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7th CONFERENCE „ENVIRONMENTAL ENGINEERING AND DESIGN"

HONOUR PATRONAGE

Rector of the Uniwersity of Zielona Gora - prof. dr hab. Wojciech Strzyżewski

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Politechnika Białostocka, Białystok, Poland

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Changes in soil properties and emissions under different soil preparation technologies

The intensity of soil tillage directly affects not only soil structure but also environmental emissions. This study compared four technologies – from minimum tillage to direct seeding – to evaluate their effects on soil aeration porosity, moisture, compaction, and nitrogen oxide (NO_x) emissions during seeding.

Tillage practices can significantly influence crop growth and yield, primarily through their effects on water retention and soil's chemical and physical properties (Patra et al., 2004). In the context of accelerating climate change and increasing soil degradation, there is a growing need for more sustainable agricultural solutions that help reduce environmental pollution.

The results showed that NO_x emissions were nearly 40% higher with minimum tillage compared to direct seeding. Meanwhile, vertical tillage combined with seeding ensured improved soil porosity and moisture retention, while maintaining a moderate emission level relative to minimum tillage. Compaction profiles indicated that this technology creates more favorable conditions for root development and water infiltration, especially at the 30–50 cm soil depth.

The work explore how appropriate tillage selection can contribute to more sustainable farming systems.

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Heavy metals as a source of pollution and health risk in agricultural systems

Soil degradation is a problem that affects many territories. Therefore, Sustainable Development Goal 15 (Life on Land: sustainably management of forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss), in its target 15.3, proposes by 2030 to combat desertification, restore degraded land and soil, including land affected by desertification, drought, and floods, and strive to achieve a land degradation-neutral world.

A large percentage of agricultural soils are degraded, with extremely low organic matter content for instance in Mediterranean environments. One way to combat soil degradation is to add biosolids, such as sludge from wastewater treatment plants. Sewage sludge contains large amounts of organic matter that contribute to improving the physical, chemical, and biological properties of degraded soil. This also makes it possible to repurpose these materials, using them as resources rather than disposing of them as waste, within the context of a circular economy.

Biosolids provide a number of advantages to the soil, such as organic matter and plant nutrients, but they also have a number of drawbacks that must be monitored, as they can contribute hazardous substances, such as heavy metals. These can pollute soil and groundwater and pass into the food chain through crops.

To study the mobility of heavy metals along the profile of a degraded agricultural soil, an experiment using PVC columns was proposed. Sewage sludge was added to the top 15 cm of soil. Total, available, assimilable, and soluble Cu, Zn, Cd, Cr, and Ni content were analyzed along a depth of 60 cm. Heavy metals were also analyzed in leachates collected at the bottom of the columns.

We found that the use of sewage sludge on this degraded soil increases the bioavailability of copper and zinc. Considering Cd, Cr, and Ni, the latter element is the one which is more available for plants (DTPA extraction). There are no significant displacements or movement of these heavy metals along the soil profile.

Significant quantities of metals have not appeared in leachates, which means that the pollutants analyzed in this research, and under these irrigation conditions, are not a relevant source of water contamination.

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Unlocking The Urban Mining Potential of Nigeria: Uncovering Value in E-Waste and Municipal Waste Streams

Nigeria, Africa's most populous country and largest economy, generates significant amounts of e-waste and municipal solid waste due to high resource consumption and a thriving second-hand market. According to the Global E-Waste Monitor (2020), about 290,000 tonnes of e-waste are produced annually, with minimal formal recovery. This study explores the untapped potential of urban mining in key cities like Lagos and Abuja. Using data from NESREA, EPRON, and UNEP, it evaluates current policy frameworks, especially the Extended Producer Responsibility (EPR) scheme. Findings reveal institutional gaps but also clear opportunities for investment and reform. The research promotes a circular economy model to align environmental sustainability with economic development. Formalizing the informal sector and improving infrastructure are essential steps. With the right interventions, Nigeria could emerge as a regional hub for urban mining. Urban mining presents a pathway to green industrialization, climate resilience, and inclusive growth.

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Heat consumption in multifamily buildings in north-eastern Poland

Knowing the accurate heat consumption makes it easier to detect anomalies caused by incorrect heat meter operation or billing errors. Data read from heat meters in residential buildings was collated with outdoor air temperatures. To make the results more applicable to other towns in the region, degree days were determined based on the normal indoor air temperature in residential buildings (20°C) and the regional heating start/end temperature (12°C) and the heat consumption per degree day was determined. The results were then compared with data from other publications.

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Adsorption of heavy metal ions on the surface of the sorption composite

Human activity has a significant impact on the environment, including water resources. The increase in municipal and industrial wastewater poses a threat to humans, drinking water supplies and the preservation of relatively good biodiversity. Pretreated sewage is constantly pumped into rivers, which contain harmful suspended solids. These biogenic compounds facilitate the growth of toxic cyanobacteria, antibiotics, pathogenic microorganisms, trace amounts of heavy metals, oils and solvents. This study aimed to develop a method for producing a sodium alginate-stabilised biochar composite and verify its ability to retain heavy metal ions. The results indicate that combining biocarbon and sodium alginate creates a material rich in acidic functional groups, shifting the nature of the sorption process from physical to chemical. The composite's efficiency in retaining selected metal ions ranged from 70 to 99%, depending on the ion, its concentration, and the adsorption process conditions.

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The use of an ultrasonic flowmeters in conditions of limited straight pipeline sections

Ultrasonic flow meters (UFMs) provide high measurement accuracy and are suitable for monitoring water consumption in pressurized pipelines. The "Dnipro-7U" UFM, for instance, specifies an accuracy of ±2%. However, this precision requires a straight pipeline section of l=20-50D (where D is the pipe diameter). In practice, such sections are often unavailable at building inlets or pumping stations, complicating proper UFM installation and operation.

A series of experiments evaluated the measurement accuracy of the "Dnipro-7U" ultrasonic flowmeter on short water pipeline sections (diameters D=75.5 mm and 88.5 mm) located before a 90° bend and a branch. The straight sections ranged from l=3.3D to 12D. The study aimed to determine flow-measurement errors near pipeline disturbances and to define the minimum straight-pipe length ensuring an acceptable error (≤ 5%). Results showed that within l≤6D before the bend, the Dnipro-7U exhibited significant errors of 8.6-20% at Reynolds numbers Re=5300-13000. High accuracy, with errors of 0.0-4.7%, was achieved at distances l≥11D under all flow regimes.

For laminar flow (Re ≤ 6000), the measurement error remains substantial – up to 11.6% – even at a greater distance of 15D before the bend. In the transition range between turbulent and laminar flow, the UFM errors become nonlinear, and accurate readings are replaced by significant deviations.

In the pipeline section downstream of the bend, the measurement accuracy of the "Dnipro-7U" ultrasonic flowmeter depends on both the distance from the bend and the flow rate. At low turbulence (Re=7000-10000), high accuracy is achieved at distances of at least 4-6D. For higher turbulence (Re≥19000), a straight section of no less than 10D is required to maintain accuracy.

