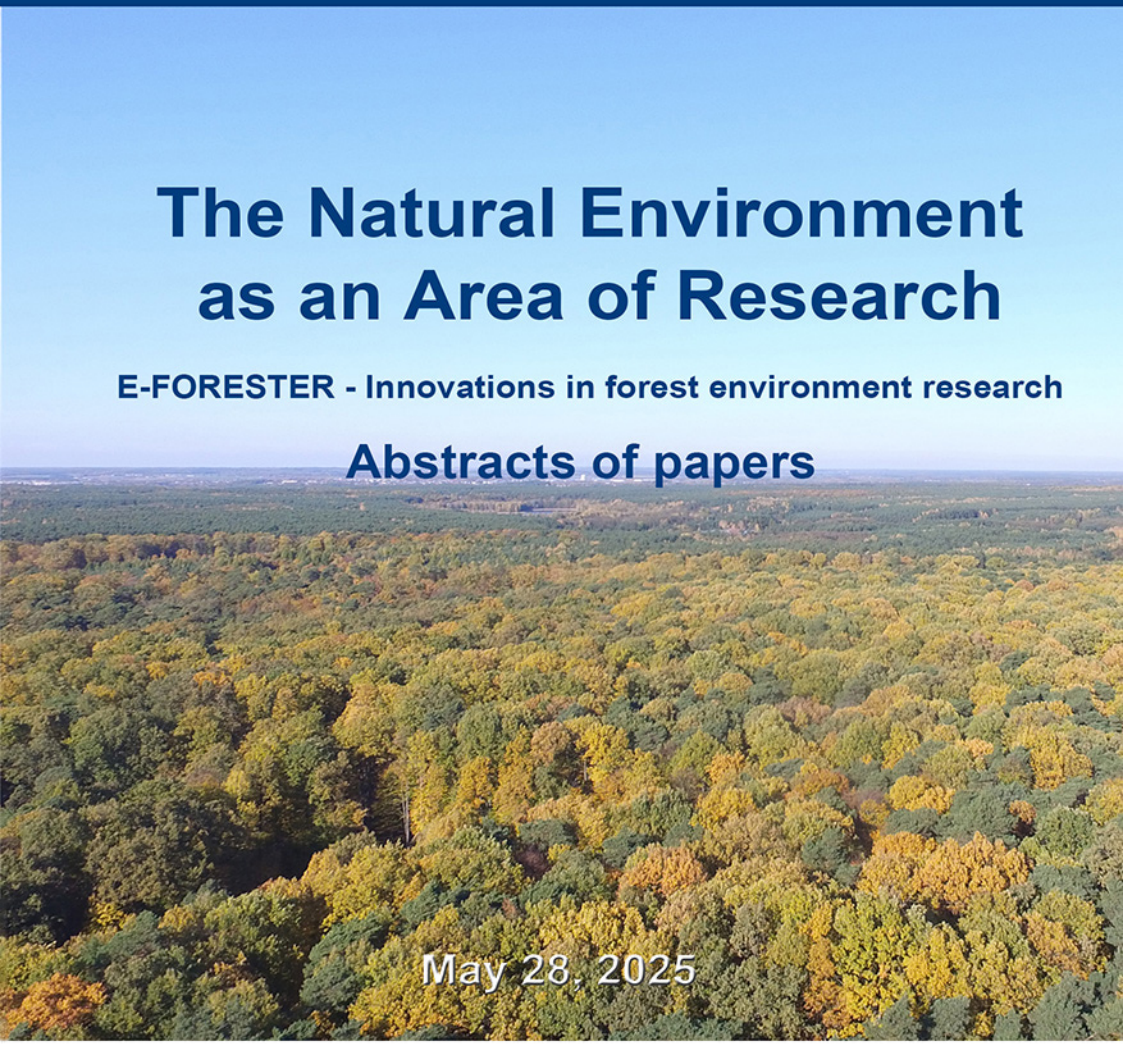
7th Conference

The Natural Environment as an Area of Research

E-FORESTER - Innovations in forest environment research

Abstracts of papers



May 28, 2025

Uniwersytet
im. Adama Mickiewicza
w Poznaniu

Space Systems Solutions (S3)
Uniwersytet im. Adama Mickiewicza w Poznaniu
Cyprus Space Exploration Organization CSEO
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S2G Technologies

7th Conference
"The Natural Environment as a Area of Research"
E-FORESTER - Innovations in forest environment research

Book of Abstracts

under the honorary patronage of
Space System Solution (S3)

Marcello Coradini

Poznan, May 28, 2025

Funded by the European Union

The study contains a collection of abstracts of papers presented by participants of the 7th Conference held on May 28, 2025 on the MS Teams platform.

The composition was made based on texts provided by the Authors. The Authors of the abstracts are responsible for the content and substantive value.

Selection of abstracts: Organizing Committee and Scientific Committee of the Conference

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Contents

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Poznań University of Life Sciences
Adam Mickiewicz University Poznań
Università degli Studi di Padova
S2G
Cyprus Space Exploration Organisation
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Università degli Studi di Padova
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Conference schedule

9:00 – 9:05	Opening of the Conference
9:05 – 9:25	Dr. Adam Młynarczyk, Prof. Marcello Coradini: E-FORESTER(EN)
9:25 – 9:50	**keynot speaker:** Prof. UPP Dr. Hab. Eng. Cezary Beker: Experimentation in the Natural Sciences (PL)
9:50 – 10:00	break
	Session 1 (PL) – moderator: Dr. Hab. Sławomir Królewicz
10:00 – 10:15	GeoAI in Practice: Analyzing the Potential of Integrating GIS and AI in Environmental Modeling – Grzegorz Górniak, Mieczysław Kunz
10:15 – 10:30	Use of GIS and Remote Sensing in Determining Potential Offroad Activity Concentration Areas in Forests – Paulina Marciniak, Łukasz Kwaśny
10:30 – 10:45	Analysis of Spatial Development Changes in the Coastal Zone of the Puck Bay in the Context of Climate Change – Natalia Glowienke
10:45 – 11:00	Assessment of the Possibility of Using Satellite Imagery for Monitoring Post-mining Land Reclamation on the Example of Selected Open Pits of Konin Lignite Mine in 1999-2022 – Bogna Mika, Jakub Ceglarek
11:00 – 11:15	Monitoring the Extent and Intensity of the Rhodes Island Wildfires in 2023 Using Medium and High-resolution Satellite Imagery – Aleksandra Cisek
11:15 – 11:30	Building Destruction Detection in Gaza Strip During IDF Invasion Based on Optical and Radar Satellite Data **–** Dawid Czajkowski
11:30 – 11:45	The Impact of Microhabitat Conditions on the Distribution of Vascular Plants in Specific Regions of the Zielonka Experimental Forest District – Jan Kłęk, Anna Grykowska, Paweł Rutkowski
11:45 – 11:50	break
	Session 2 (ENG) – moderator: Dr. Jakub Ceglarek
11:50 – 12:05	Multitemporal Analyses of Forest Stand Disturbances in Different Climate Zones Using Landsat Imagery with TVCMA and LandTrendr Algorithms – Aram Takmadżan, Adrian Ochtyra
12:05 – 12:20	Elucidating Canopy Gap Dynamics and Canopy Layer Structure of the Protected Forests in Poland using Multi-temporal Aerial Laser Scanning Data – Garry Marapao, Srdjan Keren, Jakub Miszczyszyn[1]

12:20 – 12:35	Preliminary Forest Tree Species Classification of Tree Species in Selenge Province (Mongolia) Forest Based on Sentinel-2 (ESA) and Machine Learning Approach – Erdenetuya Boldbaatar, Piotr Wężyk, Wojciech Krawczyk
12:35 – 12:50	Towards a Countrywide Canopy Height Model Based on Spaceborne Data Fusion - Results from Southern Poland – Wojciech Krawczyk, Piotr Wężyk
12:50 – 13:05	Detection of Microplastic Pollution in Soils Using UV-VIS-NIR Reflectance Spectroscopy – Agnieszka Wesołowska, Jan Piekarczyk
13:05 – 13:10	break

