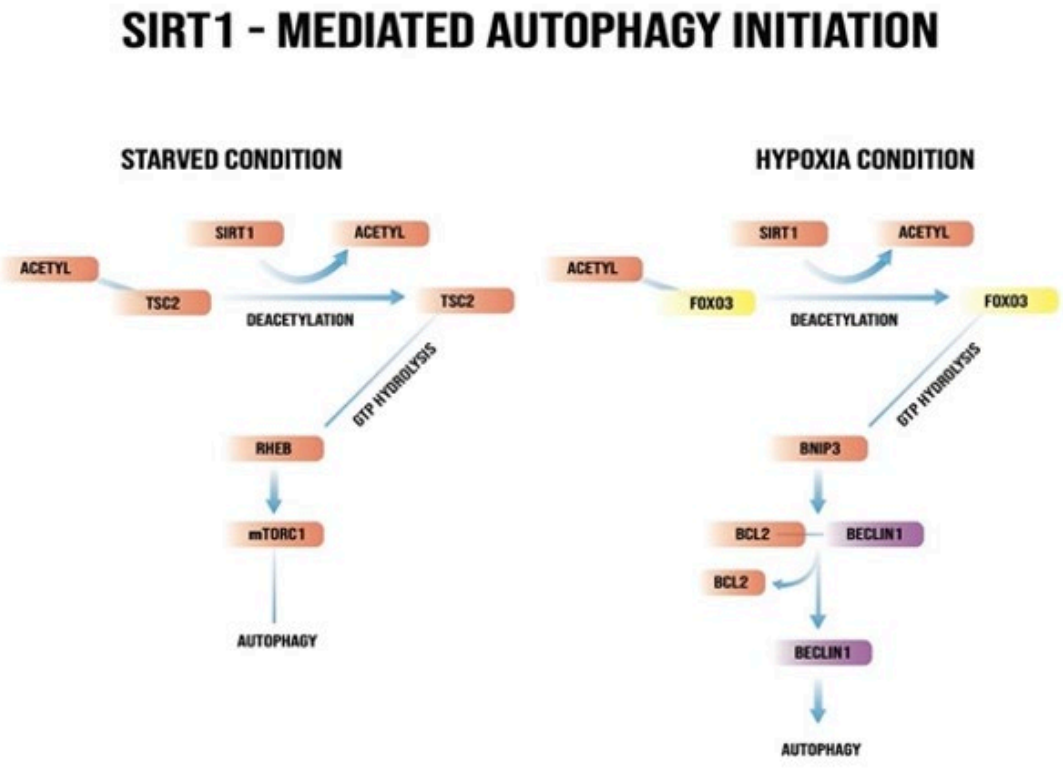

Figure 4. SIRT1 influences on the initiation of autophagy

When faced with a lack of food, the deacetylase enzyme activity of SIRT1 intensifies, contributing to greater stability of the TSC2 protein. This facilitates the breakdown of GTP by Rheb, a crucial step in stopping the signaling of the mTOR pathway, which is essential for controlling cell growth and metabolism. On the other hand, in situations of oxygen deficit (hypoxia), SIRT1 acts on FOXO3 proteins, through deacetylation, making them bind to the control sections (promoters) of the BNIP-3 gene. This leads to an increase in the production of BNIP-3, an important factor in activating autophagic processes, through which cells recycle their damaged or unnecessary components to survive in unfavourable conditions (Longo and Anderson, 2022).

Additionally, recent research has shown that, under hypoxic conditions, SIRT1 moderates the initiation of autophagy, which is mediated by BNIP-3 (Kim et al., 2022). (Figure 4). SIRT1 deacetylates the nuclear protein FOXO3, thus facilitating the binding of FOXO3 to the BNIP-3 promoter and inducing BNIP-3 expression. BNIP-3 expression stimulates autophagy by promoting the separation of Beclin1 from the Bcl-2-Beclin1 complex. Activated Beclin1 triggers the PI3K complex necessary for the initiation of autophagy. SIRT1 and autophagy have a reciprocal relationship that shows that SIRT1 controls autophagic activity and that autophagy can affect SIRT1 levels by degrading SIRT1 in lysosomes (Kim et al., 2022).

Depending on the cellular state, autophagy can adjust SIRT1 levels. Dysfunction of the autophagic process disrupts normal metabolism, which can lead to the emergence of endocrine disorders. Thus, current studies indicates that disturbances in the SIRT1-regulated autophagy process can contribute to the occurrence of obesity, type 2 diabetes, and diabetes-associated cardiomyopathy (Meijer and Codogno, 2006).

CONCLUSIONS

In conclusion, autophagy plays a critical role in maintaining cellular homeostasis and is intricately regulated by conserved signalling pathways such as mTOR, AMPK, Akt, and SIRT1. Dysfunctions in autophagy are closely associated with various diseases, including neurodegenerative disorders, cancer, and aging, underscoring its significance in health and disease. Ongoing research in autophagy has the potential to uncover novel therapeutic targets and improve treatment strategies for these conditions.

Understanding and manipulating autophagic processes could provide significant advancements in promoting health, preventing disease, and extending lifespan. Therefore, continuing studies on autophagy is essential for progress in understanding cellular biology and for developing more precise and effective therapeutic interventions.

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