For measurements before a straight branch, it was found that at l_2=3.3D and Re=10,000-20,000, the measurement error did not exceed 5.5%. With increasing distance, the error initially rose but then decreased to about 5% at l_2=12D. At lower flow rates (Re<7000), errors remained relatively high even at l_2=12D.

Overall, the results indicate that when using the "Dnipro-7U" flowmeter on short straight pipeline sections and accounting for both system and user-related errors an overall measurement accuracy of 2–5% can be achieved.

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Rapid SWMM Catchment Prototyping Usingg Fuzzy Logic

This paper presents the Rapid Catchment Generator (RCG), a fuzzy-logic platform that derives hydraulic width, mean slope, and impervious fraction from three readily available descriptors—area, landform type, and land cover type—and writes them directly into SWMM input files to accelerate early-stage urban drainage modeling. RCG operates as a simple, standalone tool that requires no integration with external GIS or machine-learning systems, generates preconfigured subcatchments directly within the SWMM .inp structure, and shortens model setup time while maintaining transparency and reproducibility in planning workflows.
RCG systematically synthesizes global landform and land-cover classification systems and encodes them into triangular membership functions and Mamdani rule bases, with centroid defuzzification to ensure smooth transitions across classes and hydrologically consistent responses for transitional landscapes. The landform typology (aligned with USDA/USGS/Meybeck) and imperviousness classes (aligned with EPA ROE/NLCD/CLC) are fused into an interpretable rule set that maps minimal qualitative inputs to SWMM-ready quantitative parameters, enabling rapid prototyping.
Validation on a calibrated urban basin confirmed strong agreement in volumetric responses—runoff MAPE of about 16% and infiltration MAPE of about 19%—while preserving hydrograph shape, supporting the use of RCG as an effective starting point for scenario screening prior to detailed calibration

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Effect of rhododendron and cattle manure ratios on biogas yield and digestate composition in dark fermentation

The growing demand for renewable energy and the need for sustainable management of organic waste have increased interest in anaerobic digestion, especially dark fermentation. This biological process enables not only the production of biogas, but also the conversion of agricultural and plant waste into nutrient-rich digestate. However, the efficiency of dark fermentation depends heavily on the type and proportion of substrates used. Rhododendron, a lignocellulosic plant species with limited practical use, and cattle manure, a nitrogen-rich agricultural waste, are both promising feedstocks for anaerobic digestion. Their co-digestion offers a potential strategy to optimize fermentation efficiency by balancing the carbon-to-nitrogen ratio and improving the biodegradability of the substrate.

In this study, the effects of different rhododendron to cattle manure ratios on biogas production and digestate composition were investigated in a semi-continuous dark fermentation system operated under mesophilic conditions (39°C). Four series were tested: rhododendron and cattle manure as single substrates and two mixtures with mass ratios of 93.75:6.25 and 87.5:12.5 (g VS/g VS). The highest biogas yield (0.93 L/d) was achieved with the 93.75:6.25 mixture and thus surpassed both monosubstrate variants. This indicates a synergistic effect when small amounts of manure are added to rhododendron. In addition, co-digestion changed the fermentation dynamics as shown by the increased concentrations of dissolved organic compounds and volatile fatty acids, indicating active hydrolysis and acidogenesis but slower microbial conversion to biogas. Analysis of the digestate revealed a nutrient-rich composition with high nitrogen and phosphorus concentrations in the manure-based treatments and increased potassium content in the rhododendron-based digestate.

In summary, co-digestion of rhododendron and cattle manure improves biogas yield and produces digestate with favorable chemical properties. These results support the feasibility of using locally available, underutilized biomass in dark fermentation and contribute to both energy production and sustainable nutrient cycling.

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The idea of rebuilding the water stage into a block ramp on the Sękówka River in Gorlice

This work proposes modernising the existing water stage in the Sękówka Riverbed (in Gorlice) by replacing it with a block ramp. The current structure consists of a massive concrete wall (the main spillway, acting as a check-dam) and three correction stages, which divide the gradient into three chambers: 18.5 m, 6.5 m, and 15 m long, respectively. Three rectangular passages (1.50 m high, 1.10 m wide) were cut into the main spillway wall, equipped with stoplog shutters on steel guides on the upper side. A currently inactive fish pass, operating only when the stoplogs are closed, is located on the left bank.

Contemporary hydrotechnical trends encourage the replacement of damaged water stages with block ramps. These elements, usually made of layered boulders ranging in diameter from 0.5m to 1.5m, serve a dual function: stabilising the riverbed and enabling free fish migration. The rough surface of the slope plate (slope 1:4–1:20) effectively dissipates flow energy and also enhances water aeration.

In place of the existing barrage, it is proposed to construct a block ramp with a gradient of approximately 2–3%, featuring a developed, meandering, shallow-water channel. The lower end of the block ramp consists of a comb-shaped stabilising buttress made of boulders with a minimum diameter of 0.8m. A subtle stone pile (grain size 20–80 cm, approximately 1 m high) is planned at the mouth, forming a natural riffle.

To protect the riverbed from erosion, the transitional section of the barrage will be reinforced with a cascade of stone steps in an arched configuration. In the central section, the boulders will gradually decrease in size, smoothing the transition between the upper and lower water levels. Additionally, selected boulders will be lowered by 30 cm relative to the remaining levels, creating a gap approximately 0.8 m wide, which will allow for the undisturbed migration of fish. The height difference between adjacent sills will not exceed 0.2 m.

Immediately below each sill, the bed of the channel will be reinforced with buried boulders with a slope of 1:5–1:10, to a depth of approximately 1 m. The section below the lowest sill will be additionally reinforced with a layer of boulders along a length of 20–30 m, with a bed slope of approximately 5%. These proposed measures will effectively stabilise the channel, minimise erosion, and create favourable biological conditions for fish migration.

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Effective tree protection during construction projects

Urbanization poses significant threats to urban trees during construction. Ensuring their vitality and stability requires diligent protection strategies. This abstract provides a concise overview of key methods for safeguarding trees on construction sites.
Four primary methods were analyzed: Tree Protection Zones (TPZ), specialized physical barriers, pre-construction root mapping using Ground Penetrating Radar (GPR), and continuous arboricultural supervision. TPZ define protected areas based on tree characteristics. Specialized fencing provides robust physical separation. GPR identifies major underground root structures, while arboricultural supervision ensures ongoing monitoring by experts.
Each protection method offers distinct benefits but also faces limitations. TPZ clearly demarcate critical root areas but may not cover all root growth and are susceptible to disregard. Robust fencing provides physical deterrence, though its efficacy hinges on strict adherence. GPR offers precise mapping of larger roots, crucial in confined spaces, yet requires expert interpretation and cannot detect fine roots. Arboricultural supervision provides comprehensive, expert oversight but is associated with additional costs. Critically, isolated application of these methods is often insufficient for comprehensive tree health preservation.
Effective tree protection during construction mandates an integrated approach combining TPZ, specialized fencing, pre-construction root mapping, and continuous arboricultural supervision. While individual methods contribute to safeguarding trees—as practiced globally, including under established standards—their synergistic application, supported by meticulous planning and universal adherence from all site personnel, yields the most successful outcomes. This holistic strategy is essential for sustainable urban development and maintaining tree health amidst construction pressures.