Session 3 (ENG) – moderator: Msc. Agnieszka Wesołowska

13:20 – 13:35	Microplastic Particles from River Sediment can Act as Fomites for Pathogens – Dongqing Zhao, Konrad Wojnarowski, Paulina Cholewinska, Dušan Palić
13:35 – 13:50	The Environmental Impact of the Russia-Ukrainian War on Ukrainian Cities – Liliia Hrytsai
13:50 – 14:05	Assessing the Impact of War on Forest Ecosystems in Ukraine Using Sentinel-2 Data – Adam Waśniewski, Alicja Rynkiewicz[2], Agata Hościło[3], Serhii Havryliuk
14:05 – 14:20	A Digital Observation System for Wild Animal Movement in Forest Environments: Integrating Sensing, Tagging, and Movement Modeling – Anna Shepel, Kamil Smolak, Dominik Teodorczyk, Adrian Kaczmarek, Dorota Włodarczyk, Witold Rohm, Grzegorz Jóźków, Wojciech Sowa, Przemysław Cwynar, Jan Sierny, Krzysztof Hulewicz, Mieczysław Łyskawa
14:20 – 14:35	Do Rove Beetles Like the Scent of Resin? An Effective Method for Catching some Rove Beetles (Staphylinidae) – Kamil Muszyński, Radosław Witkowski, Andrzej Mazur
14:35 – 14:50	UAV Photogrammetry: The Influence of GCP Placement – Marcin Kamieniczny, Jakub Ceglarek
14:50 – 14:55	break

Session 4 (PL) – moderator: Dr. Grzegorz Borkowski

14:55 – 15:10	Multi-annual and Seasonal Variability of Flow River Conditions of the Wełna River – Natalia Krupka
15:10 – 15:25	Enrichment of the Air-water Interface with Biogenic Substances in the Littoral of Four Lakes of the Słowiński National Park, Influences of the Forest Catchment – Józef Antonowicz
15:25 – 15:40	Review of Magnetic Tracing Methods in Fluvial Sediment Transport Studies – Tomasz Krupka

15:40 – 15:55	Analysis of the Species Composition of Leeches (Hirudinea) in Aquatic Habitats of the Morasko Campus – Maciej Grobelski, Bożena Sikora
15:55 – 16:10	Social Perception of Combustion Engine Vessels on Lake Areas in the Context of Environmental Protection and Tourism: An Analysis of Lake Ślesińskie" – Maciej Czaronek
16:10 – 16:25	Geocaching as a Form of Active Alternative Tourism. An Analysis Based on Forested Areas in Poland – Joanna Żak, Mieczysław Kunz
16:25 – 16:30	break
	Session 5 (PL) – moderator: Dr. Monika Konatowska
16:30 – 16:45	Typological Diversity of Forest Soils in the Miękinia Forest District – Daria Szuk, Dorota Kawałko
16:45 – 17:00	Phytoremediation Capacity of Willow under Increased Soil Salinity – Zuzanna Kaźmierczak, Kinga Drzewiecka, Magdalena Woźniak
17:00 – 17:15	Natural Deep Eutectic Solvents as a Sustainable Solution for Contaminated Natural Areas – Olga Baranowska
17:15 – 17:30	Effective Management of Coal Industry Waste in Poland – Dmytro Khomenko
17:30 – 17:45	Emission of Selected Gases from Self-heating Coal Waste Dumps on the Example of the Bytom Heap – Karolina Paszcza, Mariola Jabłońska
17:45 – 17:50	break
	Session 6 (PL) – moderator: Prof. Dr. Hab. Bożena Sikora
17:50 – 18:05	Urban Snow as a Mirror of Pollution: A Case Study from Post-industrial Starachowice – Marta Ludew
18:05 – 18:20	Particulate Air Pollution in Katowice – Pamela Gałka
18:20 – 18:35	Mercury Concentration in Non-commercial Fish from the Puck Lagoon and Vistula Lagoon – Roksana Malec, Magdalena Bełdowska, Mariusz Sapota, Anna Dziubińska, Bartłomiej Wilman, Adam Woźniczka, Ryszard Kornijów
18:35 – 18:50	Protective Effects of Fruits, Vegetables, and Seeds on the Functions and Structure of the Skin – Oliwia Żeleźnik, Katarzyna Czub, Marta Pawłowska-Olszewska, Iwona Puzio
18:50 – 19:05	The Relationship between Asthma and Hypertension in Children and Adolescents and Atmospheric Air Pollution in Bielsko-Biała – Dariusz Góra
19:05 – 19:10	End of the Conference

GeoAI in Practice: Analyzing the Potential of Integrating GIS and AI in Environmental Modeling

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In an era of growing environmental degradation, rapid urbanisation and extensive use of electrical technologies, linking technology with environmental science is essential for effective management. This article reviews ten specific applications, limitations and challenges of GeoAI—an approach that combines geographic information systems (GIS) with artificial intelligence (AI), including machine learning and deep learning.

The main aim is to demonstrate how modern AI algorithms, integrated within a GIS environment, not only model phenomena more precisely but also reveal spatial and temporal patterns that traditional methods overlook. Drawing on a systematic literature review and selected case studies, GeoAI is shown to support monitoring of land-cover change, identification of pollution sources, modelling of natural habitats and mapping of environmental hazards.

An original framework for merging geospatial data with AI is presented. The procedure encompasses data collection and preprocessing, feature extraction, predictive modelling, validation and visualisation within GIS. Key limitations of AI—high computational demands, the need for large training datasets and difficulties in interpreting "black-box" models—are also analysed. Transparent, scalable and ethical practices are emphasised, particularly for environmental decision-making.

The evidence indicates that GeoAI shifts environmental management from reactive to predictive, providing a vital tool for sustainable development.

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Use of GIS and Remote Sensing in Determining Potential Offroad Activity Concentration Areas in Forests

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In recent years, there has been a significant development of offroad tourism. Although offroad originates from extreme motor sports, it is becoming increasingly popular among people looking for active recreation, even without the appropriate preparation and experience. The dynamically developing offroad community brings together both professionals and amateurs. The forest environment is an attractive place to practice this passion and overcome offroad challenges. In many cases, this is in conflict with legal, protective and social conditions. Offroad activity can significantly affect changes in the forest environment, leading to their degradation. One way to reduce the negative effects is to try to accumulate traffic in designated areas. This paper presents the possibilities of using publicly available spatial data, GIS technology and remote sensing in the design of potential places and routes for offroad activities in forests. The research was conducted within the forests of the Jabłonna Forest District (RDLP in Warsaw).

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Analysis of Spatial Development Changes in the Coastal Zone of the Puck Bay in the Context of Climate Change

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The coastal zone of the Inner Puck Bay and the bay itself are areas of high natural and landscape value. The study area contains valuable ecosystems that are exposed to numerous threats resulting from anthropogenic pressure. A key challenge for their protection is the development of the technical buffer zone (Polish: pas techniczny), which increases the degradation of the marine shoreline and creates a risk of construction-related hazards. Ongoing climate change is leading to rising sea levels, intensified coastal erosion, and an increasing frequency of extreme weather events such as hurricane-force winds. In the future, this will accelerate abrasion processes and increase vulnerability to degradation.

In this context, the protection of the marine shoreline and the implementation of restorative actions, as well as the development of a sustainable coastal management strategy, become crucial. The aim of the study was to identify “hot spots” — areas most vulnerable to the impacts of climate change.

To analyze spatial changes, archival maps and BDOT (Topographic Objects Database) data from 2014 and 2024 were examined. Local development plans (MPZP) were also reviewed with respect to the location of buildings within the technical buffer zone. Based on this analysis, critical areas — hot spots — were identified.

Taking into account ongoing climate change, an analysis was conducted on the distribution of buildings in relation to areas at risk of flooding with a probability of occurrence once in 10 years (10%) and once in 100 years (1%). Areas particularly exposed to flood risk from both the sea and downstream river sections were delineated. At the same time, zones that should not be designated for further development due to the increasing flood hazard were identified. In total, 70 hot spots were identified.

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Assessment of the Possibility of Using Satellite Imagery for Monitoring Post-mining Land Reclamation on the Example of Selected Open Pits of Konin Lignite Mine in 1999-2022

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Open-pit mining of lignite has a negative impact on the environment, affecting various aspects such as changes in the landscape structure, changes in the balance of ground and surface waters, soil degradation and increased emissions of air, liquid and solid pollutants. This often leads to critical public perception of mining activities. One way to limit the adverse effects of exploitation is to conduct effective reclamation of post-mining areas. Properly conducted reclamation can lead to both an improvement in the natural values of the reclaimed area and the assignment of new socially beneficial functions. Reclamation is a long-term process that should be properly planned, supervised and its effects correctly evaluated. A study conducted on four open pits of Konin Lignite Mine between 1999-2022 evaluated the possibility of using satellite imagery for monitoring reclamation. The analysis was based on changes in the average value of the Normalized Difference Vegetation Index (NDVI). The applied methods allowed to assess the reclamation process in the studied area. An increase in the share of green areas was found in the case of reclaimed open pits. At the same time, the existence of fragments of areas characterized by lower NDVI values was linked with the dominant directions of development of former open pits.

