A Holistic Approach to Water Monitoring and Conservation

ABSTRACT BOOK

2nd International Conference
2026

Editor in Chief: Julita A. Dunalska

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Global Water Future…

Water defines our future. It shapes our landscapes, sustains biodiversity, drives economies, and connects societies across continents. Yet despite its fundamental role, water is under increasing threat. Global demand has grown by around 1% each year for the past four decades and is expected to continue rising at a similar rate until 2050. At the same time, water scarcity and declining quality are endangering ecosystems, human health and sustainable development. In some regions, shortages are already resulting in measurable economic losses of up to 6% of gross domestic product (GDP).

The pressures of the Anthropocene are intensifying. Rapid population growth, industrialisation, changes in land use, and climate-driven disturbances are accelerating eutrophication processes and triggering harmful cyanobacterial blooms whose toxins pose severe ecological and health risks. These challenges cannot be solved by technology alone. A holistic, interdisciplinary, and global approach is required — one that combines cutting-edge monitoring tools, innovative engineering solutions and effective legal frameworks with the active participation of society.

With this in mind, the Center for Water Monitoring and Protection proposed the Global Water Future (GloWaF) conference. This international, interdisciplinary event brings together researchers and citizens to collaborate on creating knowledge and solutions for tomorrow's aquatic environments. The programme covers a variety of fields, including engineering, biotechnology, paleolimnology, toxicology, climate adaptation and geoinformatics, reflecting the complexity of the challenges we face, and the range of tools required to address them.

The collection of abstracts presented here not only illustrates the breadth of contemporary water research, but also the creativity and commitment of the next generation of scientists. By sharing their findings and perspectives, these researchers are contributing to a common goal: safeguarding the most vital resource on our planet, ensuring that water continues to be a source of life, resilience, and prosperity for future generations.

Prof. dr hab. inż. Julita A. Dunalska
Editor in chief
The Global Water Future – a holistic approach to water monitoring and conservation
2nd international Conference
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SCIENTIFIC AND ORGANIZING COMMITTEE

Prof. Julita Dunalska

full professor at the University of Gdańsk, Head of the Center for Water Monitoring and Protection. Her research focuses on the protection and restoration of lakes, nutrient cycling, organic matter transformation, and the effects of climate change on aquatic ecosystems. She is author or co-author of over 130 publications and numerous expert reports. A Fulbright scholar at the University of Wisconsin–Madison, she is an active member of several scientific organizations, including GLEON and the UNESCO IHP National Committee. She also served on the National Council of Water Management and as editor in the Polish Journal of Natural Sciences

Prof. Monika Normant-Saremba

oceanographer and professor at the University of Gdańsk, Head of the Department of Marine Ecology and the Laboratory of Ecophysiology and Bioenergetics. Her research addresses the biology and ecology of aquatic organisms, especially the adaptations of benthic invertebrates to natural and anthropogenic stressors. She also studies non-indigenous species and their ecological and economic impacts. She has conducted research in Germany, authored numerous scientific works, and actively contributes to marine environmental protection through ICES, HELCOM, and the Polish Academy of Sciences.

Assoc. Prof. Katarzyna Jankowska

an oceanographer and Professor at Gdańsk University of Technology, she works at the Department of Technology in Environmental Engineering (Faculty of Civil and Environmental Engineering, Gdansk Tech). Her research focuses on the microbiology and ecology of aquatic environments and on microbiological aspects of water and wastewater technologies, with particular emphasis on coastal and polar ecosystems. She has conducted research in the Arctic and Antarctica, spending over two years in Spitsbergen (including a one-year stay at the Polish Polar Station Hornsund) and over three months in Antarctica. She is the author of numerous publications and leads scientific and educational projects. She serves as Gdansk Tech's delegate to the Council of the Polish Polar Consortium and is a member of the Committee on Polar Research of the Polish Academy of Sciences. She is also the founder and academic supervisor of the Gdansk Tech Student Scientific Club "Microbiology in Environmental Engineering".

Assoc. Prof. Anita Lewandowska

oceanographer and professor at the University of Gdańsk, Head of Laboratory of Biogeochemical Cycling of Elements at the Faculty of Oceanography and Geography (University of Gdańsk). Her research focuses on the causes and consequences of environmental pollution, especially the atmosphere, and the processes occurring at the sea - atmosphere interface. She is author or co - author of about 100 publications, monographs and scientific essays. She has broad international experience, including participation in COST 729 Actions on "Aassessing and managing nitrogen fluxes in the atmosphere-biosphere system in Europe", and membership of several international networks and projects, like BAEX, BASYS, BERLIOZ, ANICE, BERLIOZ, EUSAAR, ACTRIS etc. She is Editor-in-Chief of Oceanological and Hydrobiological Studies and Editor in Atmosphere.

Assoc. Prof. Maciej Tankiewicz

associate professor at the Medical University of Gdańsk and Acting Head of the Department of Environmental Toxicology. Specialist in the field of environmental health and the head of the environmental health studies program. His research focuses on food toxicology, ecotoxicology and the impact of changes in the environment on human health. He pays particular attention to health risks resulting from exposure to pesticides and endocrine active substances. He actively participates in activities for public space, including the adaptation of cities to climate change and improving the quality of life of residents. Member of the Polish Society of Environmental Medicine, Polish Chemical Society, Polish Society of Toxicology and Gdańsk Scientific Society.

Dsc. Andrzej Reindl

assistant Professor at the Department of Environmental Toxicology, Medical University of Gdańsk. He holds a PhD in Earth Sciences (marine chemistry), a law degree, and is a certified court expert in environmental protection. His research explores toxic and genotoxic substances in the environment and their impact on human health and occupational exposure. He also works as an environmental risk management expert at the law firm PORT PRAWA, is a certified lead auditor of ISO 14001 and ISO 9001 systems, and author of numerous environmental reports and analyses.

Iwona Bubak PhD

assistant professor at the Division of Marine Ecosystem Functioning at the University of Gdańsk. Her research interests focuse on taxonomy, biodiversity, and ecology of marine and lake phytoplankton and phytobenthos, with particular emphasis on diatoms; the use of biological indicators in assessing the ecological status of aquatic environments and in paleoecological reconstructions; natural and anthropogenic causes of aquatic environmental transformation. She also isolates and cultivates algae from freshwater and marine environments. She also teaches at a summer schools on the identification of diatom phytobenthos and water pollution in the Gulf of Gdańsk, as well as workshops for schoolchildren presenting tchem life (on a microscale) in water.

Rafał Chmara PhD

assistant professor at the Department of Plant Ecology, University of Gdańsk. His research focuses on the hydrobiology and aquatic ecology, macrophytes and environmental conditions. He also studies the functional traits of aquatic plants belonging to different ecological/taxonomic groups in relation to environmental conditions and and functional adaptations to the local environment. He has authored numerous publications on aquatic plants ecology and lakes, combining academic research with with expert work in the area of biomonitoring and protection of lakes.

Sambor Czerwiński PhD

paleoecologist specializing in palynological analysis to reconstruct environmental changes based on lake sediments and peat. His work focuses on human impact on vegetation over the past 2000 years, with research areas in Poland, Germany, Western Siberia, and Greenland. He teaches at the University of Gdańsk, offering courses such as Biogeography, Soil Science, and Environmental Reconstructions, integrating research with education.

Włodzimierz Golus PhD

limnologist and hydrologist at the Centre for Water Monitoring and Protection, University of Gdańsk. His research interests include the circulation of water and matter in natural and artificial reservoirs, processes of degradation and disappearance of small water bodies under human pressure and climate change, and the functioning of large coastal and urban lakes. He combines academic research with teaching and environmental education, actively promoting ecological awareness.

Maciej Markowski PhD

head of the Laboratory of Geographic Information Systems at the University of Gdańsk and Software Application Developer at Boeing Poland. He holds a PhD in Earth Sciences and has over 17 years of experience in GIS technologies, spatial data transformation (ETL), and geospatial analyses. His expertise includes GIS, remote sensing, and navigation data for environmental analyses and application development. He has authored numerous publications, participated in national and international projects, and serves as Head of Postgraduate GIS Studies and member of the Polish National Committee for the International Cartographic Association.

KEYNOTE LECTURE

Helen M. Graves

Freshwater ecologist and pond restoration practitioner specialising in biodiversity, climate resilience, and nature-based solutions.