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Transformation of toms' effect in flow of water with hydrodynamically active additives through a narrowing of the pipe

Reducing the hydrodynamic resistance of pipelines ensures significant savings in energy resources. This problem is being solved in many ways. Among them, the most effective one is the introduction of small anisometric particles into the turbulent flow the lengths of which exceeds their transverse dimensions by orders of magnitude. The-se are hydrodynamically active additives (HAAs). The phenomenon of reducing the hydrodynamic resistance using HAAs is called the Toms' effect. In a moving fluid, the HAAs are oriented with their longer axes along the walls that limit the flow. This cre-ates an elastic veil along the walls. The vortices that originate on the protrusions of the pipe wall roughness are thrown into the flow, but are damped by the veil of oriented anisometric particles. Thus, oriented HAAs reduce turbulent friction. Accordingly, the effect of reducing the hydrodynamic resistance by additives is weakened. However, behind the local drug, the orientation effect of the HAAs and the Toms effect are restored. The purpose of the work is to establish the recovery distance of the Toms' effect in a pipe behind its narrowing.

Turbulent flows of aqueous solutions of polymers (polyoxyethylene and polyacryl-amide) and that of micellar surfactant (metaupon) at different values of their concen-trations C and Reynolds criterion Re were experimentally investigated. In the experi-ments, a sharp narrowing of the pipe from a diameter of D = 20.95 mm to d = 5.81 mm and a confuser with a taper angle equal to 40^o were applied at the same values of D and d. Aqueous solutions polyacrylamide of mass concentrations C = 3–1000 ppm as well as those of polyoxyethylene C = 1-100 ppm as well as those of metaupon C = 2000–5000 ppm were used. The electrolyte NaCl C = 70,000 ppm was added to the metaupon solutions. The Reynolds criterion value varied from 1,000 to 24,000. The recovery distance of the Toms' effect behind the pipe constriction increased with increasing values of the concentration of the HAAs solution and the Reynolds criterion, and reached it 400 d. Since the fluid flow in the confuser was deformed less than in a sharp narrowing of the pipe, the Toms' effect in the flow behind the confuser was restored at a shorter distance than that behind a sharp narrowing of the pipe.

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Application of halloysite for removal of Cu(II), Zn(II) and Co(II) from water

Halloysite is a nanosized tubular clay mineral, belonging chemically and structurally to the kaolin group of clay minerals. Clays are capable of taking up both cations and anions from water solutions, throught ion exchange and/ or adsorption. Similar to kaolinite, halloysite is also a superposition of one silicon-oxygen tetrahedron sheet and one aluminium-oxygen octahedron sheet with 1:1 stoichiometric ratio. In each halloysite nanotubes, the internal lumen surface consists of aluminol (Al-OH) groups, whereas the external surface is mainly composed of siloxane Si-O-Si groups. The unit layers are separated by water molecules. One side of the interlayer is composed of Si-O-Si groups, while the other site of Al-OH groups. There are also some Al-OH and Si-OH groups on the edges of the nanotube. This rare mineral is found in Polish deposit, located in the Lower Silesia near Legnica town. The raw or biofilm coated halloysite can be used as a component of filtration barrier in the aquifer, for example near a solid domestic waste landfill. Halloysite has been found to be highly effective in the remediation of heavy metals from contaminated river sediments. Owing to the interest in halloysite application for environmental remediation a comprehensive research on the use of this clay for heavy metals adsorption is necessary. The aim of this study was to investigate Cu(II), Zn(II) and Co(II) adsorption onto halloysite coming from the Dunino deposit in Poland. The sample of halloysite mineral with a particles size ≤0.05 mm was purchased from the Intermark Company. Batch experiments were carried out to determine adsorption isotherm of Cu(II), Zn(II), and Co(II). For this purpose 0.5 g samples of halloysite were mixed with 50 mL of $Cu(NO_3)_2$ or $Zn(NO_3)_2$ or $Co(NO_3)_2$ solutions having a single metal concentrations ranging from 5 to 300 mg/L. The pH was adjusted to pH_{init} 6. The mixtures were placed in screw top polyethylene tubes and agitated at room temperature on an end-over-end tumbling shaker at 140 rpm, for 24 h (a period demonstrated to be sufficient to reach adsorption equilibrium). Then the sorbent was separated from aqueous solution by decantation, and the supernatant was analysed towards copper, zinc and cobalt content by ICP-OES. The amount of metal ion adsorbed was calculated from the mass balance equation. The one-component system equilibrium data is well represented by empirical adsorption models. The maximum adsorption capacity was obtained for copper ions (5.14 mg/g). The experimental data for halloysite were selected for modeling the adsorption behavior of material using two isotherm equations: Langmuir and Freundlich.

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Metallurgical waste landfills as anthropogenic deposits of selected metals

The modern raw materials economy faces challenges related to limited access to natural metal deposits and the growing demand for raw materials used in modern technologies. In this context, so-called anthropogenic deposits, i.e. secondary sources of raw materials created as a result of human activity, are gaining increasing importance. One of the most promising types are metallurgical waste landfills, which contain significant amounts of metals such as zinc, lead, copper, nickel, iron and chromium. The article presents the characteristics of selected metallurgical waste landfills , with particular emphasis on their mineralogical and chemical composition, raw material potential and the possibilities of metal recovery from the technological and economic point of view. Attention was drawn to the environmental aspects related to the reclamation of post-industrial areas and the possibility of combining environmental activities with the recovery of valuable raw materials.
The article highlights the need to develop a circular economy strategy in which waste becomes a source of raw materials rather than just a problem to be managed.
Using the potential of metallurgical storage sites can significantly contribute to increasing raw material security and reducing impact it on the natural environment.

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Microplastics in the Environment and the Human Body: Where Engineering Meets Biology

Since 1950, global plastic production has increased from less than 2 million tons to over 460 million tons annually by 2024, contributing to the growing problem of environmental pollution. Due to its durability, plastic does not readily degrade and gradually fragments into microplastics (<5 mm) and nanoplastics (<1000 nm). These particles are now commonly detected in water, soil, air, and in the bodies of both humans and animals. Recent studies have confirmed the presence of microplastics in human lungs, blood, and even in the brain- particularly in individuals suffering from neurodegenerative diseases. Although the mechanisms by which these particles affect the human body are not yet fully understood, preliminary evidence suggests their involvement in triggering inflammation, oxidative stress, and disturbances in nervous system function.
This poster summarizes the current state of knowledge regarding the sources and environmental distribution of microplastics, with particular emphasis on the role of wastewater treatment plants, industrial emissions, and urban drainage systems in their continued spread. The scale and complexity of the microplastic issue underscore the need for an integrated approach involving collaboration among scientists, engineers, and environmental policy-makers to reduce emissions and mitigate associated health risks.