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Monitoring the Extent and Intensity of the Rhodes Island Wildfires in 2023 Using Medium and High-resolution Satellite Imagery

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This study presents a detailed analysis of the extent and intensity of wildfires that occurred on the Greek island of Rhodes in July 2023. The study utilized satellite imagery from Sentinel-2, Landsat 8/9, and PlanetScope, representing medium and high spatial resolutions. These datasets enabled the calculation and comparison of three spectral indices: NDVI (Normalized Difference Vegetation Index), NBR (Normalized Burn Ratio), and BAI (Burned Area Index), which were used to assess vegetation condition and the extent of fire-related damage.

The analysis aimed to evaluate the capabilities of each satellite system in wildfire monitoring and to propose a new fire intensity index derived from PlanetScope data, which offers very high spatial resolution (3–5 meters) and daily revisit capability. Despite the lack of the SWIR band in PlanetScope, the proposed method allowed for reliable daily monitoring of fire dynamics and spatial changes in vegetation cover. Sentinel-2 and Landsat 8/9 data were also thoroughly analyzed, particularly with respect to the SWIR bands that enhance fire damage detection.

The results of the study include a daily visualization of fire progression, differentiation of burn severity classes, and a comparative analysis of satellite capabilities. Delta NBR (dNBR) calculations allowed for burn severity classification in line with USGS standards. PlanetScope's data was correlated with Sentinel-2 and Landsat 8/9 outputs to assess consistency and identify strengths and limitations of each dataset. The findings confirmed that Sentinel-2, thanks to its spatial and spectral richness, allows for precise monitoring of fire severity, whereas Landsat 8/9 offers robust regional trend analysis. PlanetScope excels in short-term, high-resolution monitoring but is limited in classifying moderate burn intensities due to the lack of SWIR.

The proposed tools and methods demonstrate practical utility in natural disaster monitoring, environmental management, and future wildfire response strategies. The thesis underlines the importance of combining multiple data

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sources for improved wildfire assessment, and suggests further research involving machine learning and additional indices (e.g., EVI, SAVI) for enhanced post-fire landscape evaluation.

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Building Destruction Detection in Gaza Strip during IDF Invasion Based on Optical and Radar Satellite Data

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This thesis focuses on the detection and classification of urban destruction resulting from the Israeli Defence Forces' (IDF) invasion of Gaza, which commenced on 7 October 2023. The study primarily utilizes satellite imagery from two key sources: Sentinel-1 synthetic aperture radar (SAR) data and high-resolution optical imagery from PlanetScope. The dual approach of combining low-resolution SAR with high-resolution optical data enables a comprehensive assessment of destruction in urban environments during ongoing conflict scenarios. The objective is to evaluate the efficacy of different types and resolutions of satellite data for real-time or near-real-time monitoring of urban damage.

A central part of the research involved the development and implementation of a Random Forest classification model. This machine learning algorithm was trained using the UNOSAT dataset, which provides detailed records of building destruction in Gaza between 1 May 2023 and 1 August 2024. Several indices derived from Sentinel-1 data, including backscatter coefficients and coherence change, were employed as key inputs for the model. These indices are sensitive to structural changes and ground disturbances, allowing for effective detection of demolished or heavily damaged buildings. By training the model on verified destruction data, the process achieved a high level of accuracy and reliability in damage detection, even in complex urban environments.

The study further compares the outcomes of the SAR-based classification with those obtained from PlanetScope's optical imagery, highlighting how resolution and sensor type influence the results. Optical data, due to its higher spatial resolution, provides detailed visual cues that enhance manual verification and ground-truthing efforts. However, SAR data, while lower in resolution, offers the advantage of cloud-penetrating, day-and-night imaging capabilities, making it invaluable during extended conflict periods when optical acquisition may be limited by atmospheric conditions.

The thesis also examines the influence of the arid terrain typical of the

Middle East on SAR backscatter behavior, and how these environmental factors were accounted for during preprocessing and analysis. The classification results were mapped over multiple dates to capture the progression of destruction and to categorize it based on severity and spatial distribution.

Ultimately, the research aims to determine how satellite data resolution and sensor characteristics influence our ability to monitor conflict-driven urban destruction. The findings suggest that while high-resolution optical imagery improves detection accuracy at the individual building level, SAR data provides continuous and consistent monitoring capabilities critical for long-term conflict observation. The integration of both data types, coupled with robust machine learning models, offers a powerful framework for assessing damage in active warzones and supporting humanitarian and reconstruction efforts.

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The Impact of Microhabitat Conditions on the Distribution of Vascular Plants in Specific Regions of the Zielonka Experimental Forest District.

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Performed investigations aimed at the determination of spatial variation in soil reaction and its potential effect on the occurrence and distribution of different forest vegetation cover species in the experimental plot located in compartment 73 in the Zielonka Experimental Forest Division.

In 80 mean sample plots, of 0,36 m2 each, arranged uniformly using the grid method with the net of squares of 50 m x 50 m, a total of 36 vascular plant species were recorded, including seedlings of 5 forest tree species. The biggest number of localities was recorded for wood anemone and seedlings of European hornbeam, which is correlated with the classification of a vast majority of the experimental area in terms of plant sociology to the Central-European oak-hornbeam forest (Galio sylvatici-Carpinetum).

The above mentioned plant association in the area of analysis is found in the brown rusty soils with pH in surface soil layers ranging from pH 2.73 to pH 6.53.

No distinct correlation was found between the distribution of individual plant species and the reaction of surface soil layers.

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Multitemporal Analyses of Forest Stand Disturbances in Different Climate Zones Using Landsat Imagery with TVCMA and LandTrendr Algorithms

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Multi-temporal analyses of satellite imagery used in vegetation studies facilitate the monitoring of forest stand conditions by detecting changes occurring either suddenly (e.g., wildfires) or gradually over a selected period (e.g., insect outbreaks). This study assesses the accuracy of change detection algorithms for forest stand disturbance detection between 1984 and 2024 across five research areas. The selection of research sites was based on climate diversity and the varying causes of main forest stand changes in these locations. The study includes the following areas: Área De Proteção Ambiental Paytuna (Brazil), Parque Nacional de Cabańeros (Spain), Prince Albert National Park (Canada), Triglavski narodni park (Slovenia), and Parc national de forêts (France).

The study tested time series of four remote sensing vegetation indices derived from Landsat satellite imagery: NBR (Normalized Burn Ratio), NDVI (Normalized Difference Vegetation Index), NDMI (Normalized Difference Moisture Index), TCG (Tasseled Cap Greenness), as well as the short-wave infrared spectral band (SWIR). The generated time series were analyzed using the LandTrendr algorithm (Landsat-based detection of Trends in Disturbance and Recovery) and the TVCMA algorithm (Threshold and trend-based vegetation change monitoring algorithm). The accuracy of the results was then assessed using a validation mask. The validation mask was developed through visual interpretation and spectral trajectory analysis for 100 randomly selected points.

The accuracy of both algorithms was assessed based on the F1 Score, which is the harmonic mean of precision and recall metrics. The TVCMA algorithm performed better, with values ranging from 0.44 to 0.84, while for Landtrendr values of F1 Score were obtained in range 0.09 to 0.23. The best variables were the SWIR spectral channel and the NBR and NDMI indices. This study provided insights into the capability of detecting forest stand disturbances categorized by their cause for both algorithms. The most accurately detected

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changes originated in wildfires. The final outcome of the study consists of disturbance maps for the analyzed areas for the whole investigated period.