Helen Margaret Greaves is a freshwater ecologist and Research Associate at University College London (UCL), working with the Pond Restoration Research Group. Her research focuses on the ecological restoration of freshwater ponds and their role in supporting biodiversity, ecosystem functioning, and climate resilience within agricultural landscapes. She has most recently contributed to the EU Horizon 2020 PONDERFUL project, an international collaboration investigating the ecological and societal value of ponds across Europe, including research examining how pond restoration influences greenhouse-gas dynamics and the role of small waterbodies in climate regulation.

Helen is co-founder and executive director of the award-winning Norfolk Ponds Project CIC, a conservation partnership established in 2014 that integrates academic research with practical habitat restoration. Working with farmers, conservation organisations, and public bodies, the project has restored historic farmland ponds - including long-buried "ghost ponds" and overgrown "zombie ponds" - demonstrating their remarkable capacity to rapidly recover biodiversity and deliver ecosystem services following restoration.

From 2018 to 2023, Helen served as Secretary of the European Pond Conservation Network, helping to strengthen international collaboration among researchers and practitioners working to conserve small freshwater ecosystems. Alongside her academic work, she is founder and director of Restoreco Ltd., which develops the concept of restorative ecology - an approach that links ecological restoration with the restoration of human wellbeing through participation in practical conservation.

Through both research and practice, Helen uses the humble pond as a model system for understanding wider freshwater processes, demonstrating how the restoration of small aquatic habitats can contribute to biodiversity recovery, water resilience, and climate-sensitive landscape management.

WORKSHOPS

Workshop 1: How to build a relationship with nature and care for mental health through forest bathing?

Izabela Sałamacha

ecological educator & climate expert; member of Polish Forest Bathing and Forest Therapy Association

ecological and climate educator, communication & ESG expert. Graduate of journalism and social communication at the University of Warsaw and the Pharmacoeconomics Study at the Warsaw University of Technology Business School. She also completed postgraduate studies in CSR at ALK in Warsaw. Lecturer and speaker in the field of corporate social responsibility and sustainable development at Kozminski University and Vistula University. Engaged in public debate on the state of Polish rivers and the protection of water resources on our planet. Author of the podcast *„Zmieniaj Świat"*. Press spokesperson for Operation Clean River, the largest social cleanup action of rivers and green areas in Poland. Certified Forest Therapy Hub guide and certified Climate Mosaic moderator.

Forest bathing — *Shinrin-yoku* — is a practice rooted in Japanese tradition that encourages slowing down, opening the senses, and reconnecting with nature in a mindful, healing way.

This workshop aims to introduce participants to the key principles of forest bathing; it combines guide-led sensory exercises with group reflection and practical techniques that can easily be incorporated into daily life.

During the session, we will explore how consciously spending time in nature and amidst greenery can reduce stress, lower cortisol levels, improve mood, and foster an enduring sense of belonging to the natural world. Through a series of gentle invitations to engage, we will seek to read the language of nature and build a deeper, reciprocal relationship with the natural environment.

Forest bathing is a practice that participants can continue after the workshop concludes, helping them build a connection with nature in their own local surroundings. Whether you are just beginning your journey with forest bathing or are already familiar with its benefits, this workshop offers a safe and supportive space to deepen your relationship with nature and yourself. No prior experience is required—all that is needed is an open mind and a willingness to slow down and immerse yourself in the natural world.

Recommended accessories for participants: comfortable clothing and footwear suitable for the weather, a sweatshirt or something to sit on, water.

Workshop 2: How can algae affect our health?

Iwona Bubak, PhD

algae specialist & phytoplankton ecologist

specialist at the Culture Collection of Baltic Algae. Her research focuses on the taxonomy, biodiversity, and ecology of marine and lake phytoplankton, with a particular emphasis on diatoms. She works on the application of biological indicators in the assessment of the ecological status of aquatic environments and in palaeoecological reconstructions. She also investigates the natural and anthropogenic drivers of environmental change in aquatic systems.

Algae and cyanobacteria are among the most important biological components of aquatic ecosystems. These photosynthetic micro- and macro-organisms produce oxygen and organic matter, forming the base of the food chain. They play many positive roles — from water self-purification and element cycling to serving as bioindicators of pollution. Yet their excessive growth (blooms) can also lead to fish kills and eutrophication.

Algae are far from indifferent to humans. Rich in fats, sugars, minerals, and bioactive compounds, they have found applications across the food, cosmetics, and medicine industries — including aesthetic medicine and environmental protection.

During this hands-on workshop, we will learn to identify microalgae and cyanobacteria characteristic of Polish fresh waters using laboratory microscopes. We will also explore how humans have harnessed algae — with a special focus on their beneficial effects on our health and appearance. As a curiosity, we will also get to know marine macroalgae and their uses

Century-Scale Hydrological Transformation of an Urban Lake: The Case of Lake Czerniakowskie

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Small urban lakes are increasingly vulnerable to the combined pressures of urbanization and climate change. This study analyzes the century-scale hydrological decline of Lake Czerniakowskie, a post-riverine lake in Warsaw, by comparing historical bathymetric data from 1921, with modern monitoring (2008–2024). The lake's degradation was initiated by the construction of flood-protection dikes that severed its natural connection to the Vistula River. Subsequent intensive urbanization further modified the system through significant groundwater lowering caused by industrial drainage and a pronounced reduction in the lake's effective catchment area due to modern stormwater systems. These factors have led to a substantial reduction in both surface area and water volume, accompanied by the progressive terrestrialization of former bays now lost to vegetation and land development.

Currently, the lake functions as a closed system, making its water levels highly sensitive to meteorological conditions, with evapotranspiration now the dominant cause of water loss. Observed decreasing trends in water levels suggest a rapidly accelerating disappearance of the lake. These findings highlight the critical need for climate-adaptive management to preserve remaining urban aquatic ecosystems and provide essential context for future ecological assessments.

Proposals for the restoration of lake Rogoźno based on 25 years of observations

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Lake Rogoźno is a natural body of water through which the Mała Wełna River flows, with an average depth of 3 m (maximum 5.8 m) and a surface area of approximately 130 ha. In the 1980s, many tons of fish were caught annually from Lake Rogoźno; the swimming areas were open throughout the season, and while diving, fishes were visible thanks to the water's greater clarity. Mussels and other organisms clung to the rocks removed from the lake. At that time, water from the lake was used to water animals. Since then, numerous actions have been taken that have led to the destruction of the lake and the natural environment surrounding it. Many of these actions were carried out at the initiative of the local government in Rogoźno. In the 1990s, during the breeding season, the natural shoreline with its reed beds was destroyed; a large amount of waste was dumped there, and a promenade was built. In 2000, a dam was built at the lake's outlet, turning the body of water into a sedimentation basin for pollutants from the entire Mała Wełna River basin, which is heavily burdened by agricultural pollution. Even after the dam was built, raw—untreated—sewage from Rogoźno continued to flow into the lake for many years.

The fish passage built next to the dam does not function properly and prevents fish from migrating to their spawning grounds. In many areas around the lake, trees and shrubs were cut down without the required permits—these trees served as an important natural protective buffer for the lake. A few years ago, near to outflow from Lake Rogoźno, floodplains that served as breeding grounds for amphibians and birds were filled in without authorization. On several occasions in recent years, fallen trees were removed from the Mała Wełna River. The work was carried out without the required permits on the lake's tributary. This contributed to faster water runoff from the landscape and increase the drought problem. In 2019, the lake was opened to jet skis and motorboats. They create a great deal of noise and waves as they travel across the lake, scaring away birds in the reed beds. In 2017, lake restoration began without any protective measures—it involved the introduction of large quantities of chemicals, but without conducting the required examination on bottom sediments. The restoration did not improve the lake's ecological condition, but it does temporarily improve water clarity; therefore, chemicals are added mainly before major events that draw large crowds to the lake. In the lake's immediate watershed, many areas have been paved to create new streets and parking lots without implementing systems for effective stormwater treatment.

The presentation outlined the risks, as well as the actions taken by the Rogozińskie Lake Association to protect the lake and the proposed remedial measures.