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Green Infrastructure in Brazil: A study of research and initiatives with a focus on Sorocaba Municipality

Brazil, a country of continental dimensions, is characterized by a wide range of climates and biomes, harboring one of the richest biodiversities and most abundant freshwater resources in the world. Nevertheless, municipalities across the country—regardless of their size—are increasingly experiencing the adverse effects of climate change. In response, studies and initiatives have been developed around the concept of green infrastructure, aligning with broader strategies for smart city development. This paper presents data and case studies of projects aimed at preserving and enhancing local biodiversity, while also addressing the evolving trends in this field. A particular focus is given to the municipality of Sorocaba, located in the state of São Paulo, Southeastern Brazil. Faced with recurring flooding, the local government has implemented a system of water containment structures designed to manage surface runoff during heavy rainfall. These freshwater installations not only serve hydrological functions but also support biodiversity by providing habitats for native species and offering recreational spaces for the population. I gathered data for this study through aerial drone surveys and field observations. The preliminary findings suggest favorable conditions for local authorities to develop and implement targeted, evidence-based interventions. For these solutions to have lasting impact, future efforts must emphasize strategic planning, particularly in terms of site selection and infrastructure design, which are critical to ensuring long-term sustainability and community benefits.

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Random Forest vs. Geostatistics: Mapping air pollution around Kraków

Air pollution poses a serious problem in the Kraków region, where regulatory differences between the city and surrounding areas lead to complex spatial patterns of emissions. This study compares two approaches to mapping particulate matter (PM) concentrations: the machine learning-based Random Forest method and traditional geostatistical interpolation (kriging).

The analysis is based on data from 51 low-cost air quality sensors, combined with terrain elevation and meteorological parameters (temperature, humidity, wind speed). Five time points over a 24-hour period were analyzed, capturing dynamic changes in pollution distribution under inversion and low wind conditions.

The Random Forest model achieved high predictive accuracy (R^2 between 0.90 and 0.95) and demonstrated strong spatial robustness. It allowed for the integration of multiple predictors and provided interpretable results showing how factors such as elevation, temperature, and humidity influence PM distribution over time. In contrast, kriging produced smoother but less detailed maps because it could not explicitly account for environmental factors.

Results show that in the early morning and late night, pollution tends to accumulate in valleys, with elevation as the dominant factor. During the evening, increased emissions coincide with greater influence from humidity and temperature. The Random Forest model also revealed pollution inflow pathways into Kraków along river valleys, which are not captured by kriging.

This comparison highlights the advantages of combining traditional and modern methods. While kriging offers simplicity and smooth interpolation, Random Forest adds value through flexibility, predictor integration, and temporal sensitivity. Together, they provide a comprehensive view of air quality dynamics in complex urban environments.

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Hazards associated with additive manufacturing in the working environment

Fused Deposition Modeling (FDM) is one of the most widely used additive manufacturing technologies, thanks to its simplicity, affordability, and ability to create durable parts. However, it involves potential risks of ultrafine particles (UFP) and volatile organic compounds (VOCs) emissions and requires proper safety measures to ensure the operator’s safety.

Tests were conducted in the lab chamber on particulate and chemical emissions during 3D printing process using common polymer materials. The materials came from various Polish manufacturers and differed, often unreported, in the additives affecting the physicochemical properties of the printed product. For each filament considered, the highest particle concentrations were obtained at the beginning and end of the 3D printing process. The values of particle emission parameters during 3D printing from PETG filament (PETG-3 1.63 × 10^5) were an order of magnitude smaller than during 3D printing from ABS filament (ABS-3 was 1.11 × 10^6). Significantly lower concentrations of VOCs were also measured when printing with PETG filament than with ABS. However, total endocrine-active compound PAEs in the inhalable and gaseous fractions were found to be significantly higher when using PETG filaments. Thus, attention should be given to the materials used in the printing process.

By following proper safety guidelines and taking proactive steps to mitigate risks, users can ensure a safe printing environment while maximizing the efficiency and effectiveness of the FDM process.

*This task was completed on the basis of results of research carried out within the scope of the 6th stage of the National Programme “Governmental Programme for Improvement of Safety and Working Conditions”, funded by state services of the Ministry of Family, Labour and Social Policy (task no. 3.ZS.05). The Central Institute for Labour Protection – National Research Institute is the Programme’s main co-ordinator.

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Selected properties of hardening slurries with the addition of fly ashes from thermal treatment of municipal solid waste

The mass of municipal waste generated in Poland in 2023 amounted to 13,447,908 Mg. The management of such a significant quantity of waste constitutes a major challenge. One of the methods of processing the accumulated waste is thermal treatment. This process produces, among other by-products, ashes that also require safe management. In 2022, the consumption of hard coal for energy purposes reached 41,300,000 Mg. Its combustion in power plants (using both conventional and fluidized technologies) generates by-products of combustion, including fly ash. Fluidized fly ash is characterized by a considerable variation in properties, which, combined with its specific characteristics, poses a limitation to its widespread application.

In the context of pursuing the implementation of the Circular Economy, a new research area is emerging — the search for methods of utilizing ashes, such as their incorporation as an additive in hardening slurries. This approach enables the conversion of undesirable waste into ingredients for the production of building materials that meet relevant performance requirements. One such material may be hardening slurries, applied in the construction of cut-off walls.

The aim of the study was to assess selected properties of hardening slurries with the addition of fluidized fly ash and ash from the thermal treatment of municipal waste. The research encompassed both technological and operational parameters and was conducted in three stages. The analysis of the results was performed in reference to the literature requirements for hardening slurries intended for the construction of cut-off walls in flood control embankments. The obtained results indicate the potential for utilizing ash from the thermal treatment of municipal waste as an additive to hardening slurries.

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Effects of heavy metals from roadside dust on the environment

Roadside dust, which is created through road use and heavy traffic as well as through processes such as erosion and the wearing down of road materials, is a significant source of environmental pollution. A major issue is the presence of heavy metals such as lead (Pb), cadmium (Cd), zinc (Zn), copper (Cu), nickel (Ni) and chromium (Cr). These metals enter the dust primarily through exhaust emissions, tyre and brake component abrasion, and vehicle part corrosion. Once they have accumulated in the dust layer on roadside surfaces, they become a persistent source of environmental contamination.

The ecological risk posed by heavy metals in dust is primarily due to their toxicity, bioaccumulation and persistence in ecosystems. Dust containing these elements can settle on plants, penetrate the soil and enter surface water, where it can be absorbed by living organisms. This disrupts the functioning of ecosystems and leads to the accumulation of metals in food chains, amplifying the health risk for both animals and humans.