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Elucidating Forest Canopy Gap Dynamics and Canopy Layer Structure of the Protected Forests in Poland using Multi-temporal Aerial Laser Scanning Data

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Canopy gaps are footprints of disturbances in the forest ecosystem. Hence, a useful metric for studying forest disturbance and restoration regimes in temporal and spatial scales. A notable development in this field of study is the use of aerial laser scanning data, which addresses the spatial coverage constraints associated with traditional field-based methods. In this context, the study elucidates the progression of disturbance and restoration cycles in Polish protected forests by assessing patterns of canopy gaps and vertical forest structure. Moderate-resolution, publicly available, 11-year interval aerial laser scanning (ALS) datasets were used to extract canopy gaps and forest structural properties. The study specifically examined the gap size frequency distribution (GSFD), gap fraction, gap transition, and gap shape patterns. Additionally, gap vertical distribution and canopy layer structure were examined. Our results indicated that the GSFD for all sites followed a power-law distribution and that no significant changes occurred in gap proportions across time. Meanwhile, the gap fraction increased for Baniska and Hajnik and decreased for Uhryn. Canopy transitions (new openings, persistent gaps, extended gaps, and closed gaps) show varying trends among sites. In shape complexity, Baniska, Hajnik, and Uhryn have mean GSCI indexes for 2012 and 2023 of 2.49 and 2.50, 2.14 and 2.28, and 2.14 and 2.03, respectively. Moreover, gap shape complexity was observed to increase with gap size. In vertical structure, the forests were majorly composed of upper layer canopy at a mean 84.75% and variability of tree height (m) were 8.08, 6.1, and 5.84. The mean Gini coefficient of canopy height within the gap for the three protected forests ranges from 0.33 to 0.51 indicating a modest level of inequality. This study demonstrated the potential ALS data for monitoring disturbance and restoration trends in forests at a lower cost. This protocol is highly replicable across protected forest units in Poland.

Preliminary Forest Tree Species Classification of Tree Species in Selenge Province (Mongolia) Forest Based on Sentinel-2 (ESA) and Machine Learning Approach

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Forest ecosystems are vital carbon sinks and biodiversity reservoirs, but face growing threats from climate change and land-use anthropogenic pressures (FAO, 2023). Mongolia's forest areas, which have warmed at nearly twice the global rate (+2.1°C since 1940), are particularly vulnerable. Between 2010 and 2023, national forest cover declined from 8.5% to 7.7% of the total area of Mongolia (Asian Forest Cooperation Organization, 2022). Addressing this urgent concern, this study develops a machine learning-based (ML) framework for classifying forest tree species in Selenge province - one of Mongolia's biggest forested regions - in support of the "One Billion Trees" national afforestation initiative (Mongolian Presidential Decree No. 152, 2021).

We used multi-temporal Sentinel-2 (ESA) imageries (2020–2024) at 10 m GSD and trained a Random Forest (RF) classifier on forest inventory data (updated 2019) following Ho (1998). The study area (Mandal sum, ~12,000 km¸) is covered by five dominant tree species like: Birch (Betula spp.), Larch (Larix sibirica), Scotch pine (Pinus sylvestris), Siberian pine (Pinus sibirica), and Spruce (Picea obovata), along with non-forest LULC classes such as burned forest areas and pastures. 30 areas of interest per each class were used for training.

The classification achieved high accuracy across all dates (Overall Accuracy: 85.9% ÷ 99.9%, Kappa: 0.83 ÷ 0.99), with best results obtained from combined time-series S-2 (ESA) (OA = 99.94%, Kappa = 0.9993). The tree species like Birch, Spruce, and Siberian pine showed consistently high sensitivity and specificity (often >99%), while Scotch pine and Spruce had lower performance in some scenes, particularly in mid-summer. Key findings include:

1. Consistent underestimation of Scotch pine (3.5–6% classified vs. 16.2% from forest inventory data; in situ).

2. High accuracy in detecting burned forest areas, covering 18.7% of the study area (F1-score = 89.7%).

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3. Seasonal trends in accuracy, with May and October imagery returning the highest performance (OA > 98%), while July data showed reduced accuracy (OA = 85.9%), likely due to spectral mixing and phenological overlap.

Our study confirms the operational potential of Sentinel-2 (ESA) for forest species monitoring in Mongolia's boreal-taiga ecotone. The results demonstrate can be utility for:

- Seasonal tree species discrimination a specially for forest inventories purpose.
- Detection of forest disturbances (e.g., fire scars)
- Supporting monitoring of afforestation efforts and national forest policies.

Future work will focus on integrating higher resolution datasets (e.g., PlanetScope, MS UAV) to address the problem of forest tree species classification of similar tree species. This methodology, based on satellite imagery, provides a scalable and transferable approach for boreal forest monitoring, aligned with global sustainability and climate resilience goals.

Keywords: Random Forest, Sentinel-2, boreal forest, tree species classification, Mongolia, Machine Learning

Towards a countrywide Canopy Height Model based on spaceborne data fusion - results from southern Poland

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Forest stand height is one of the key stand characteristics, utilised in estimation of quantities such as timber volume, aboveground biomass, or carbon sequestration. Due to challenges faced by forests connected with climate changes, large-scale monitoring of forest height structure changes is becoming increasingly important. Remote sensing technologies, such as Airborne Laser Scanning (ALS) have been successfully used to provide precise forest height measurements, but its acquisition frequency is usually low (every 10 years) due to high costs of flight campaigns and the extent of acquired data is limited. Spaceborne LiDAR (SLS – Satellite Laser Scanning) missions, such as GEDI (NASA), have addressed these drawbacks opening new possibilities in large-scale forest height monitoring, but also created new challenges because of its discrete measurement model.

The study aimed to explore methods of various satellite data integration and modelling approaches to obtain a multi-temporal Canopy Height Model (CHM) of forest stands in southern Poland (dolnośląskie, opolskie, śląskie, świętokrzyskie, małopolskie, podkarpackie and lubelskie voivodeships) and assess its accuracy based on reference ALS data. GEDI forest stand height measurements were used as predictor variable. GEDI measurements were integrated with Sentinel-2 (ESA) imagery, ALOS PALSAR-2 (JAXA) yearly global mosaic product, Sentinel-1 (ESA) imagery, WorldClim bioclimatic variables and NASADEM digital elevation model. Used satellite data was collected for each year in the 2019-2022 period and all raster products were resampled to 10 m resolution. Random forest, xgboost and support vector machine algorithms were tested to train the forest height estimation model with various combinations of satellite imagery. The resulting 10 m CHMs, obtained for each year in the analysed time period were compared with reference CHMs generated based on ALS point clouds. The obtained CHMs were also compared with each other to detect changes in forest height structure.

The best performing model was obtained using random forest algorithm and was described by R2=0.73, RMSE=5.18 m and MAE=4.09 m, which is a

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better result than published global CHMs (Potapov 2021, Lang 2023) based on spaceborne data integration. However, the developed model underestimated the height of tallest forest stands (>25 m) and overestimated the height of short forest stands (<15 m). Year-to-year forest height change analysis showed that the accuracy of obtained models is not sufficient to observe forest stand height increment or changes in forest structure due to thinning, but developed CHMs can be used to detect intensive changes such as clearcuts, or stand-replacing disturbances. Canopy Height Models based on integration of spaceborne data might be interesting source of 3-D forest structure data for areas of Poland without up to date ALS airborne data, but their accuracy is substantially lower than the accuracy of ALS derived CHM.

Detection of microplastic pollution in soils using UV-VIS-NIR reflectance spectroscopy

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Environmental pollution by microplastic (MP) particles is a growing global concern. To date, the majority of studies have focused on the presence of MPs in aquatic environments. However, increasing attention is now being directed toward other ecosystem components, including soils. Traditional methods for analyzing MP concentrations in soil involve collecting field samples and either sieving them in the laboratory to isolate larger particles or using visual identification techniques. More advanced approaches, while potentially more accurate, are complex, time-consuming, and require specialized sample preparation, trained personnel, and expensive equipment and software. Additionally, some techniques necessitate the manual identification and counting of individual MP particles, limiting scalability.

Reflectance spectroscopy in the visible, near-infrared, and short-wave infrared (VIS-NIR-SWIR) regions offers a rapid and non-destructive alternative. It relies on measuring the reflectance of electromagnetic radiation across specific spectral ranges and does not require chemical or physical pretreatment of samples —only drying, brushing, and sieving. It is relatively simple to use and, aside from the initial investment in equipment, involves minimal additional costs. For these reasons, VIS-NIR-SWIR spectroscopy is increasingly being used to assess MP contamination in soils.

Recent studies have shown that MPs in soil affect spectral reflectance, making it possible to detect their presence through VIS-NIR-SWIR measurements. This technique also enables qualitative analyses, including plastic type classification and concentration estimation. However, several methodological gaps remain in the development of reflectance spectroscopy protocols for MP detection, particularly concerning the spectral variability of different MP types and the influence of soil properties on spectral responses. Further research is needed to address these challenges and advance the development of reliable and scalable analytical methods.