Surface water contamination by polycyclic aromatic hydrocarbons in selected Norwegian seaports and on the transect between them

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The aim of this study was to determine the concentration and origin of five polycyclic aromatic hydrocarbons (fluoranthene, pyrene, benzo(a)pyrene, chrysene, and benzo(a)anthracene) in the sea surface microlayer (SML) and in the underlying water (UWL) in two Norwegian ports (Bergen and Bodø) and along the transect between them. Samples were collected aboard the R/V Oceanograf in the period between 13 and 21 June 2024. For the sea surface microlayer, a stainless-steel Garrett screen was used, while for the underlying water it was an oceanographic bucket. Salinity, temperature, and pH were measured in the water of both layers. Additionally, simultaneously with seawater sampling, air temperature, relative humidity, wind speed and direction as well as precipitation volume were recorded. All samples were filtered through QMA Whatman filter and then frozen at −20°C until analysis. The PAHs analysis was performed using a Dionex UltiMate 3000 liquid chromatograph equipped with a fluorescence detector. Studies conducted in the region of the Norwegian seaports as well as along the transect between them showed that the concentration of Σ_5 PAHs was always higher in the sea surface microlayer than in the underlying water. The concentration of Σ_5 PAHs in the sea surface microlayer ranged from 34.3 ng/dm³ (at the offshore station S7) to 120.9 ng/dm³ (Port of Bodø). The concentration of Σ_5 PAHs at the analysed stations was higher when the concentration of suspended organic matter was high and when air masses were flowing in from industrialized areas. Local fuel spills or discharges of contaminated water could also have caused the increase in Σ_5 PAH concentrations. The obtained results were similar to those reported from other regions of the world after 1999, when Council Directive 1999/32/EC regulating the composition of liquid fuels was introduced.

Diatom communities of springs in the coastal zone of northern Poland

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Springs are hydrologically unique yet poorly studied habitats. They are connections between groundwater and surface water, meaning they are natural outlets of groundwater to the surface. Their characteristic feature is stable and relatively low temperatures, which favor the development of stenothermic organisms. Among them, diatoms constitute one of the most important groups. The development of benthic diatom communities in springs is influenced by many factors, including the quality of the outflowing water, the type of substrate, and the degree of anthropogenic transformation of spring niches and their immediate surroundings.

Diatom communities are relatively well known, but only in springs located in southern Poland. In northern Poland, spring diatom communities remain very poorly understood. Therefore, the aim of our study was to analyze the diatom flora of three springs: Lubowidzkie, Roztoka, and Kamienne, located in the coastal zone. One of the factors differentiating the selected springs was human use of the land.Material for diatom analysis was collected from various microhabitats (sand, stones, and vegetation). Samples were taken monthly throughout 2022 to capture seasonal variability (Lubowidzkie and Kamienna springs), and in spring in Roztoka - from 2019 to 2022. In addition to diatom species diversity, the ecological status of the springs was also assessed using the Multimetric Diatom Index (IO), which takes into account trophicity, saprobity and reference species abundance indices.

Analysis of physicochemical parameters and diatom flora revealed that pH and electrical conductivity were the main environmental factors influencing diatom communities. Typical spring water diatom taxa (crenophiles) were present in springs. Diatom species from the lacustrine-littoral zone were found in spring Lubowidzkie. The biodiversity of the springs confirms the presence of diatom species rarely found in other aquatic environments, including newly described or previously unknown species. Species from the Red List of Plants and Fungi of Poland were also recorded.

Enrichment of the sea surface microlayer in selected contaminants in low and high anthropopressure region – a comparative view

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The marine surface microlayer (SML) is the uppermost layer (1–1000 μm) of the ocean, covering over 70% of the Earth's surface. It lies at the boundary between the atmosphere and the hydrosphere. The SML is a unique biological, physical, and chemical environment characterized by different properties than the subsurface layer (UWL). Its content in natural and anthropogenic pollutants deposited from the atmosphere can be up to 1000 times higher than in the UWL. The SML plays a significant role in the exchange of gases, aerosols, and energy on a global scale. Despite its importance, there is still insufficient information on SML contamination with toxic and hazardous compounds that can be incorporated into the trophic chain or deposited in sediments. Those that exist focus especially on highly urbanized areas of the northern hemisphere. In turn almost nothing is known about the degree of SML contamination in such a remote regions like Antarctica. This area—though naturally isolated from other permanently inhabited, urbanized continents—is not immune to the impact of anthropogenic pressure due to climate change, growing interest among scientists, increasing tourism as well as fishing. For this reason, the aim of this study was to determine the importance of conducting broader research on anthropogenic pollution of sea surface microlayer in regions with very low anthropogenic pressure. Thus, the degree of SML contamination with selected polycyclic aromatic hydrocarbons (PAHs), selected phenols, and elemental carbon (EC) in the South Shetland and South Orkney Islands (West Antarctica) was compared with contamination of SML in that compounds in selected sea ports of Europe.

Holocene Environmental Changes in Eastern Carpathians - Multi-Proxy Reconstruction of Varved Sediments of Lake Synevyr

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In this study, we will explore the potential of the varved lake sediment core to understand the Holocene environmental changes using physical, chemical and biological proxies. Lake Synvyr (48°37′01″N, 23°41′02″E, 989 m a.s.l.), located in the National Nature Park Synevyr in the western part of Ukraine, will be used for this study. The lake was most likely formed in the Younger Dryas due to an earthquake-induced landslide which blocked a narrow stream valley (Laptev G. et al. 2020). The location of Lake Synevyr provides a chance for extending already existing transects of varved lakes from western and central Europe towards the east. This is of crucial importance for a wider-scale, a W-E European transect of paleoenvironmental reconstructions. Non-destructive sediment logging techniques, such as μ X-ray Fluorescence (μ-XRF) and high-resolution Hyperspectral Imaging (HSI), will be used to acquire semi-quantitative elemental distribution and diagnostic biomarker, respectively (Croudace et al., 2019; Zander P.D. et al. 2022). In addition, data series of elemental organic compounds, pollen and diatom assemblage variability for the entire Holocene will be reconstructed. Finally, developing a robust age-depth using isotope dating and varve counting will enable the reconstruction of Holocene-long reconstructions of land-use changes in the catchment, soil erosion, aquatic productivity and periods of anoxia; interpretation of the underlying processes and forcing factors.

A settlement gap or an evidence gap? High-resolution multiproxy palaeoecology and archaeology reveal landscape dynamics during the first millennium CE in Greater Poland (western Poland)

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We present a high-resolution multiproxy palaeoecological reconstruction from the Kazanie peatland and associated archaeological evidence of settlement dynamics in Greater Poland (western Poland), to investigate human–environment interactions during the first millennium CE. This contiguous record spans ca. 280–940 CE with ~13-year resolution sub-sampling and is supported by a high-resolution age–depth model. Multi-proxy analyses included pollen, non-pollen palynomorphs, plant macrofossils, micro- and macrocharcoal, and XRF geochemistry. The results identify a phase of intensified land use between ca. 390 and 490 CE, corresponding to the final phase of the Przeworsk culture and characterized by increased cultivation, grazing, fire activity, and landscape openness. This was followed by an approximately 80–100-year interval of markedly reduced anthropogenic activity, accompanied by declining landscape openness and progressive regeneration of natural oak–hornbeam forests. From ca. 600 to 850 CE, archaeological evidence indicates an expansion of Early Medieval settlement, while pollen data indicate limited agricultural activity and continued forest regeneration, culminating in exceptionally high hornbeam abundance. Recurrent microcharcoal peaks during this interval indicate that small-scale fire activity did not result in substantial forest opening. After ca. 850 CE, increasing settlement density, continuous cultivation, rising ruderal and meadow indicators, and increasing landscape openness document renewed agricultural expansion preceding the emergence of the early Piast state. The Kazanie record provides evidence for substantial changes in human impact across the transition from the Przeworsk to the Early Medieval period, including a prolonged phase of reduced land-use intensity and forest regeneration. Continuous human presence did not necessarily prevent forest recovery; rather, the intensity of land use appears to have been an important control on the persistence of mature deciduous forests. These results highlight the value of densely sampled palaeoecological records for resolving short-term changes in land-use intensity and vegetation dynamics that remain difficult to detect from lower-resolution archaeological evidence.