This study analysed roads with varying traffic intensity in Zielona Góra. The research was conducted over two years. Zinc (262.75 mg/kg) and copper (165.64 mg/kg) were the dominant heavy metals in the dust, originating mainly from the abrasion of tyres and brake pads. However, none of the samples exceeded the limit values specified by regulations.

The heavy metal content of the analysed samples varied. The order of their occurrence can be arranged as follows: Zn > Cu > Pb > Cr > Ni > Co > Cd.

Although the level of heavy metals in the analysed material did not exceed the standards for roadside soils, these metals can still transfer to soil, water and living organisms via roadside dust. This can lead to the degradation of ecosystems and pose a health risk to humans through bioaccumulation in the food chain.

This study, which was conducted in autumn 2023, indicates the need to implement risk management strategies. These include promoting public transport and installing plant barriers alongside roads. In the long term, these measures can help to improve the quality of the urban environment and reduce the risk of fine street dust and its pollutants being transferred elsewhere.

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Use of ash and slag from municipal waste incineration as an ingredient of solid concrete

The decreasing availability of natural resources, limitations related to greenhouse gas emissions, and the growing volume of municipal waste highlight the need to find ways to manage and utilize these materials. This approach aligns with current climate policy, whose main objectives include reducing the consumption of natural deposits, transitioning from a linear to a circular economy (closing loops through waste utilization), and reducing the carbon footprint generated by industry, including the concrete industry. Confirming the feasibility of using ash and slag from the thermal treatment of municipal waste in concrete production will contribute not only to a better understanding of the properties of this type of waste, but also to limiting the exploitation of natural deposits used in concrete manufacturing. The presentation will showcase research conducted to date as part of the doctoral dissertation on this subject. The results will include the basic properties of mortars and concrete incorporating ash and slag from municipal waste incineration.

The expected outcome of the doctoral research will be the optimization of the composition of concrete modified with by-products from the thermal treatment of municipal waste (ash and/or slag) in order to achieve properties desirable for massive structural elements. Utilizing these materials in concrete production can significantly reduce the amount of waste that is landfilled. Until now, the only method of managing these by-products has been their disposal in landfills.

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Lewis acid catalyzed synthesis of dialkyl H-phosphonates

Among the fascinating phosphorus compounds, phosphonates have attracted attention as synthetically flexible synthons with valuable pharmacological and therapeutic effects. Since being discovered in the 19th century, numerous studies and applications have appeared, encompassing a wide array of uses such as antidepressants, anticancer agents, anti-Alzheimer treatments, antimicrobials, anti-parasitics, anti-hepatitis medications, antiproliferatives, anti-influenza drugs, anti-HIV therapies, and anti-malarial agents. This importand class of compounds was utilized in agrochemicals, industrial applications, and as ligands for transition metal complexes. Considering the significant role and accessibility of phosphonates acids in chemical synthesis, extensive research has been focused on determining convenient and efficient reactions. In recent decades, various reactions resulting in phosphonates derivatives have been documented, including Kabachnik–Fields, Mannich, Arbuzov, and Michaelis–Becker reactions, among others.
The diesters of H-phosphonic acid can be synthesized by various methods, mostly involving the reaction of alcohols with white phosphorus or phosphonic acid. Dialkyl H-phosphonates are produced in the USA, Japan, Germany and other countries on an industrial scale primarily from phosphorus trichloride and alcohols. However, in our research, we will present a green method for the synthesis of H-phosphonates using Lewis acids in an aqueous environment and mild condition.

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Comparative Analysis of Climate Change Adaptation Strategies in the European Union: Case Studies of the Netherlands and Poland

This paper presents a comparative study of climate change adaptation strategies in tackling climate-related flooding in both the Netherlands and Poland with emphasis on the use of raw materials, climate policy, infrastructure adjustments, eco-engineering, technology, and nature-based solutions. The important role of raw materials such as sand, gravel, and aggregates is highlighted in both nation's approaches. The Netherlands constructed over 1500 km of dikes and has launched innovative initiatives like the Sand Motor, which distributed 21.5 million m^3 of sand to boost coastal resilience through natural sediment redistribution, demonstrating sustainable and large-scale use of raw materials in nature-based engineering. In contrast, Poland, which boasts more than 8600 km of flood levees and over 100 multifunctional reservoirs, depend largely on domestic sand and gravel for embankments and flood infrastructure, while also deploying more than 270 Internet of Things (IoT) based flood sensors to enhance its early warning systems. Both nations operate under the EU Floods Directive framework; however, the Netherlands employs advanced risk-based management and hybrid nature-based infrastructure, while Poland is advancing in eco-engineering and urban blue-green networks. Supported by EU funding and policy guidance, these strategies illustrate diverse yet complementary methods for flood adaptation. This analysis highlights the significance of sustainable raw material usage, technological advancements, and nature-based approaches in strengthening resilience against climate-induced flooding in Europe.

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Example of using selected machine learning algorithms to assess the raw material potential of waste accumulated in heaps after iron ore extraction

Artificial intelligence (advanced machine learning algorithms, neural networks or deep learning) is nowadays more and more used in various scientific and economic fields. One of the areas of science in which machine learning algorithms have been applied is the assessment of the secondary raw material potential of waste accumulated in heaps. Historic mining and processing heaps from iron ore exploitation in the Częstochowa region were selected to research where more than 40 such heaps were inventoried. These sites represent different forms and heights, types and the amounts of accumulated waste.

The heaps were described with criteria developed for this purpose and appropriate features assigned to them. Due to the selection of features and expected results, supervised machine learning methods with classification process were used for data analysis. Algorithms belonging to the following groups: Decision Trees, Ensembles, Support Vector Machines (SVMs), Nearest Neighbor, Linear, Neural Networks, Gaussian Processes and Naive Bayes were selected for the studies. The results of analyses presented that the most accurate prediction matches are 0.85 for the algorithms: GaussianProcessClassifier (GaussianProcess group of algorithms) and SGDClassifier (Linear group) using input scaling algorithms, respectively: RobustScaler and MiniMaxscaler. A slightly lower accuracy value, at 0.83, was obtained for the GaussianNB (Naive Bayes group) and MLPClassifier (Neural Networks group) algorithms using the scaling algorithms: Quantile-transformer and RobustScaler respectively. The results provide information about potentially prospectives or non-prospective sites for further use. The tool can be used to support the decision-making process of utilizing accumulated waste in iron ore mining heaps. However, it is advisable to confirm the results on a larger data set.

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Air quality in an educational building – a case study

Nowadays, people spend most of their time indoors. Therefore, in order to ensure their physical and mental health, it is important to provide adequate air quality. Educational buildings should receive special attention due to their function. Poor air quality can not only affect the wellbeing of students, but can also impair concentration and make it difficult to carry out tasks in class. The topic of air quality in educational facilities is also important because one of the most common types of ventilation is still natural, which is highly dependent on atmospheric conditions and does not guarantee constant air exchange in the room. The problem is particularly significant in new buildings constructed in accordance with the latest requirements for thermal insulation of facade elements such as walls and windows, or in buildings undergoing thermal renovation. In these facilities, the building envelope is often airtight, preventing fresh air from flowing into the rooms through leaks, which can result in a deterioration of air quality.