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Microplastic Particles from River Sediment can Act as Fomites for Pathogens

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A high abundance of microplastic particles (MPs) in the aquatic environment may contribute to the spread of pathogens. The aim of our study was to assess changes in the microbial community developing on microplastic surfaces incubated in sediment from the Oder River—one of Central Europe's major rivers, flowing through three countries (Czech Republic, Germany, and Poland). Its diverse 20,000 km¸ catchment area, encompasses industrial, agricultural, and urban regions, and supports a relatively high abundance of microbial communities.

Sediment samples were collected from the Oder River in the Wrocław area. The pre-drained sediment was transferred to disinfected glass containers. Control samples were collected on day 0. Subsequently, microplastic particles (~500 mg; ~1 mm in size, Polyethylene) were added. Additional sampling was performed after 7 and 14 days of incubation. From each group, sediment samples were collected after the incubation period (n = 5/group) for microbial DNA extraction and library preparation.

Sequencing was carried out using a MinION sequencer with a 10.4.1 flow cell. The Galaxy Europe platform and R (v4.3.3) were used for analysis, including alpha diversity calculations and PERMANOVA with Benjamini–Hochberg correction for multiple comparisons. To identify biomarker taxa differing between groups, ANCOM-BC (Analysis of Compositions of Microbiomes with Bias Correction) was applied.

The results showed an increase in abundance of pathogenic bacteria such as Aeromonas salmonicida, Vibrio spp., Escherichia coli, and Salmonella after 7 days of the microplastic particle incubation in the sediment.

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The Environmental Impact of the Russia-Ukrainian War on Ukrainian Cities

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The Russian-Ukrainian war has not only reshaped geopolitical landscapes but also profoundly impacted the environment across urban areas in Ukraine. Ukrainian cities, as epicenters of industrial production, energy infrastructure, and civilian habitation, have been subjected to significant environmental degradation due to military activities. Shelling, missile strikes, and occupation have led to the destruction of critical infrastructure, resulting in widespread contamination of air, water, and soil. Industrial hubs like Mariupol, Kharkiv, and Zaporizhzhia have experienced hazardous emissions from damaged factories, chemical spills, and uncontrolled fires. Additionally, the targeting of energy facilities has triggered ecological crises, disrupting water treatment systems and contaminating river ecosystems. Urban resilience strategies are being tested, with cities adapting to manage waste, restore clean water access, and mitigate pollution amidst conflict. The environmental repercussions extend beyond immediate damage, posing long-term risks to biodiversity, human health, and regional climate stability. Understanding the environmental role of Ukrainian cities in this conflict underscores the need for sustainable urban planning and international cooperation to address ecological restoration in post-war recovery. The main goal of this research is to analyze the environmental impact of the Russia-Ukrainian war on Ukrainian cities, including sustainable development.

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Assessing the Impact of War on Forest Ecosystems in Ukraine Using Sentinel-2 Data

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Forests play an important role in ecology, economy, climate regulation, urban planning, and social well-being, making their monitoring and detection of changes essential. This study focuses on mapping forest cover and detecting forest changes in four representative regions in Ukraine: Lviv, Kyiv, Zhytomyr, and Kharkiv, where the ongoing military situation has increased the urgency of environmental monitoring. The study aimed to assess the forest cover, dominant leaf types for 2020 and detect forest losses between 2020 and 2022 to evaluate the environmental impact of the war using a time series of Sentinel-2 data.

The classifications of forest cover and dominant leaf type were performed using the Random Forest classifier, implemented in a Python environment on cloud computing virtual machines. Forest loss was detected using the change detection method in Google Earth Engine, applied to the study areas for the periods 2020-2021 and 2021-2022. This method involved training the classifier using the Kyiv region data for 2020-2021, and then applying the pre-trained model in space and time over the remaining regions. The classification detected the following classes: no changes, wood to non-wood, and burnt forest.

The results revealed significant changes in forest cover, with forest losses affecting approximately 1-2% of the total forest area (51 661 ha). The largest areas of burnt forest were detected in the Kyiv region during 2021-2022, a period of intense military activity. Notably, the Kharkiv region, which was severely affected by the war, showed a substantial increase in forest loss, with a dramatic rise in the area of burnt forests, from 655 ha before the war to 4 632 ha in 2022.

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This highlights the severe ecological damage inflicted upon forests due to military operations, particularly in areas along the conflict's frontlines.

The conflict has significantly intensified deforestation and fire-related damage, further emphasizing the urgent need for systematic environmental monitoring. Sentinel-2 imagery proved to be an effective data source for detecting these changes, enabling precise and timely mapping of forest losses. This study underscores the important role of remote sensing in assessing the environmental impacts of war and its potential to support future ecological recovery efforts in affected regions.

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A Digital Observation System for Wild Animal Movement in Forest Environments: Integrating Sensing, Tagging, and Movement Modeling

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Effective observation of wild animal movement in natural forest environments requires a flexible system that combines non-invasive sensing, spatial data integration, and behavioral modeling. We have developed a multi-component framework that integrates aerial thermal imaging, animal tagging, and trajectory analysis – designed for both controlled and open natural conditions.

The system operates at the Forest Experimental Station in Złotówek, where two enclosures – a hectare educational and 12-hectare research pens – enable continuous monitoring in ecologically varied but structured conditions. These areas offer the opportunity to study animal movement in semi-natural settings, with controlled environmental diversity.

The observation infrastructure includes UAV-based thermal imaging and a detailed geodetic survey.

Drawing from our own field experience, we carried out animal tagging using low-power GNSS devices, successfully tracking individual trajectories inside the fenced research area as well as in open forest conditions. By combining tagging and controlled observation, we captured fine-scale animal movements and behavioral responses to varying environmental features.

As part of the system, we developed a method for detecting animals in daytime thermal images captured during low-altitude winter flights to enhance thermal differentiation. Image processing involves Gaussian smoothing and adaptive thresholding, followed by filtering based on segment size and thermal variance. Each segment is described by a hybrid feature set combining geometric, thermal, and multiscale convolutional features. A machine learning classifier is applied to this compact set, providing efficient object-level classification under real-world conditions, without the need for deep learning or specialized hardware.

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We extend detection insights through trajectory analysis of tagged animals. Behavioral events such as foraging or resting are extracted using stop-detection algorithms and enriched with environmental context (terrain, land cover, weather). We compute movement metrics including visitation frequency, distance locations over time, jump length distribution, waiting time and mean square displacement.

To model underlying mobility patterns, we apply and evaluate Random Walk, Lévy Flight, and density-based Exploration and Preferential Return (d-EPR) models. These help interpret movement structure and support predictive understanding of animal behavior.

This approach – from thermal detection to behavioral modeling – represents our contribution to the Integrated Science of Movement, bridging field observation with formal mobility models for improved ecological research in forested environments.

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Do Rove Beetles Like the Scent of Resin? An Effective Method for Catching some Rove Beetles (*Staphylinidae*)

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This study focuses on rove beetles (family *Staphylinidae*). The main objective was to evaluate the effectiveness of a mixture of α-pinene and ethanol as a potential attractant for these beetles. Insects were collected using screen traps placed at eight locations within the Forest Experimental Station in Murowana Goślina. The specimens were preserved, sorted, and identified. Some of it was prepared. As a result, part of the entomofauna of the Zielonka Forest was documented. The research was conducted as part of a project led by the Department of Entomology and Forest Phytopathology at the University of Life Sciences in Poznań. The results demonstrated that traps using a combination of α-pinene and ethanol were significantly more effective—capturing many times more rove beetles than control traps. The species richness of *Staphylinidae* in selected parts of the Zielonka Forest was notable. The Margalef richness index for traps with the attractant was considerably higher than that for control traps. Overall, the research area was characterized by high species diversity, as confirmed by the Shannon-Wiener index. A comprehensive species list was compiled and analyzed, including a notable presence of rare and relict species.