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Environmental Contamination of Recreational Beaches in Northern Poland with Soil-Transmitted Helminths: A One Health Study

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Soil-transmitted helminths and zoonotic geohelminths are parasites whose developmental forms may persist in the environment, including soil and sand, creating a potential risk of human exposure in public recreational areas1. Monitoring environmental contamination is therefore particularly relevant in popular coastal tourist destinations such as Gdańsk, Gdynia and Sopot. In May 2026, 75 sand samples were collected along more than 35 km of the Tricity coastline in northern Poland. Each sample, weighing approximately 50 g, was examined for the presence of developmental forms of geohelminths. Samples were homogenized in 0.0025% Tween 80 solution, filtered and centrifuged, followed by flotation in saturated NaCl and sucrose solution with a specific gravity of 1.25 g/mL. The recovered material was analysed microscopically using a modified sedimentation–flotation technique2. Microscopic examination revealed the presence of helminth eggs in beach sand samples, including eggs morphologically consistent with *Toxocara* spp., *Trichuris* spp. and hookworms, including *Ancylostoma* spp. The detection of developmental forms of zoonotic and soil-transmitted helminths in recreational beach sand indicates environmental contamination and highlights the need for continued parasitological monitoring of public coastal areas. This study supports the value of a One Health approach in assessing parasitological risks at the human–animal–environment interface. The increasing presence of synanthropic and domestic animals in urban coastal areas, including dogs, foxes and wild boars, may contribute to contamination of recreational environments with parasite eggs. These findings emphasize the importance of responsible animal management, beach hygiene and public awareness in highly visited coastal areas.

Enrichment of the sea-surface microlayer with dissolved organic matter across various regions of the Baltic Sea

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The surface microlayer (SML) forms the interface between the sea and the atmosphere, influencing the exchange of mass and energy between these two environments. It is the uppermost layer of the sea, up to 1000 µm thick, whose physical and biogeochemical properties differ from those of the subsurface water (SSW). It can be described as a hydrated, gelatinous layer that accumulates organic matter and microorganisms from deeper layers of the sea, along with pollutants and material deposited from the atmosphere. The formation, thickness, and spatial distribution of the SML are strongly influenced by biological parameters, such as the presence of phytoplankton, as well as by meteorological and hydrophysical conditions, including wind speed, salinity, and surface water temperature.

The hypothesis of the self-sustaining SML states that its presence and enrichment in organic matter (i.e., the multiplication of the quantity describing organic matter in the SML (C_{SML}) relative to this quantity in the subsurface layer, SSW (C_{SSW})) may have significant implications for the results of subsatellite studies and for the global sea-atmosphere CO_2 exchange. It is well known that surfactants (organic matter forming the SML), which ubiquitously cover the world's oceans, significantly affect the rate of gas transport across the water surface, but parameterising their role poses a significant challenge for researchers studying sea-atmosphere exchange processes. Therefore, studies of the stability of the SML in relation to the wind field, hydrophysical properties, and the biology of the sea surface layer, especially at the sea-air interface, are necessary to better understand the connections between these two largest environmental "niches" of the Earth's biosystem.

Verification of the possibility of using graph models to forecast changes in lake water quality

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In the context of increasing anthropogenic pressure and climate variability, there is a growing need for advanced analytical frameworks capable of capturing the complex dynamics of inland water quality. This study presents an integrated approach combining statistical inference, network theory, and physics-inspired methodologies, applied to environmental time series data from Lake Raduńskie Górne (northern Poland). The analysis focuses on key physicochemical indicators, including thermal conditions, oxygen regime, nutrient levels, and fundamental hydrochemical parameters. The workflow begins with rigorous data preprocessing, including missing data imputation and standardization. Dimensionality reduction is performed using Principal Component Analysis (PCA), followed by network reconstruction via Graphical Lasso (GLASSO), enabling sparse inverse covariance estimation.

The system is subsequently analyzed within a graph-theoretical framework. Network complexity is quantified using spectral von Neumann entropy, while temporal centrality analysis identifies dynamically important parameters. Nonlinear structural properties are further investigated using visibility graph methods. Additionally, diffusion dynamics are modeled using both classical random walk theory and quantum continuous-time walk approaches. Classical forecasting models (ARIMA, SARIMA, VAR) are employed as baseline methods.

The results demonstrate that water quality parameters form a dense and highly interconnected network (90 significant edges; 47% density). The normalized von Neumann entropy (Snorm = 0.594) indicates a moderately complex system. Visibility graph analysis reveals that 85% of parameters (17/20) significantly deviate from white noise behavior ($p < 0.05$, FDR-corrected), confirming the presence of non-random structure. The quantum walk model achieves a mean speedup of 28.75× over the classical counterpart, suggesting enhanced efficiency in information propagation. Classical forecasting models perform well only for water temperature ($R^2 = 0.955$), while other parameters remain challenging to predict due to limited sample size (N = 48).

In contrast, the network model already indicates significant interdependencies at this stage, e.g., strong links between water temperature and nutrient dynamics, as well as between pH and dissolved oxygen, suggesting coupled biogeochemical processes. This enables holistic system diagnostics and supports early detection of regime shifts. All results were exported to standard geoinformatic formats and visualized in QGIS, allowing spatial representation of parameter dependencies in line with integrated monitoring concepts. The study demonstrates that graph-based and quantum-inspired methods provide a promising direction for water quality forecasting and support evidence-based water management strategies.

Floating between two worlds – tychoplanktonic species occurring in plankton and benthos

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Tychoplankton is a group of organisms able to live both in littoral zone and between sediments at the bottom of reservoir. They are of benthic origin but can be moved to a water column by currents (Zelnik et al., 2018; Sheath & Hellebust, 1978). The study covered the coastal section of the Bulwar Nadmorski in Gdynia, near the pier. The coastal zone of the bay is a heterogeneous environment, where water currents play a significant role in shaping phytoplankton and phytobenthos communities, including phytosestone. The main goal of the study was to distinguish planktonic and benthic species, as well as to demonstrate the presence of tychoplankton species and attempt to identify the factors regulating their occurrence. It was shown that the sandy substrate of the bay (which was the main research material in our work) is preferred primarily by diatoms, which gain an advantage over representatives of other algae groups, becoming clear dominants. Four tychoplanktonic species were identified: Bacillaria pacilifer, Fragilaria capucina, Fragilaria construens and Fragilaria leptostauron. Their occurrence was limited to March, April and July only, but they were found both in planktonic and benthic samples. Their percentage share was small: 1,53% in April and 2,61% in July for planktonic samples; 2,78% in March and 11,07% in July for benthic samples. Their ecological preferences were determined by Denys's checklist with each species' ecological codes (Denys, 1991). All species prefer brackish-freshwater conditions, alkaliphilous and alkaliphilous-neutrophilous and eutrophic or mesotrophic water.The species structure indicates that benthic forms (psammon) are carried into the water column by the water current, thus enriching the phytosestone with tychoplanktonic algae species. It also demonstrates the richness and diversity of the bay's bottom zone.

Application of phosphorus-adsorbing agents based on expanded-clay bed coated with a multilayer biopolymer

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As society develops, human impact on the environment is also increasing. This is driving the growing amount of pollutants entering surface waters. Excessive nutrient inputs, particularly phosphates, are considered one of the most important pollutants. Excessive phosphate content in surface waters can lead to eutrophication, which is considered as a significant threat to the ecosystem.

Many methods for phosphate reduction are currently available. However, the developing world requires newer, cheaper, and more effective methods. One of the newer methods is the use of the BioKer expanded clay bed. This bed is coated with a multi-layer biopolymer that can be used as a chemical exchanger in reactive permeable barriers (PBRs). Two variants of the bed reinforced with calcium hydroxide and calcium carbonate were used for the study: a bed coated with a single and a double layer of the active substance.

A bed of known weight was placed in a beaker, near the bottom. An aqueous phosphate solution, previously prepared by dissolving potassium dihydrogen phosphate (KH2PO4) in double-deionized water, was also placed in the beaker. Once in the beaker, the solution was stirred with a mechanical stirrer while in contact with BioKer to achieve conditions similar to natural water flow in a reservoir or stream. The study included changes in the content of phosphates, calcium, magnesium, total hardness, as well as electrolytic conductivity and pH values, depending on the bed used and the concentration of the solution. The study showed that the BioKer coated with a double layer of the active substance achieved a higher level of phosphate removal within the first few days of the experiment. However, in the long-term, the BioKer coated with a single layer of the active ingredient achieved a higher level of phosphate reduction.

Hydrographic Network of Young Post-Glacial Landscapes and Its Contemporary Transformations: A Case Study of a Small Catchment in Poland

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Small water bodies are shallow aquatic ecosystems that play an important role in water retention, biodiversity conservation, the local water balance and microclimatic regulation. At the same time, they are sensitive to land-use changes and progressive urbanisation, which contribute to soil sealing, reduced infiltration and increased surface runoff.