The study covers the analysis of air quality in four computer classes at university with natural ventilation, located in two buildings, each with different cubic capacity, orientation, and number of students. The scope of the research includes measurements of indoor air temperature, humidity, CO_2 concentration and air velocity and determination of the thermal comfort factors PMV and PPD.

The test results indicated significant exceedances of the permissible CO_2 levels (1000 ppm) in all tested rooms, ranging from 100 to 200%. Regarding the PMV and PPD indicators, only one class had absolute PMV and PPD values lower than 0.2% and 6%, respectively, indicating high air quality according to the PN-EN 16798-1:2019 standard. In one computer class, absolute PMV and PPD values were lower than 0.5% and 10%, respectively, indicating standard air quality. The remaining two classes were characterized by moderate and poor air quality. The highest PMV and PPD values obtained during the measurements were 0.9 and 22.1%.

Studies have shown significant variations in air quality in university computer labs with natural ventilation. CO_2 concentrations were exceeded in all of them, which can negatively impact student well-being and learning ability. This indicates the need to introduce changes in the functioning of the facilities in order to ensure the required quality of indoor air.

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Potential of extensive green roofs for reducing rainwater runoff

The combination of climate change and rapid urbanization has significantly increased interest in green roofs as a sustainable way to introduce greenery into cities and improve stormwater management. One of the primary advantages of green roofs is their ability to regulate building temperature. Improved insulation decreases the need for energy used in heating and cooling, which is especially beneficial in warmer climates where traditional buildings often lack adequate thermal protection. Furthermore, by reducing surface temperatures and adding vegetation, green roofs help counteract the urban heat island effect and enhance urban biodiversity. A major role of green roofs lies in their hydrological performance, particularly their contribution to stormwater management. They help reduce the overall volume of runoff and delay the timing of peak flow during intense rainfall events. This function is essential for easing the load on urban drainage and combined sewer systems, which are often overwhelmed during heavy storms. The hydrological behavior of green roofs depends on two key processes: retention and detention. Retention refers to the permanent storage of a portion of rainwater that is later lost through evaporation and plant transpiration. Detention, on the other hand, involves the temporary storage of excess water, which is released more slowly than it would be from a conventional roof. In real-world conditions, both processes occur simultaneously, resulting in an overall reduction and delay in runoff.

The effectiveness of green roofs in managing water depends on several interrelated factors. Design parameters such as the composition and thickness of substrate layers, roof slope, drainage systems, and choice of vegetation all influence water storage and release. Environmental conditions - including rainfall patterns, seasonal temperature variations, and rates of evapotranspiration - also play critical roles. Studies conducted in European cities have reported annual retention rates for extensive green roofs ranging from 18% to 59%. For instance, locations such as Denmark and Sweden show average retention of around 45–50%, while in wetter regions like western Scotland and Norway, retention can drop below 20% due to higher precipitation and lower evapotranspiration. It is also evident that retention performance fluctuates significantly between individual rainfall events. Seasonal differences, initial substrate moisture levels, and the intensity and duration of precipitation all influence how much water is stored or released. Because of this variability, the water storage capacity of green roof materials alone cannot reliably predict their real-world performance. Therefore, accurate design requires combining material specifications with long-term monitoring data and predictive hydrological models that account for regional climate patterns.

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Characterization of spinel-based materials for an application in CLOU and CLC Technologies

Due to increasing energy consumption needs combined with restrictions on reducing greenhouse gas emissions, solutions are being sought for new energy production technologies. A promising new technology for obtaining energy from solid fuels is chemical looping combustion (CLC), the pillar of which is a material called an oxygen carrier. This material is responsible for the cyclic transport of pure oxygen extracted from the atmosphere into the fuel. Previously, oxygen carriers based on transition metal oxides have received the most attention. Today, complex metal oxides such as bimetallic oxides, perovskite or spinel structures are gaining interest.
Spinel-based materials (AB2O4) appear to be promising candidates for permanent oxygen carriers in CLC technology. They are characterized not only by high mechanical strength, but also by high oxygen transfer capacity and good reactivity with fuel. Moreover, depending on their chemical composition, these materials may be capable of spontaneously releasing oxygen during the reaction, driven by changes in the partial pressure of oxygen in the reaction environment, which is particularly advantageous in the combustion of solid fuels.
This study proposed spinel oxygen carriers composed of magnesium, manganese and iron oxides. The synthesis was carried out by mechanical homogenization of raw materials and calcination. The ability of the materials to transport oxygen was tested on a thermogravimetric analyzer in range of temperatures 800-1100°C commonly used in CLC reactors. Direct solid fuel combustion experiments were also carried out (TGA-QMS) to evaluate the reactivity of the materials and their ability to regenerate to the initial state.

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Impact of ground-mounted photovoltaic microinstallations on soil environmental conditions

Photovoltaic (PV) installations represent a promising technology for generating clean and renewable electricity from solar energy. In Poland, the development of photovoltaic farms is accelerating in response to the growing demand for clean energy and the need to reduce greenhouse gas emissions. However, the expansion of these installations presents significant environmental challenges that must be addressed within renewable energy development strategies. Some of their environmental impacts remain insufficiently studied. In particular, understanding the effects of photovoltaic panels on soil is essential for ensuring the sustainable development of renewable energy sources and the effective conservation of natural resources.

The aim of this study is to assess the impact of photovoltaic microinstallations on selected soil environmental properties.

Most studies indicate that soil beneath photovoltaic (PV) panels and in their immediate vicinity retains higher moisture compared to unshaded areas. This effect is primarily due to shading, which reduces the evaporation of water from the soil surface and lowers soil temperature. PV installations create a favorable microclimate: they decrease soil temperature (by as much as 2–9°C), reduce evaporation, and increase the efficiency of water use by plants. Agrivoltaic research has demonstrated more than a threefold increase in water use efficiency and a significant rise in plant biomass under the panels.

Ground-mounted photovoltaic installations also influence the biochemical activity of soil through changes in microclimate, light availability, moisture, temperature, and the cycling of organic matter. These effects are complex and depend on local environmental conditions, soil type, vegetation management, and the duration of the installation’s operation.

Further multifaceted and long-term research is essential to fully understand the impact of ground-mounted photovoltaic installations on the soil environment and to enable the implementation of best practices for soil protection and management on PV investment sites.

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Analysis of water consumption in Lubin

Water consumption is determined by numerical values describing both the quantity and unevenness of consumption in different time intervals. These parameters are important for the design and operation of water supply systems.

The analysis of water consumption in Lubin was performed on the basis of data from 2013-2022. The number of inhabitants in 2013 was 74,970, while by 2022 it had decreased to 65,429. The highest unit water consumption rate - 129 $dm^3 \cdot M^{-1} \cdot d^{-1}$ - was calculated for 2018, and the lowest value - 114 $dm^3 \cdot M^{-1} \cdot d^{-1}$ - was recorded in 2013. The average value of the unit water consumption index in 2013-2022 was 122.45 $dm^3M^{-1}d^{-1}$, which falls within the average standards specified in the Regulation of the Minister of Infrastructure.