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UAV Photogrammetry: The Influence of GCP Placement

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Photogrammetry has established itself as a valuable technique across various industries, particularly in building and surveying, due to its capacity to generate high-resolution orthomosaics and Digital Elevation Models (DEMs). The emergence of Unmanned Aerial Vehicles (UAVs) has further revolutionized photogrammetric practices, offering an efficient means to create diverse outputs. This study delves into the accuracy of orthomosaics and DEMs derived from UAV-based photogrammetry, with a specific focus on the impact of Ground Control Point (GCP) placement strategies. The research investigates how different GCP configurations influence the precision of photogrammetric products. By comparing outputs from three distinct UAV models, the study emphasizes the combined influence of GCP distribution and drone specifications on the accuracy of the resulting data. The findings indicate that strategic GCP placement can substantially enhance the quality and precision of photogrammetric outputs. Moreover, the selection of the UAV platform is shown to affect resolution and processing efficiency. This study underscores the critical role of careful GCP allocation within the UAV photogrammetry workflow to ensure the reliability of generated products. Optimal GCP deployment is essential for achieving accurate georeferencing and minimizing errors stemming from GPS inaccuracies, lens distortion, and insufficient image overlap. The research contributes to a deeper understanding of how to balance precision and efficiency in UAV photogrammetry by analyzing the trade-offs associated with various GCP placement strategies. These insights are particularly valuable for practitioners aiming to optimize project outcomes while considering budget constraints and accuracy requirements.

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Multi-annual and Seasonal Variability of Flow River Conditions of the Wełna River

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The aim of this study is to quantify the seasonal and multi-annual variability of river levels and flows in the Wełna River. The study was conducted using daily river flow values at 2 measuring stations for the hydrological years 1980–2023. The results show typical seasonal changes for lowland rivers, such as low flows occurring during the warm season and an increase in water levels at the end of the winter season, which is associated with the period of snowmelt and spring rainfall. An increasing trend in temperature was observed during the warm season; however, no direct correlation with low water levels was found. Similarly, rainfall in the summer season was found to have a small effect on water levels and flow, increasing both values for a short time. These results suggest that the initiation and maintenance of low water levels in the Wełna catchment is more dependent on local water circulation conditions than on atmospheric factors, especially when the time interval between events is short. The volume of water flowing in Wełna is also influenced by the numerous lakes, of which there are 12, because they are equipped with weirs and other hydrotechnical devices that slow down the outflow of water from the reservoirs.

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Enrichment of the Air-water Interface with Biogenic Substances in the Littoral of Four Lakes of the Słowiński National Park, Influences of the Forest Catchment

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The water surface microlayer (SML) is a thin layer at the interface between the hydrosphere and the atmosphere. It is an ecotone with unique properties and the habitat of neustonian organisms, for which this layer is a source of biogenic substances. SML has unique physical, biological and chemical properties (Norkrans, 1980). The special features of SML include the ability to accumulate many chemical substances and microorganisms to a much higher degree than observed in the water column. This applies, among others, to biogenic substances (Hillbricht-Ilkowska and Kostrzewska-Szlakowska, 2004).

There are four lakes in the Słowiński National Park (northern Poland): estuary lake Łebsko (7141 ha), estuary lake Gardno (2468 ha), lake Dołgie Wielkie (156 ha), lake Dołgie Małe (6.3 ha). Lakes Dołgie Wielkie and Dołgie Małe are almost entirely surrounded by forests. All these lakes constitute 31% of the area of the Słowiński National Park. A common feature of these lakes are flat shores and shallow depth. Lake Dołgie Małe is one of the strict protection areas of the park (information from the Słowiński National Park, accessed 2020).

In 2020, samples of the surface microlayer (Garrett, 1965) were collected in the littoral zone of the lakes: Dołgie Wielkie, Dołgie Małe, Gardno and Łebsko. The concentrations of organic and inorganic forms of nitrogen and phosphorus were determined in the tested samples using spectrophotometric methods. The concentration of chlorophyll a was determined in parallel. Statistical tests and multivariate analyses were performed to examine the relationships between the tested components. Enrichment factors in SML relative to subsurface water were calculated.

The obtained enrichment factors for SML differed in the studied lakes. In the case of lakes Dołgie Wielkie and Dołgie Małe, it was probably due to the surrounding forests. These lakes differ significantly in the presence of chloride ions and calcium, which probably affects the chemical composition of SML.

Review of Magnetic Tracing Methods in Fluvial Sediment Transport Studies

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Tracing methods have been used in studies of river sediment transport intensity and gained popularity in the 1980s, particularly in mountain rivers. Currently, their application relies on modernized techniques for the preparation, collection, and measurement of sediment transport processes and bed material abrasion. Additionally, tracing methods are often integrated with other techniques to assess the intensity of sediment movement.

This study presents the importance of magnetic tracing methods in river sediment research, along with their stages of development and specific research characteristics. Methods for marking materials with magnetic tracers, sampling techniques, and tracer measurement procedures are described and compared in terms of their respective advantages and limitations, with particular emphasis on their functionality, durability, and the reliability of results under both laboratory and field conditions.

In addition to the review of magnetic methods applied in fluvial transport, the main practical limitations and prospective directions for future methodological development are also presented.

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Analysis of the Species Composition of Leeches (*Hirudinea*) in Aquatic Habitats of the Morasko Campus

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Leeches (*Hirudinea*), a class of annelid worms, play an important ecological role in freshwater ecosystems by regulating invertebrate populations and serving as vectors for parasites and pathogens. This study investigates the species composition of leech communities across various types of water bodies located on the Morasko Campus in Poznań, Poland. The main objective was to assess taxonomic diversity and evaluate how leech assemblages vary depending on environmental features such as trophic state, hydrological type, and microhabitat structure.

Fieldwork was conducted in five morphometrically distinct water bodies differing in their degree of anthropogenic impact. Specimens were collected manually and examined under a stereomicroscope. Identification was carried out using a diagnostic key developed for native Polish leech species. Additionally, environmental parameters were recorded, including substrate type, presence of littoral vegetation, and water transparency.

A total of 13 leech species (of the 49 known in Poland) representing five families were identified, including members of the genera Hirudo, Erpobdella, and Glossiphonia. Marked differences in species composition were observed between eutrophic and oligotrophic habitats. Stenotopic species such as Hirudo medicinalis—legally protected in Poland—were found exclusively in highly eutrophic, structurally complex environments rich in submerged wood and stones, which is its typical habitat. Several rarely recorded taxa in the country were also documented, including Erpobdella nigricollis, highlighting the ecological value of the study area. In contrast, species typical of degraded or simplified habitats were prevalent in less structured water bodies. Flowing waters harbored Erpobdella vilnensis, a leech species rarely reported in Poland and associated with riverine habitats.

The findings indicate that leech community composition in the Morasko Campus is closely linked to habitat characteristics, suggesting a high degree of ecological specificity. These results contribute to a better understanding of local

Hirudinea diversity and underline the importance of the campus area as a valuable site for invertebrate biodiversity research. Moreover, the presence of rare and protected species reinforces the need for ongoing ecological monitoring and conservation efforts.

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Social Perception of Combustion Engine Vessels on Lake Areas in the Context of Environmental Protection and Tourism: An Analysis of Lake Ślesińskie

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The article analyzes the social perception of combustion units on lake waters, focusing on their impact on environmental protection and tourism, using Lake Ślesińskie as an example. The paper presents the results of two surveys conducted among tourists and users of motorboats. The research shows a variety of opinions on the impact of combustion units on the natural environment and the quality of tourist experiences. The postulates concerning legal regulations and management of water tourism in the context of lake protection were also analyzed. The article aims to indicate key aspects of the social perception of this type of activity and to propose actions aimed at the sustainable development of tourism on inland waters.

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Geocaching as a Form of Active Alternative Tourism. An Analysis Based on Forested Areas in Poland

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People are constantly seeking motivation to be physically active, especially in open spaces, to commune with nature in various ways, to discover interesting and attractive places, and – a sign of the times – to document or publicize this experience systematically. This was the message behind the launch almost 25 years ago, at a time when the global GPS was improving its positioning accuracy, of an outdoor game offered free of charge to all age groups, which involves searching for geocaches, hidden by other participants using geographical coordinates. Geocaching has developed intensively over the following two decades, attracting new participants to this activity on the one hand and, on the other, steadily increasing the number of geocaches offered to be found, covering ever larger areas. Registered participants of this active alternative tourism obtain information – description, coordinates, or additional clues – about the places where geocaches are hidden from two main geocaching portals: geocaching.com and opencaching.pl, in which a total of almost 100,000 geocaches have been registered to date in our country. The aim of the study was to analyse all the geocaches established to date in Poland by geocaching portals about the provincial areas and areas managed by the Regional Directorates of State Forests, taking into account the main forms of land cover, including primarily forest areas, which today cover nearly 30% of Poland.

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Typological diversity of forest soils in the Miękinia Forest District

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River valleys represent a mosaic of terrestrial and aquatic environments. Most of the natural habitats found in these areas are associated with regular flooding, while the frequency and duration of these floods are the most important ecological factors determining their existence. In small areas such as forest districts, soil conditions are the decisive factor behind habitat variability and consequently the species composition of forest stands.