The aim of this study was to analyse changes in the number and morphometric characteristics of small water bodies and to assess their relationship with urbanisation processes in the Kashubian and Starogard Lake Districts. The research was based on BDOT10k topographic data from 2014 and their most recent equivalents from 2022–2025, conventionally referred to as the 2024 dataset. Water bodies with a surface area of less than 1 ha were identified, and nine types of transformation were distinguished. Human pressure in their surroundings was assessed using the Land Use Intensity Index (LUI), land-use types identified through k-means clustering, and the proportion of built-up area and building density within 100 m buffers.

Between 2014 and 2024, the number of small water bodies decreased from 24,165 to 23,775. The disappearance of 3,317 water bodies was partly offset by the formation of 2,994 new ones, while stable water bodies predominated in the overall transformation structure. Development processes were more prevalent in the Kashubian Lake District, whereas disappearance processes were more pronounced in the Starogard Lake District. Water bodies located in forest–agricultural landscapes showed the greatest stability, while disappearance processes occurred more frequently in agricultural areas. Agricultural–settlement landscapes were characterised by the highest transformation dynamics. No clear relationship was found between an increase in built-up area and a greater frequency of disappearance processes. Among the analysed measures of human pressure, land-use structure most effectively differentiated the directions of water-body transformations, although the relationship remained weak. The results therefore indicate that changes in small water bodies are driven by multiple factors and cannot be explained solely by progressive urbanisation.

Greenhouse Gas Emissions from Intermittent Rivers: A Meta-analysis and Field Study of the Mała River

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Intermittent rivers and ephemeral streams (IRES) are increasingly recognized as dynamic components of fluvial systems, particularly under the influence of climate change and growing hydrological pressures. Despite their widespread occurrence, intermittent rivers remain insufficiently investigated as potential sources of greenhouse gas (GHG) emissions to the atmosphere. The periodic disappearance of flow leads to substantial changes in biogeochemical conditions, which may significantly influence the production and release of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

This study presents the results of a meta-analysis concerning GHG emissions from intermittent river channels under different hydrological conditions. A comprehensive literature review was conducted to compile published data on CO_2, CH_4, and N_2O fluxes from river systems experiencing flow cessation. The literature data were statistically synthesized for three key hydrological phases: (1) exposed river sediments (dry channels), (2) isolated stagnant ponds, and (3) flowing waters. To enable comparison of the overall climatic impact of individual gases, emission data were converted into CO_2 equivalents.

The results indicate substantial variability in GHG emissions depending on hydrological conditions. Exposed sediments (dry riverbed) were characterized by the highest total CO_2 equivalent emissions (14.5 g CO_2e/m^2*d), while isolated ponds and flowing waters had comparable values (9.9 and 9.6 g CO_2e/m^2*d, respectively). This shows that hydrological fragmentation and progressive drying of river channels may strongly affect the magnitude and structure of GHG fluxes.

Literature data will be confronted with GHG emission patterns observed in the Mała River, which is affected by long-term riverbed drying. The comparison will be based on in situ measurements of CO_2 and CH_4 fluxes conducted under contrasting hydrological conditions, including dry riverbed, sections with disappearing flow and permanently flowing water. In the subsequent phase, field measurements will be performed using a portable LiCOR LI-7810 trace gas analyzer. This approach will enable the assessment of how progressive flow cessation influences the magnitude and variability of GHG emissions in the river under study.

The study contributes to a better understanding of the role of IRES in regional carbon cycling and highlights the importance of incorporating temporary river systems into GHG budgets and climate-related environmental assessments.

A New Lens on Baltic Plankton: Applying PlanktoScope in Routine Research

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Plankton imaging techniques are now rising as one of the most promising tools for the pelagic ecosystems research, and yet there are still many places, where their implementation is more challenging, places of unique ecosystems which are standing out from the plankton research typical to the world ocean. The Baltic Sea may be considered as one of such places, with its exceptional brackish conditions linking the ocean with inland waters. With high seasonality, strong water stratification, and highly influential harmful algal blooms, investigating its fragile pelagic ecosystems is crucial for a better understanding and, therefore, better protecting this unusual sea.

Our pilot study proposes an imaging approach to the Baltic Sea plankton research with the use of PlanktoScope [1] – one of the best and yet affordable plankton imaging tools. PlanktoScope combines the powerful in-flow microscope photography with high mobility and easy handling. The device was used for the analysis of freshly collected samples during regular, seasonal research cruises in the Southern Baltic Sea throughout 2025. Tens of thousands of acquired images were then transferred to the online software for plankton analysis – EcoTaxa [2], where, using both experts' knowledge and deep-learning features, each object captured during the study was taxonomically annotated.

The results show high potential of using PlanktoScope for an easy detection of key environmental changes observed in the Baltic, such as inflows of marine waters from the North Sea, rise in the abundance of potentially dangerous cyanobacteria, or major seasonal shifts in the composition of planktonic species.

Prymnesium parvum Harmful Algal Blooms during the Oder River disaster in summer 2022, and after-effects in aquatic ecosystem

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The ecological disaster on a large scale occurred in the Oder River and hydrologically connected waters with this river. The tragedy concerned the 360 tonnes (with German reports) of large to small-sized fish killed during the summer 2022 (Free et al. 2023), what constituted ca. 50% of the whole fish population, 65 million of mussels, and 147 million of snails (Szlauer-Łukaszewska et al., 2024). *Prymnesium parvum* due to its availability to produce toxic prymnesins of the B-type formed Harmful Algal Blooms (*Prymnesium* HABs) (Mazur-Marzec et al., 2022) which were recognized as the primary cause of massive fish and benthic macroinvertebrates (Siwicki et al., 2022).

The study focused on identifications (1) the relations between *P. parvum*, B-type prymnesins, hydrochemical parameters, and massive fish kills; (2) the biodiversity loss; (3) and the after-effects for functioning the aquatic ecosystem. The study was conducted during the ecological disaster in the Oder River in summer-autumn 2022 at sites located along the entire length of the Oder River within Poland, as well as in waters hydrologically connected with the Oder River and it was continued thereafter, until 2024. Hydrochemical, biological and toxicological parameters were analyzed. This microalga formed the blooms with density up to 610 million cells l-1 (maximum occurred in Gliwicki channel). The *P. parvum* densities exceeding threshold values of above 50-100 million cells l-1 (Napiórkowska-Krzebietke, Kalinowska 2022) were mostly related to the massive fish and benthic macroinvertebrates kills. During this ecological disaster, there were noted the strong relations between hydrochemical and biological parameters, and furthermore, the *P. parvum* density closely related to prymnesins concentration and fish kill events, especially in the middle course of the Oder River and adjacent water reservoirs (Mazur-Marzec et al., 2022). Thus, both hydrochemical gradients (mineralization) and biological processes (phytoplankton blooms and toxin production) played key roles in shaping the functioning the water ecosystems being under *Prymnesium* HABs. The phytoplankton biodiversity was also very poor during ecological disaster, but along with low *P. parvum* density it increased, especially in 2023 and 2024. Such massive fish kills did not occurred in the following years, but the functioning of the aquatic ecosystem suffered a lot. Polish research can be one of the key elements of research on *Prymnesium* HABs, due to their universality and potential application in river water management and protection strategies. The knowledge of *Prymnesium* HABs in the context of environmental conditions in Europe is useful in developing appropriate monitoring procedures and planning revitalization activities.

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Water quality and quantity assessment in the context of agro-hydrosystem – what about the water future?