An analysis of the unevenness of water consumption in different time intervals was also carried out. The highest water consumption values were recorded in June, July, and December, while the lowest were in February. A comparison of water consumption on individual days of the week showed that the highest values occurred at the beginning of the week: Monday, Tuesday, and Wednesday.

One factor that may influence water consumption is its price. During the analyzed period, the price of water increased by 50%. Comparing the price level and water consumption, it was found that the change in the tariff did not significantly affect water consumption.

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NanoEngineered porous Carbon textiles as protection media against toxic vapors

The rising need for reliable personal protection in hazardous environments, like industrial accidents, chemical spills, fires, and potential chemical warfare, demands advanced materials that go beyond simple barriers. Modern protective media aims to integrate lightweight fabrics with multifunctional capabilities, enabling them not only to capture but also to catalytically neutralize toxic compounds. Such textiles must perform under realistic conditions, including high humidity, which often accompanies intense physical activity or stress.

Nanoporous activated carbon textiles (C-Texts) are promising due to their light weight, flexibility, high (nano)porosity, and versatile surface chemistry. Their performance can be further enhanced by nanoengineering with active nanostructured phases deposited on their surface or/and within their pores. Chemical Warfare Agents (CWAs), including blister agents like mustard gas and nerve agents such as sarin, remain persistent threats. While studies on C-Texts' interactions with toxic vapors and droplets are limited, such insights are critical for advancing protective technologies against CWAs, other hazardous compounds, and biological threats.

This presentation highlights strategies to boost the detoxification performance of nanoporous carbon textiles. We first assessed the adsorption efficiency of commercial C-Texts and identify key physicochemical features. Given humidity's strong impact under real-life conditions, the role of water was systematically investigated. Progress was further achieved by developing scalable, cost-effective procedures to decorate C-Texts with minimal amounts of nanostructured active phases, like mono- or bimetallic Metal-Organic Frameworks (MOFs). These composite textiles showed superior detoxification of CWA vapors and droplets, owing to homogeneous dispersion of active phases and synergistic interfacial effects. Their main advantage lies in combining catalytic detoxification efficiency with stable retention of captured toxic molecules.

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Conditions and consequences of location of renewable energy installations on the environment

The location of renewable energy installations (RES) is a complex process that requires compliance with a variety of environmental and legal conditions. These conditions are primarily aimed at safeguarding natural resources and ensuring consistency with the principles of sustainable development. This paper discusses the key environmental considerations of investing in renewable energy technologies, such as wind, hydropower, solar and biomass. Particular emphasis is placed on environmental impact assessment (EIA) procedures, covering strategic environmental assessments at the spatial planning stage and project-specific evaluations. An Environmental Decision (ED) is required before advancing to subsequent investment stages, including the building permit procedure.
A major locational constraint for RES projects stems from nature conservation regulations. Such installations cannot be located within strictly protected areas, such as national parks or nature reserves. Additional environmental and legal requirements apply to protected landscape areas, landscape parks and Natura 2000 sites. Failure to comply with these criteria, particularly where significant adverse environmental impacts have been identified, may result in the project being suspended or abandoned. Furthermore, legal provisions specify minimum distances that must be kept between residential buildings and installations to protect inhabitants from noise emissions and electromagnetic field exposure.
The development of renewable energy is a cornerstone of climate policy and energy transition strategies. While renewable energy sources (RES) contribute to reducing greenhouse gas emissions and decreasing dependence on fossil fuels, the location and operation of RES projects can have significant environmental impacts on biodiversity, landscapes, water, soil and air quality. This study analyses formal environmental procedures and assesses the potential environmental impacts of RES projects. It emphasises the importance of integrating legal requirements on nature conservation with spatial planning principles, as this minimises environmental risks and enhances social acceptance. A properly conducted siting process is therefore essential for the continued, sustainable development of the renewable energy sector.

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The influence of temperature and starch-acrylic copolymer on selected microbiological parameters of soils

In the context of ongoing climate change, changes in soil properties are being observed. An increase in temperature influences the rate of biological processes, including soil respiration, which tends to intensify at higher temperatures, thereby contributing to increased carbon dioxide emissions into the atmosphere. Simultaneously, reduced water availability leads to soil desiccation. Under these conditions, effective water management becomes crucial, particularly in agriculture, where water deficits directly affect crop yields and soil productivity. One potential solution for enhancing soil water retention is the application of superabsorbent polymers (SAPs). SAPs are synthetic polymers with the ability to absorb and retain water in amounts several times their own weight. Functioning as water reservoirs, they gradually release stored moisture during drought conditions, thereby improving water availability for plants and reducing the need for frequent irrigation.

Three soil samples were tested and incubated at different temperatures (5°C, 15°C, 22°C, and 32°C), both with and without the addition of SAP (starch-acrylic copolymer), to measure soil respiration rates. The study also simulated variable humidity conditions (60%, 100% WHC). The influence of temperature, moisture level and SAP addition on soil respiration rates was analyzed to investigate how these factors may alter the functioning of soil ecosystems. The addition of SAP increased the soil's ability to retain water, thereby also increasing its microbial activity and respiration values. Thanks to the addition of SAP, moisture fluctuations in the soil can be reduced. The most significant finding of the study is the recommendation to coordinate the application of SAP prior to heavy rainfall, given the highest respiration values recorded for SAP-added samples with a moisture content of 100% WHC.

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Engineering community resilience: innovative design solutions for climate change adaptation in east africa's rapidly changing climate and ecosystems

East Africa is facing unprecedented climate challenges such as rising temperatures, erratic rainfall, prolonged droughts, and widespread ecosystem degradation. These environmental changes pose severe threats to the livelihoods, food security, and well-being of millions, especially vulnerable rural and pastoral communities often living in or near mining regions. Mining activities, while economically important, can exacerbate environmental degradation and resource scarcity, making sustainable and climate-resilient approaches critical. Traditional top-down methods have proven insufficient to address these complex, interlinked issues, highlighting the need for innovative, community-centred engineering and design solutions.

This paper demonstrates that integrating community-based design principles with advanced environmental engineering enhances resilience and adaptive capacity in East Africa's rapidly changing climate and mining-impacted ecosystems. Through interdisciplinary research and case studies, it shows that participatory design empowers local communities to co-create climate-resilient housing, sustainable water management systems, and environmentally responsible infrastructure. A key finding is that blending indigenous knowledge with modern technologies produces adaptation strategies that are culturally relevant and scalable. Furthermore, embedding these approaches within regional planning, policy, and education frameworks is essential for their long-term sustainability. Ultimately, this work advocates for a paradigm shift toward inclusive, bottom-up climate adaptation methods that build resilience in partnership with communities, offering valuable models for other regions facing similar environmental and mining-related challenges worldwide.