Soils in the middle Oder valley are subject to constant transformation. As a result of river flow regulation and the reduction of flood events, the natural process of alluvial soil substrate deposition has been halted. This often leads to a lowering of the groundwater table, which is also reflected in the vegetation cover. The specific characteristics of alluvial soils are crucial for maintaining biodiversity and the uniqueness of natural habitats.

The aim of the study was to demonstrate the diversity in the morphology and properties of alluvial soils and to assess their transformation under river regulation conditions. Research sites were selected based on two criteria: soil moisture levels and plant communities. Soil profiles were established in the Miękinia Forest District across five habitat types: riparian forest, hornbeam forest, alder swamp, moist forest, and fresh mixed coniferous forest. Soil samples were analyzed using standard soil science methods and forest habitat classification was performed using the Soil Habitat Index (SIG).

The analyzed soils were classified as alluvial soils (fluvisols), organic soils, and arenosols. The results revealed significant variation in soil and habitat properties, indicating the dominance of eutrophic and mesotrophic habitats (forests and mixed forests). Based on the SIG index assessment, inconsistencies and discrepancies in habitat classification were identified suggesting possible habitat degradation linked to anthropogenic pressure. The conclusions from the study are of both scientific and practical significance—they may be used to update habitat maps and develop recommendations for forest management planning and nature conservation in the middle Oder valley.

Phytoremediation Capacity of Willow under Increased Soil Salinity

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The study evaluated the growth response of two willow varieties, *Salix* × *smithiana* and *Salix viminalis* var. *Gigantea*, to heavy metals and soil salinity under simulated phytoremediation conditions. Plants were developed from stem cuttings and cultivated in pots with soil artificially polluted with a mixture of heavy metals. Sodium chloride was added to increase soil salinity and induce osmotic stress. *S.* × *smithiana* showed enhanced growth under combined stress, with higher relative water content in leaves and greater Zn and Cd accumulation in shoots, suggesting tolerance mechanisms. In contrast, *Gigantea* exhibited growth inhibition and metal sequestration in roots, indicating stress avoidance. Salinity alone suppressed growth of both genotypes, but in *S.* × *smithiana* its combination with metals mitigated the effect. Zn and Cd showed the highest bioconcentration and translocation to aboveground organs. Based on accumulation patterns, *S.* × *smithiana* may be applied for phytoextraction, and *Gigantea* for phytostabilization of investigated metals under increased soil salinity.

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Natural Deep Eutectic Solvents as a Sustainable Solution for Contaminated Natural Areas

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Environmental pollution by heavy metals such as Cu poses a significant risk to natural and forest ecosystems due to its persistence, bioavailability, and ecotoxicological effects. Conventional soil washing agents such as EDTA, though effective in metal removal, are associated with poor biodegradability and potential secondary pollution. This study investigates the use of Natural Deep Eutectic Solvents (NDES), based on choline chloride and citric acid, as a sustainable alternative for Cu removal from contaminated soils. The impact of varying molar ratios (1:1, 1:2, 1:3) and dilution levels (10–50% v/v) on extraction efficiency was evaluated, along with the kinetic behavior of the system over a 48-hour period. The most effective configuration (1:1, 50% v/v) was subsequently compared with a standard EDTA-based extraction system (0.05 M), allowing for direct evaluation of removal efficiency and ecological safety. The most effective configuration (1:1, 50% v/v) achieved copper removal efficiencies up to 93% from total soil content, with most extraction occurring within the first 180 minutes, following pseudo-second-order kinetics. While EDTA exhibited slightly higher maximum removal rates (up to 97%), its use resulted in significant adverse effects on microbial biomass and enzymatic activity in the soil. While EDTA achieved slightly higher maximum removal rates (up to 97%), it negatively affected soil microbial activity and raised concerns due to its low biodegradability. In contrast, the NDES system, despite its slightly lower removal efficiency, successfully reduced the residual Cu concentration in soil below permissible regulatory limits, ensuring compliance with environmental quality standards. These findings support the implementation of NDES-based strategies in the remediation of Cu-contaminated soils within environmentally sensitive landscapes.

Keywords:
Cu extraction, Deep eutectic solvents, Soil remediation, EDTA comparison, Forest ecosystem safety, Green technologies

Effective Management of Coal Industry Waste in Poland

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The management of coal mining waste is a critical issue for the Polish energy and environmental sectors. Coal mining generates vast amounts of waste, including coal fines, tailings, and mine water, which pose environmental challenges and economic opportunities. Effective management of these by-products aligns with global sustainability goals and helps mitigate environmental degradation while extracting value from waste. This study aims to analyze current practices, technological advancements, and potential improvements in coal waste management in Poland, incorporating recent literature and practical examples.

Poland, with its long-standing tradition of coal mining, has accumulated significant experience in handling coal waste. Research shows that coal waste management practices have evolved over the years, focusing on minimizing the environmental impact and enhancing resource recovery. Bondarenko (2020) and Drezhpak (2021) highlight the critical need for adopting sustainable and innovative methods to manage coal waste effectively. These scholars emphasize that coal waste contains economically valuable minerals, including rare earth elements (REEs), which are essential for various high-tech industries.

This research utilizes a mixed-method approach, combining qualitative analysis of existing literature with quantitative data from case studies in Poland's coal mining regions. The study assesses the chemical composition of various coal by-products, evaluates the effectiveness of extraction and recycling methods.

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Emission of Selected Gases from Self-heating Coal Waste Dumps on the Example of the Bytom Heap

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Coal waste dumps have become part of the landscape of the Silesian region, where mining has been conducted for over a century. Once deposited, organic matter and minerals undergo many secondary processes (e.g., water washing, biodegradation, and oxidation), generating harmful gases and odors during self-heating and self-combustion of the accumulated material and leaching of water-soluble components (e.g., Drenda et al. 2007; Misz-Kennan, Fabiańska, 2010; Fabiańska et al., 2017; Różański, 2018). Self-heating waste emits significant amounts of dust, greenhouse gases (CO2 and CH4), and other gases: NH3, NOx, SOx, H2S, HCl, and PAHs. In addition, dust pollution containing heavy metals (e.g., Se, Pb, Hg, and As) is released into the atmosphere (Nádudvari et al., 2021)

Gaseous, liquid, and solid products of these changes can migrate into the surrounding environment, so coal waste dumps should be treated as an important environmental problem. The scale of the problem is enormous, as it is estimated that there are over 136 coal waste dumps located in the Upper Silesia region. They cover an area of 3,500 ha, and the estimated amount of deposited materials is 750 Mg (Drenda et al., 2007). However, this issue is not limited to this region of Poland, but similar problems occur everywhere in the world where hard coal is or was extracted in the past, e.g. in China, the USA, Australia, Ukraine, the Czech Republic, Portugal, India, Indonesia, South Africa and Russia (Ribeiro et al., 2022; Nadudvari et al., 2020; Jelínek et al., 2014; Querol et al., 2011; Kuenzer et al., 2007; Boekemeier et al., 2002; Deng et al., 2001; Glover, 1998; Prakash et al., 1999; Prakasz & Gupta, 1998).

The general objective is to investigate the impact of pollutants from self-heating landfills as uncontrolled emission sources that affect the environment, especially air quality and human health. So far, 14 measurement campaigns have been carried out at the mining landfill in Bytom, taking into account selected gases (e.g., CO, CO2, H2S, benzene, formaldehyde, TVOC, etc.). The measurements of the concentrations of gases polluting the atmosphere were performed using specialist measuring equipment of the University Laboratories of

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Atmosphere Control (ULKA) - DUVAS gas analyzers (the only such device in Poland) and Grey Wolf AdvancedSense PRO with sensors for measuring gases. Then the results were converted into real concentrations in the air. Among the gas components, alarming concentrations are reached by HCN, H2S, NH3, and SO2. The results obtained will be used to prepare a doctoral dissertation.

Key words:
self-heating, coal waste dumps, hard coal mining, atmospheric pollutants, gases

Urban Snow as a Mirror of Pollution: A Case Study From Post-industrial Starachowice

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Urban snow serves as a temporary sink for atmospheric pollutants, especially in post-industrial areas. When melting, it releases accumulated contaminants—such as heavy metals and particulates—into the soil and water, affecting ecosystems and posing health risks. This study analyzes the chemical composition of snow in Starachowice, a medium-sized city in southeastern Poland with a complex industrial past and ongoing urbanization.