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In accordance to the One Health concept, one of the most precious life resources is water. Its qualitative and quantitative states are of special concern in the European Union Water Framework Directive (WFD, 2000/60/EC) and Nitrates Directive (ND, CD 91/676/EEC). Both Directives are focused on protecting ground- and surface waters by ensuring good qualitative and quantitative health, i.e. reducing and removing pollution and ensuring that there is enough water to support wildlife and human needs. For this purpose, many indicators are used for water quantity and quality monitoring which consequently should be helpful to sustainable water management and diffuse pollution reduction. This study focused on the key indicators of water resources and water quality related to pollution in the agro-hydrosystem. According to data from 2022 (3rd River Basin Management Plan, EC 2025), a large proportion of European surface waters, ca. 62%, failed to achieve at least good ecological status, and ca. 52% failed to achieve at least good chemical status. The European groundwaters are not as polluted as surface waters with good quantitative status in 91% of total area, and good chemical status in 78% of total area. In Poland, the agri-food sector is of a great national economic, social and environmental importance due to prevailing of rural areas and agricultural areas (85% and 52% of the country's area, respectively), with approximately 1.4 million farms identified. Among the Polish freshwater surface water bodies only 31% of rivers and 34% of lakes met the WFD required at least good ecological status or potential in 2017 (2nd River Basin Management Plan, EEA, 2018). Whereas in 2022, additionally only 8% of rivers and 9% of lakes, were in good ecological status, and 24.8% of surface water bodies in Poland had good chemical status. The 94% of groundwater area were in good quantitative status. Both main rivers: Vistula and Oder – play a dominating role as River Basin Districts (RBDs) since they cover 97% of the country. Overall up to date, 94% of river water bodies in the Vistula RBD and 95% in the Oder RBD are subjected to significant changes caused by anthropogenic pressures that they are at risk of failing to achieve the environmental objectives. 61% of lake water bodies in the Vistula RBD and 71% in the Oder RBD are at risk of not achieving the environmental objectives.

What about the water future? The whole territory of Poland is designate as a Nitrates Vulnerable Zone, and the measures to reduce diffuse pollutants from agriculture were implemented in the ND action plan. Therefore, the primarily needed actions include educational and advisory activities for farmers; control activities to the use of pesticides; and voluntary application of actions for improving agricultural practices. Then, the introducing actions are needed like increase of organic farming, and protection of soil health, surface waters, wetlands and peatlands or increase of buffer strips for lakes. These actions can have positive impact on the water bodies quality, water infiltration and retention. To improve quantitative status of groundwater, the needed actions include measures to reduce water consumption; foster water-saving irrigation techniques; improve retention of rainwater, soil; and slowing the run-off from the catchment area. From agro-hydrosystem point, the model of regenerative agriculture which is a holistic food production system aimed to rebuild soil health, increase biodiversity, retain water, and sequester carbon from the atmosphere would be suitable as one key element to achieve the environmental objectives.

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Occurrence of selected pharmaceuticals in bottom sediments of aquatic environments determined by UHPLC-MS/MS

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The presence of pharmaceuticals in aquatic environments has become an increasing environmental concern due to their widespread use, continuous release into the environment, and incomplete removal during conventional wastewater treatment processes. Aquatic ecosystems constitute important recipients of municipal and hospital wastewater, as well as urban runoff, making them particularly vulnerable to pharmaceutical contamination. Consequently, numerous pharmaceutical compounds and their metabolites entering aquatic ecosystems may accumulate not only in the water column but also in bottom sediments. Bottom sediments represent an important environmental compartment, acting both as a reservoir and a potential secondary source of contaminants. Therefore, investigations into the occurrence of pharmaceutical residues in bottom sediments are essential for understanding their environmental fate and potential impacts on ecosystem functioning.

The aim of this study is to assess the occurrence of selected pharmaceuticals in bottom sediments of aquatic environments using ultra-high-performance liquid chromatography coupled with tandem mass spectrometry (UHPLC-MS/MS). The analyzed compounds include selected pharmaceuticals belonging to different therapeutic classes, including antibiotics (trimethoprim), non-steroidal anti-inflammatory and analgesic drugs (diclofenac and ketoprofen), an antiepileptic drug (carbamazepine), as well as other pharmaceuticals commonly used in medicine and their metabolites.

Bottom sediment samples were subjected to appropriate extraction and purification procedures prior to instrumental analysis. Quantitative determination of the selected compounds was performed using UHPLC-MS/MS operating in multiple reaction monitoring (MRM) mode, enabling sensitive and selective analysis of trace contaminants in complex environmental matrices, as demonstrated in recent studies on pharmaceutical analysis in environmental solid matrices.

The study contributes to the growing body of research on the occurrence of emerging contaminants in aquatic ecosystems and highlights the importance of bottom sediment monitoring as an integral component of environmental quality assessment. The analysis of pharmaceuticals in bottom sediments will enable the evaluation of long-term contamination of aquatic environments and the identification of compounds characterized by high persistence and accumulation potential. The obtained results will contribute to a better understanding of the transport, transformation, and retention processes of pharmaceuticals in aquatic ecosystems and will provide a basis for assessing the potential environmental risks associated with their presence.

Insights for adaptive management of eutrophic lakes on an example of a protected eutrophic lake (Lake Góreckie, Wielkopolski National Park, Poland)

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Lake Góreckie, a dimictic postglacial lake located in a strictly protected area (the Wielkopolski National Park, western Poland, central Europe), has experienced long-term eutrophication driven by historical sewage discharge, agricultural runoff, and internal nutrient loading. From 2009 to 2022, restoration measures, including aeration, phosphorus inactivation, and fish biomanipulation, were implemented to improve water quality. This study assessed the lake's current state in 2022, immediately after cessation of reclamation, and in 2025, three years later, using physico-chemical parameters, phytoplankton, and macrophyte communities.

Field studies were carried out in the summer seasons 2022 and 2025. Physico-chemical properties of the lake water and the structure of phytoplankton community were analysed at three deepest points of the lake pelagial. On each sampling campaign samples were taken from the surface and above-bottom layers. In addition, water was sampled from two active out of three springs located along the northwestern shore and flowing directly into the lake. The lake's vegetation structure was investigated along 1-meter depth gradient of nine transects with the use of the mid-European Braun-Blanquet's method. Land-use changes within the catchment of Lake Góreckie were assessed for the temporal cross-sections between 1996 and 2025. Changes in the water level for the hydrological years 2022 - 2025 were determined based on automated 12-hour interval monitoring.

In light of the obtained results, the water chemistry of Lake Góreckie is shaped predominantly by groundwater inflow from the catchment, internal nutrient loading from nutrient-rich bottom sediments under anoxic conditions in the near-bottom water layer, and additional inputs from waterfowl. Water properties have long determined the abundance and biomass of phytoplankton, which historically formed blooms in the lake but unexpectedly declined in 2025.

The long-term trend of declining water levels may have counteracted the improvement in water quality anticipated following restoration measures. In contrast, the pronounced increase in water level observed between the 2022 and 2025 surveys may have contributed to persistently elevated nutrient concentrations due to the leaching of flooded shoreline vegetation. At the same time, higher water levels may have reduced phytoplankton proliferation in the surface layer, thereby decreasing the flux of organic matter to bottom waters. This, in turn, may have resulted in a marked increase in water transparency and enhanced oxygenation of deeper layers. In this context, prolonged spring mixing in 2025, reflected in unusually high hypolimnetic temperatures, may have played an additional supporting role.

In addition to the phytoplankton shift, macrophyte diversity and coverage increased during the study period. The re-establishment of charophytes, particularly the increased abundance of *Nitellopsis obtusa*, was recorded between 2022 and 2025. According to Kutyła et al. (2024), who demonstrated a positive effect of forest cover on charophyte abundance irrespective of the catchment spatial scale, the catchment of Lake Góreckie appears conducive to the recovery of submerged macrophytes, particularly charophytes. This is supported by the observed trend of afforestation: over the three-decade period, forest cover increased by approximately 16%, while the proportion of arable land decreased from ca. 30% to ca. 17%.

Our results highlight the complex interplay between catchment hydrology, long-term afforestation, nutrient dynamics, and primary producers in shaping lake ecosystem recovery and provide critical insights for adaptive management of eutrophic lakes located in protected areas subject to anthropogenic pressure.

Environmental Controls on Macrophyte Contributions to Softwater Lake Sediments: A Bayesian Isotope Mixing Model Approach

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To check the potential source contribution to sediment organic matter in characteristic Central European softwater lakes with isoetids we applied the Bayesian mixing stable isotopes model (MixSIAR). Our calculation is based on the isotopic signal (δ13CORG and δ15NORG) of different environmental components both obtained by us in the field and those from the literature. Our study in the field was conducted in Jun 2020 in 14 softwater lakes in northern Poland. The lakes were chosen along the alkalization gradient due the fact that alkalization is recognized as one of the most important threats for these sensitive types of lakes and its characteristic vegetation from isoetids group (the evergreen submerged aquatic plants from oligotrophic lakes). Our previous study based on this isotopic data revealed the moderate relationships between the macrophytes isotopic signal and the sediment on which they grew. Moreover, both the δ13CORG and δ15NORG of the plants varied more than the sediments, suggesting that allochthonous materials are also engaged in sediments creations. The Bayesian MixSIAR model was applied to check the probability of the OM origin of sediments' sources. The model showed that macrophytes were generally the most probable source of OM in the sediments of the investigated lakes. However, the model results for ecological groups of species show significant differences between sediments co-created by the investigated species. In sediments collected from the stands of isoetids plants, the probable source of OM was dominated by macrophytes. On the other hand, in sediments collected from elodeids stands, the contribution of macrophytes was the lowest, which might be related to higher variability, especially of the δ13CORG values recorded for elodeids along alkalization gradient of the studied lakes which was a consequence of using different C sources in the photosynthesis process.

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The role of seasons influence on the variability of physicochemical characteristics of wastewater from the Płaszów Wastewater Treatment Plant in the context of reducing the eutrophication potential

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A significant problem for water management is municipal wastewater rich in biogenic elements. With the increasing development of urbanization, population growth, and intensification of agriculture, the amount of urban wastewater increases, and its composition deteriorates. Currently, urban wastewater is considered one of the main anthropogenic causes of eutrophication. The phenomenon of eutrophication itself leads to a number of negative ecological effects, such as changes in the species diversity of aquatic plants and animals or deterioration of water quality and requires measures to prevent its intensification. In the context of preventing the development of eutrophication, wastewater treatment plants play an important role, reducing the nutrient load in wastewater before it is discharged into water bodies. For this reason, the analysis of the composition of urban wastewater is an important topic of scientific research, necessary to ensure an effective and efficient treatment process.

The aim of the study was to determine the eutrophication potential of municipal wastewater from the Płaszów Wastewater Treatment Plant. The scope of the study included a comparison of the physicochemical properties of raw sewage and wastewater after the biological treatment process, calculation of the share of bioavailable forms of nitrogen and phosphorus in wastewater and assessment of the effectiveness of wastewater treatment at the Płaszów Wastewater Treatment Plant. Samples were collected from I 2020 to V 2022. The phenomenon of eutrophication and biogenic elements were discussed. The research part focused on the analysis of bioavailable forms of nitrogen and phosphorus in wastewater. Furthermore, the physicochemical properties of raw and biologically treated wastewater were compared, the change in selected properties depending on the season was investigated and the effectiveness of the wastewater treatment system in Płaszów was evaluated. The parameters analyzed were: pH, total suspended solids, BOD5, COD, ammonium nitrogen, nitrate(III) nitrogen, nitrate nitrogen(V), total Kjedahl nitrogen, total nitrogen, orthophosphates, total phosphorus.

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The influence of elevated temperature on the germination success of aquatic plants

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Global warming, a consequence of climate change, may alter the performance of aquatic plants in freshwater ecosystems. In our previous experiment with *Myriophyllum spicatum* L. and *Ceratophyllum demersum* L. under elevated temperature (from 22°C -control- to 27°C), we found only a minor effect of higher temperature on the performance of both species, which can be interpreted as a high tolerance of the studied species to warming, due to better adaptation to this warmer condition. However, the influence of elevated water temperature on the germination and growth responses of submerged macrophytes, especially in a geographic context, remains poorly understood, particularly when the effects of iron coagulants are also considered. To fill this knowledge gap, we present here the integrated results from two complementary experiments, primarily to assess how temperature shapes a relevant process, such as the germination success of aquatic plants. In the first experiment (two experimental temperatures, microcosm scale, duration: 8 weeks, n=20, presence of iron coagulants), the sediments were collected from eutrophic waterbodies in the Albufera de València Natural Park (València, Spain). The germinated macrophytes were charophytes (mainly *Chara vulgaris* L.). We observed a tendency for biomass growth rates to be higher at higher temperatures. Therefore, the results led to a second experiment (6 weeks, n=96) examining the effect of elevated temperature on the germination of aquatic plants from sediments originating from a higher latitudinal area (Poland), but from two different regions differing by 1.5°C in mean air temperature: a warmer region near Poznań, and a cooler region near Olsztyn. The obtained results will allow a comparison of the effect of elevated temperature on germination rates from sediments of different latitudinal origins. These observations will allow us to understand and estimate potential germination trends in a warming future, which may help plan the recovery of submerged vegetation in restored lakes.

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Physicochemical and Toxicological Assessment of Sediment Contamination in Deep-Water Pockmarks of the Gdańsk Basin

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Marine sediments act as natural geosorbents for anthropogenic contaminants (Mielczarek and Szydłowski, 2017; El-Sharkawy et al., 2025), yet the role of deep-water pockmarks as accumulation or remobilization sites for heavy metals remains poorly understood. This study aimed to assess the degree of pollution and toxicity of pockmark sediments in the Gdańsk Basin in relation to their unique physicochemical conditions. Research involved the analysis of pore and bottom water parameters, heavy metal concentrations (Cd, Co, Cr, Cu, Ni, Pb, Zn, Fe, Al) via optical emission spectrometry, and acute toxicity assessment using the Microtox® Solid-Phase Test. Results indicate that concentrations of most metals (Cr, Ni, Zn, Pb, Cu, Fe, Al) in pockmark sediments are low, often below Probable Effect Level and Threshold Effect Level, and show no statistically significant differences between pockmark and reference stations ($p>0.05$). Significant differences were noted for Co ($p=0.05$), with higher concentrations in pockmarks, and Cd ($p=0.04$), where for which pockmark concentrations (median 1.48 mg/kg) were lower than at reference stations (2.16 mg/kg). Pockmark activity promotes sediment resuspension and metal remobilization, hindering their long-term accumulation. Despite low heavy metals concentrations, Microtox® tests revealed high sediment toxicity (EC50 median 0.43% for pockmarks vs. 0.54% for reference stations, $p=0.36$), which is determined not by total metal content but by their bioavailability, controlled by local conditions (oxidation-reduction potential, salinity, pH and presence of hydrogen sulfide). This study demonstrates that pockmarks are dynamic remobilization zones where environmental toxicity is dictated by the physicochemical specificity of sediment rather than total metal concentrations.

Blue-Green Infrastructure in Urban Areas: Trends, Tools, and Challenges

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Climate change is a major driver of both water scarcity and hydrological extremes. These challenges are particularly pronounced in urban and suburban areas, where extensive impervious surfaces limit natural water retention and exceed the extent of biologically active areas. To mitigate these impacts, landscape architects, urban designers, and planners collaborate to develop sustainable and resilient solutions. Blue-Green Infrastructure (BGI) is one such solution. Widely promoted as a holistic approach to stormwater management, BGI aims to mimic natural hydrological processes while providing regulating ecosystem services, including runoff reduction and peak flow attenuation, together with a range of socio-economic benefits. This scoping review synthesizes recent research on BGI in the context of water management and land use planning, highlighting the role and limitations of spatial tools and modelling in addressing inadequacies in urban stormwater infrastructure. The research also examines terminology used to describe BGI, its geographical distribution and different types of BGI discussed in literature. Findings indicate that BGI can effectively control urban runoff and Storm Water Management Model (SWMM) can serve as a tool for allocating and simulating specific BGI types. However, most studies focus on small catchment-scale modelling, commonly limited to the scale of a single building, and typically consider only a single type of BGI (e.g., green roofs), rather than combinations of different types with linear solutions being particularly underrepresented or omitted. Future research should explore the potential of integrating multiple BGI types at a larger spatial scale, considering GIS tools for supporting BGI allocation planning.

Changes in the Carbon and Nitrogen Isotopic Composition of Organic Matter in Bottom Sediments Following a Cyanobacterial Bloom

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Stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope analyses of organic matter (OM) provide valuable tools for identifying the sources of sedimentary organic matter and tracing its transformation pathways in aquatic ecosystems. This approach is particularly relevant in eutrophic reservoirs, where intensive primary production leads to excessive accumulation of organic matter, which settles in bottom sediments.

The aim of this study was to evaluate the extent to which $\delta^{13}C(OM)$ and $\delta^{15}N(OM)$ signatures can be used to identify zones of organic matter deposition following cyanobacterial blooms and to assess their applicability in tracking organic matter transformation processes within bottom sediments.

The study was conducted in the eutrophic Sulejów Reservoir, a relatively long and narrow dam reservoir (15 km long and 2 km wide) with a storage capacity of 75 million m^3 and an average water residence time of approximately 30 days.