Samples were collected in December 2023 from different sites representing diverse land uses: former and active industrial zones, commercial areas, roadsides, and green spaces. The snow cover averaged 11.4 cm and was influenced by recent snowfall and air mass movement. Laboratory tests assessed pH, electrical conductivity (EC), and concentrations of heavy metals (Pb, Cd, Cr, Co, Cu, Mn, Ni, Zn, Al, Fe). Results showed a slightly alkaline pH (6.71–7.23) and elevated heavy metal levels, particularly near the Odlewnie Polskie S.A. plant in the city's south. Lower concentrations were found in the central part of the city.

SEM/EDS analyses revealed the presence of coarse angular particles and spherical particulates composed of aluminum, iron, and magnesium—indicative of industrial emissions. These particulates may disrupt plant physiological processes, reducing forest ecosystem resilience. Additionally, the presence of toxic metals in airborne dust raises public health concerns, including risks of respiratory and cardiovascular diseases and developmental effects in children.

The findings confirm that snow in urban-industrial areas reflects spatial pollution patterns and acts as a carrier for contaminants during melt periods. The study highlights the importance of snow monitoring as a low-cost tool to assess environmental quality. Addressing these pollution sources requires integrated strategies that consider both historical industrial activity and present-day emissions. In transitional landscapes like Starachowice, regular snow analysis can inform urban planning, public health initiatives, and environmental protection policies.

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Particulate Air Pollution in Katowice

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Atmospheric air pollution is one of the most important environmental problems globally. A fundamental problem during the heating season is the above-normal concentrations of pollutants, especially particulate matter, which are often exceeded. Currently, the main source of air pollution in Poland is low emissions, which consists of from the inefficient burning of fossil fuels in single-family homes and road transportation. Particulate matter is understood to be a mixture of solid and liquid particles suspended in the air. Dusts, and fine particles of solid or liquid matter, when emitted into the atmosphere, remain suspended in the atmosphere and form aerosols with different properties, depending on the fraction, surface area, morphology, shape and chemical composition of the particles. For the purpose of this research, field measurements of particulate matter of various fractions were carried out using the specialist equipment of the University Laboratories for Atmosphere Control of the University of Silesia in Katowice. Field measurements were carried out in early 2023 using the Overhead Mobile Laboratory and the Field Mobile Laboratory in selected districts of Katowice.

When conducting the study, attention was paid to the type of development, which determines the specifics of heating and the proximity of roads, which are a source of traffic pollution. Due to the high variability of atmospheric conditions and other components, such as current traffic, the data should be treated as indicative. The results of the study depend primarily on the conditions found and reflect the situation at a particular place and time. The occurrence of low emissions was confirmed by the results of the study, which showed very high concentrations of particulate matter in the southern districts of Katowice, where single-family old buildings predominate and building heating is unsuitable. An impact of automobile traffic on air quality was found.

Mercury Concentration in Non-commercial Fish from the Puck Lagoon and Vistula Lagoon

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Due to intensive human activity (especially in the second half of the 20th century), a large load of chemical elements has been extracted from the Earth's natural deposits. One of them is mercury (Hg), which plays no beneficial role in living organisms and is a neurotoxin. Ideally, it would be absent from our environment, but that is not the case and never will be, as it is a naturally occurring element on our planet. Moreover, humans have introduced it into circulation through its widespread use in industry. Thanks to restrictions implemented in many European countries at the turn of the 20th and 21st centuries, emissions of toxic substances such as mercury from anthropogenic sources have significantly decreased. However, its concentration in the natural environment has not decreased proportionally.

Therefore, it is crucial to understand mercury cycling in the environment, especially in the marine environment, as fish and seafood are the main sources of mercury intake in humans. Many scientific studies focus on mercury concentrations in sediments and commercially important fish species, but there is a lack of information on its transfer across different trophic levels—especially in small, non-commercial fish.

The aim of this study was to investigate the role of small, non-commercial fish in mercury transfer within the marine trophic network, using the southern Baltic Sea as a case study. The Puck Lagoon and the Vistula Lagoon were selected as research areas.

Mercury concentrations were measured using the DMA-80 mercury analyzer, which uses thermal desorption. Preliminary findings indicate that non-commercial fish are an important vector of mercury in the southern Baltic trophic network. Notably, in some species (e.g., ninespine stickleback, rudd), mercury concentrations were higher than in commercial fish from the same area. Fish from the Puck Lagoon exhibited lower mercury concentrations compared to similarly

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sized fish from the Vistula Lagoon. The mercury concentrations in the analyzed fish ranged from 17.2 to 181.3 ngHg/g dry weight.

Protective Effects of Fruits, Vegetables, and Seeds on the Functions and Structure of the Skin

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The skin performs a number of important physiological functions. Its condition reflects the influence of environmental and internal factors, as well as dietary habits. Interest in nutritional approaches is growing significantly, particularly in dermatology and biocosmetology. Special attention is paid to the consumption of fruits and vegetables as sources of bioactive compounds. The fruits and vegetables described in this paper are valuable sources of vitamins, minerals, carotenoids, polyphenols, and antioxidants. A diet based on high consumption of plant-based products may influence skin physiology and function. The aim of this study is to present knowledge on the impact of consuming selected fruits and vegetables on skin health.

One of the most popular fruits is avocado, which is a rich source of carotenoids (lutein, zeaxanthin) and unsaturated fatty acids. Carotenoids delay skin aging in humans by stimulating fibroblasts to synthesize collagen and elastin, inhibiting the activity of metalloproteinases, and exhibiting anti-inflammatory properties as well as the ability to absorb UV radiation.

Similar properties are also found in other tropical plants, such as Garcinia mangostana, which positively affects skin condition by protecting epidermal keratinocytes from oxidative stress induced by free radicals. This helps delay aging processes and supports skin regeneration mechanisms. Its biological activity stems from the presence of bioactive compounds, particularly xanthones such as alpha-mangostin and beta-mangostin, which are considered key to its pharmacological properties.

Beetroot is a vegetable that plays an important role in skin care and protection. It is a natural source of betalains – plant pigments with strong antioxidant properties. Specifically, betanin, abundant in beets, effectively neutralizes harmful free radicals. In dermatology, betalains are studied for their

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ability to protect skin cells from oxidative stress, which significantly contributes to accelerated skin aging and inflammation. These compounds also support the skin's natural regenerative mechanisms and can positively affect its color and elasticity.

Another significant group is the seeds of Passiflora edulis, which are characterized by high polyphenol content. In the context of skin health, seed extracts exhibit protective effects by stimulating collagen synthesis and increasing levels of endogenous antioxidants.

In summary, skin condition largely depends on diet. Plant-derived compounds such as carotenoids, xanthones, polyphenols, and betalains exert beneficial effects on skin structure and function demonstrating antioxidant and anti-inflammatory properties, stimulating collagen synthesis, improving elasticity, hydration, and skin tone, and counteracting signs of aging. Available research indicates the potential of selected fruits and vegetables in dietary therapy for the prevention and supportive treatment of dermatological conditions.

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The Relationship Between Asthma and Hypertension in Children and Adolescents and Atmospheric Air Pollution in Bielsko-Biała

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Chronic diseases are a serious problem in the modern world. Even short-term exposure to polluted air increases the incidence of both hypertension (hypertension) and asthma.

The aim of the study is to determine the relationship between the level of selected atmospheric air pollution in Bielsko-Biała in the years 2018-2022 (nitrogen dioxide, suspended dust PM2.5 and PM10 and benzo(a)pyrene) and the incidence of asthma and hypertensive disease among children and adolescents. from 0 to 18 years of age in Bielsko-Biała**.**

Based on data from the Department of Health - Silesian Voivodeship Office in Katowice, tables illustrating the incidence of the above-mentioned diseases were prepared. Annual average concentrations of air pollutants, the Statistica program and Pearson's correlation coefficients were also taken into account.

The incidence of hypertensive disease and asthma is decreasing and amounts to 24.6/10,000 in 2018 and 20.3/10,000 in 2022 in the case of hypertensive disease and 349.8/10,000 in 2018 and 317 .4/10,000 in 2022 for asthma. The average annual concentration of PM10 and benzo(a)pyrene is decreasing.

Between 2018 and 2022, the discussed average annual concentrations of substances were not exceeded. The decreasing incidence of both asthma and hypertension is related to the improvement in atmospheric air quality.

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