Stable isotope analyses of $\delta^{13}C(OM)$, $\delta^{13}C(CaCO_3)$, and $\delta^{15}N(OM)$ were performed on the upper 3-cm sediment layer using a Thermo Delta V Advantage isotope ratio mass spectrometer coupled with an elemental analyzer (EA). The isotopic data were normalized against international standards (USGS-24, USGS-40, and UREA IVA). In addition, physicochemical parameters, including temperature, pH, redox potential, electrical conductivity, concentrations of NH_4^+, NO_3^-, and PO_4^{3-}, total bacterial abundance, and organic matter content determined as loss on ignition (LOI), were measured in both sediment and pore-water samples. The organic matter content in the sediments ranged from 6.04% to 21.06%. The $\delta^{13}C(OM)$ and $\delta^{15}N(OM)$ values varied from −32.33‰ to −25.61‰ and from −0.52‰ to 2.14‰, respectively. A pronounced shift in sedimentary $\delta^{13}C(OM)$ values was observed following the deposition of freshly sedimented cyanobacterial biomass. Mean $\delta^{13}C(OM)$ values reached −20.60‰ (SD = 4.85) in May, whereas immediately after cyanobacterial bloom sedimentation in August they decreased to −27.33‰ (SD = 1.10). Both $\delta^{13}C(OM)$ and $\delta^{15}N(OM)$ exhibited substantial spatial variability, reflecting differences in the supply of freshly deposited organic matter as well as variations in its subsequent degradation and transformation processes. A significant positive correlation was found between $\delta^{15}N(OM)$ and organic matter content ($r = 0.99$, $p = 0.002$), as well as between $\delta^{15}N(OM)$ and $\delta^{13}C(OM)$ ($r = 0.55$, $p < 0.005$). Furthermore, a strong relationship between $\delta^{13}C(OM)$ and $\delta^{13}C(CaCO_3)$ ($r = 0.85$, $p = 0.014$) was identified. This relationship is likely associated with calcium carbonate precipitation under elevated pH conditions (>8.5) occurring during cyanobacterial bloom events.

The results demonstrate that $\delta^{13}C(OM)$ and $\delta^{15}N(OM)$ can serve as effective indicators of cyanobacterial bloom deposition zones in eutrophic aquatic ecosystems. The application of these isotopic tracers may support reservoir management and restoration strategies, particularly those focused on the removal of accumulated organic sediments and on reducing cyanobacterial recruitment from sediments in subsequent growing seasons.

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Environmental impact assessment of inland aquaculture facilities: legal framework, best practices and recommendations

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The development of inland aquaculture, identified as a key element in consultations for the draft document “Fisheries and Aquaculture – Vision 2040”, requires consistent environmental impact assessment criteria aligned with EU law and national practice. This paper presents the European Union legal framework and the main identified impacts of aquaculture facilities. Key aspects include biogenic loading, eutrophication, organism escapes and greenhouse gas emissions. The review of assessment methods encompasses EIA/SEA, risk assessment, dispersion models, biological indicators and GIS, and leads to proposed criteria for the development of national guidelines for water-permit issuance, appraisal of aquaculture investments and procedures for determining new permit validity periods. The paper is a review-analytical study and provides recommendations for further work.

Environmental microplastics as vectors of pharmaceuticals in the aquatic environment – studies on the adsorption of selected compounds

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Microplastics (MPs) are ubiquitous contaminants of aquatic environments and are increasingly recognized as important vectors of contaminants of emerging concern (CECs) [1]. Due to their large specific surface area, hydrophobic character, and susceptibility to environmental aging, MPs can adsorb and transport various organic pollutants, potentially affecting their environmental fate, persistence, and bioavailability. Among these contaminants, pharmaceutical residues are of particular concern because of their continuous release into aquatic ecosystems through municipal wastewater treatment plant effluents and sewage sludge [2,3].

This study investigated the adsorption of selected pharmaceuticals onto environmental microplastics isolated from marine plastic and from sewage sludge originating from municipal wastewater treatment plants. The objective was to evaluate the sorption behavior of environmentally relevant MPs and assess their potential role in the transport of pharmaceutical contaminants.

Adsorption experiments were performed using batch systems, and pharmaceutical concentrations were determined using LC–MS/MS analysis. Adsorption efficiency (R, %) and sorption capacity (q_e, μg g^{-1}) were calculated to characterize the interactions between pharmaceuticals and microplastic particles.

The obtained results demonstrate that environmental microplastics can effectively adsorb pharmaceutical compounds, with adsorption dynamics depending on contact time and the physicochemical properties of the polymer matrix. The findings confirm that microplastics may serve as reservoirs and transport vectors of pharmaceuticals in aquatic environments, contributing to their persistence and potential transfer within ecosystems. Improved understanding of these interactions is essential for assessing the environmental risks associated with the co-occurrence of plastic pollution and pharmaceutical contaminants in marine and wastewater-derived environments.

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Legal protection of rivers in crisis situations – the case of the ecological disaster on the River Oder

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In the EU, the legal protection of rivers is primarily governed by the Water Framework Directive (2000/60/EC), and these provisions have been implemented in the 2017 Polish Water Law. The main legal instruments for water management and protection are water management plans, a system of water law permits, a monitoring and control system and an information system. The State Water Management Authority (Wody Polskie) and the Environmental Protection Inspectorate are responsible for implementing these instruments. The aim of this paper is to present the legal framework for the protection of river waters in Poland before and after the environmental disaster on the River Oder. The analysis highlights the importance of specific legal instruments in the management and protection of river waters, as well as the tasks and responsibilities of the authorities involved in their enforcement. Significant legal gaps in water law have been identified, particularly those arising from the inadequate and overlapping powers of water authorities, as well as the lack of procedures for dealing with crisis situations and an effective rapid-alert system (Zębek and Napiórkowska-Krzebietke 2023; Zębek and Napiórkowska-Krzebietke 2025). The paper then outlines the legal measures taken following the event in question, paying particular attention to the provisions of the 2023 Act on the Revitalisation of the River Oder, highlighting the strengths and weaknesses of the legislation introduced and its significance for the protection and restoration of the river ecosystem (Zębek, 2025). It should be noted that the enactment of this Act also led to the introduction of stricter requirements regarding the granting of water law permits as an effective regulatory and protective instrument for the conservation of river ecosystems. As part of these measures, a procedure for monitoring and reporting on golden algae (Prymnezium parvum) by the Chief Inspectorate for Environmental Protection (GIOŚ) has also been developed, which will enable faster preventive and remedial action to be taken in the event of the appearance and mass growth of this algae. The final part of the paper will be devoted to the idea of granting legal personality to the River Oder in the context of the challenges and prospects in this regard.

Integrated autonomous systems for environmental monitoring developed by PM Ecology

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PM Ecology is a Polish technology company specialising in the design, manufacture, integration and maintenance of autonomous systems for continuous environmental monitoring. The solutions developed by the company include sensors and measurement systems, data acquisition and transmission systems, autonomous power supply systems, server infrastructure, and software for the collection, archiving, visualisation and analysis of environmental data. The company's activities focus primarily on meteorology, hydrology, and the monitoring of surface water, stormwater and wastewater quality, as well as on the development of measurement systems intended for use in marine environments. Water quality monitoring systems enable continuous measurement of parameters including temperature, pH, electrical conductivity, redox potential, dissolved oxygen concentration, turbidity and chlorophyll.

An important area of PM Ecology's activities is research and development in the fields of measurement technologies, telemetry, and solutions supporting water management. The company collaborates with Polish universities and research institutions, including Gdańsk University of Technology, AGH University of Krakow, Lodz University of Technology, and the Institute of Hydro-Engineering of the Polish Academy of Sciences. Current research and development activities include, among others, the development of methods and sensors for the detection of selected chemical pollutants and biological hazards. More than 2,500 PM Ecology devices are currently in operation across Poland, providing continuous measurements of environmental parameters. The systems are used by public administration bodies, municipal utilities, research institutions, and organisations responsible for environmental monitoring and protection.

The integration of expertise in device engineering, electronics, automation, telemetry, software development and operational support enables PM Ecology to provide complete measurement chains – from data acquisition under field conditions, through transmission and archiving, to data analysis and delivery to end users. PM Ecology's solutions form part of the infrastructure supporting long-term environmental monitoring and data-driven water resources management.

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