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Environmental protection issues in the political discourse of election campaigns – a case study

Climate change requires action aimed at reducing greenhouse gas (GHG) emissions. The European Union's climate and energy policy places particular emphasis on the development of renewable energy, which is considered a key means of achieving climate neutrality by 2050. One of the socio-economic challenges is the effective transition of the economy to low- and zero-emission energy sources, although not all EU countries will be able to reach climate neutrality by 2050 at the same pace.

The energy transition is underway, and Poland faces a particularly difficult task due to the economy's heavy dependence on coal and high levels of emissions. The aim of this article is to analyze the issues addressed by Polish political parties regarding environmental protection during the 2023 parliamentary election campaign. The Green Transformation requires significant investments in energy technologies and renewable infrastructure, in key sectors of the Polish economy such as energy, transport, and construction, while making a substantial shift away from fossil fuels.

A major challenge for the ruling elite is to frame climate policy in terms of instruments that offer tangible benefits to those who fear such changes. This may prove difficult without a clear strategic vision from political leaders.

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The influence of pH on the flocculation properties of alginic acid towards polystyrene derivative nanoparticles

In a moving fluid, the HAAs are oriented with their longer axes along the walls that limit The purpose of the work is to establish the recovery distance of the Toms’ effect in a pipe behind its narrowing. Turbulent flows of aqueous solutions of polymers (polyoxyethylene and polyacrylamide) and that of micellar surfactant (metaupon) at different values of their concentrations C and Reynolds criterion Re were experimentally investigated. In the experiments, a sharp narrowing of the pipe from a diameter of D = 20.95 mm to d = 5.81 mm and a confuser with a taper angle equal to 40^{o} were applied at the same values of D and d. Aqueous solutions polyacrylamide of mass concentrations C = 3–1000 ppm (1 ppm = 1 kg of HAAs per 10^6 kg of solvent) as well as those of polyoxyethylene C = 1-100 ppm as well as those of metaupon C = 2000–5000 ppm were used. The electrolyte NaCl C = 70.000 ppm was added to the metaupon solutions. The Reynolds criterion value varied from 1.000 to 24.000.

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Thermal Mass and Ground Coupling: Full scale evidence for summer and winter resilience

This study investigates the role of structural thermal mass and ground coupling in enhancing the passive thermal resilience of single-storey residential buildings during both summer heatwaves and winter heating outages. The study compares two identical test dwellings with different constructions: a medium-weight masonry building (B1) with direct ground-floor interaction, and a lightweight timber-frame building (B2) with a fully insulated slab. Results from monitored heat events in 2018 and 2019 demonstrate that the ground-coupled, heavy structure (B1) effectively prevents overheating during severe summer conditions, maintaining safe indoor temperatures without mechanical cooling, whereas the lightweight, insulated slab building (B2) experiences significant overheating, crossing comfort thresholds for extended periods.

During controlled winter heating outages, B1 maintained habitable conditions for over 60 hours, with higher minimum indoor temperatures compared to B2, which exhibited rapid temperature declines and deeper cold stress. The findings show that structural mass and ground coupling offer passive buffering benefits throughout the year: they moderate indoor temperature swings in summer and extend winter safety periods in case of heating system failures. While lightweight insulated envelopes offer short-term efficiency for winter heating, these are more susceptible to both summer overheating and rapid winter cooling during outages, especially as climate extremes become more frequent.

The research concludes that building envelopes combining structural mass with ground-floor interaction can improve resilience to temperature extremes, reducing reliance on active systems and enhancing occupant safety under both heatwaves and heating interruptions.

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Impact of Floor - Ground Coupling and Thermal Mass on Seasonal Heating Energy Use in Single - Storey Residential Buildings in a Temperate Climate

This study reports on an experimental investigation into the winter heating performance of two full-scale, single-storey houses located in the temperate transitional climate of western Poland. The test buildings were designed to be identical in terms of size, layout and insulation quality. However, they differed in terms of wall construction type and subfloor configuration, enabling a comparison to be made between thermal mass and structural systems. Monitoring during the 2018/19 heating season revealed that the dwelling with medium-mass masonry walls required 3.6% less heating energy than the lightweight timber-framed house. In the subsequent season, the floor insulation in the masonry building was intentionally removed to allow direct thermal contact with the ground. This modification resulted in an increase of 12.2% in overall heating demand, which only occurred in the second half of winter. Measurements of ground temperature supported the observation that heat stored in the subsoil during the summer acted as a buffer, postponing higher energy losses. Therefore, the penalty associated with removing floor insulation was significantly lower than values estimated by conventional calculation procedures, which tend to overstate steady-state ground losses. These results emphasise the importance of the dynamic interaction between buildings and the ground, demonstrating that heavy structures and soil-coupled envelopes can enhance energy performance and resilience. These strategies are particularly relevant in temperate regions, where variable weather patterns and the risk of supply interruptions can affect the stability of seasonal heating demand.

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Healthcare buildings in modular technology - a case study

Modular construction is increasingly being recognized as a viable solution for healthcare buildings due to its rapid implementation, cost efficiency, and adaptability to changing functional requirements. This construction method, based on prefabricated modules or container systems, allows for the swift assembly of fully operational medical facilities, making it particularly suitable for emergency healthcare infrastructure. A widely cited global example is the Huoshenshan Hospital in Wuhan, China, which was constructed in just 10 days during the COVID-19 pandemic to provide 1,000 beds and advanced medical equipment. Its success demonstrated the potential of modular technology for crisis response and mass medical care.
In Poland, modular construction is also gaining importance in healthcare-related facilities. A notable example is the Faculty of Veterinary Medicine and Animal Science at the University of Life Sciences in Poznań, built with container modules. This project highlights how modular technology can create modern, functional, and cost-effective laboratory and teaching spaces, which can be easily expanded or reconfigured according to new requirements.
The advantages of modular healthcare buildings include significantly reduced construction time, cost optimization, minimal environmental impact, and flexibility in space planning. Prefabrication in factory-controlled conditions ensures higher quality standards and reduces construction waste, which aligns with sustainable building strategies. Moreover, modular systems can be relocated or reused, extending their life cycle and making them an eco-friendly alternative to traditional construction.
The research suggests that modular construction will continue to evolve as a strategic approach to medical infrastructure development, combining speed, economic efficiency, and environmental responsibility. Its increasing implementation worldwide indicates a paradigm shift in how healthcare buildings can be planned and delivered in the 21st century.

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The relationship between soil skeletal fractions and physical properties of soils

Soils in urban areas, particularly near infrastructure, often show atypical compositions due to anthropogenic influences. This study aimed to assess how skeletal fractions and various contaminants affect the physical properties and water retention capabilities of soils collected from tram tracks in Zielona Góra.

Three soil samples from tram track areas were analyzed. Each was separated into skeletal (>2 mm) and fine-earth fractions. The mass and percentage content of key skeletal components, including glass, quartz, mortar, metal, bitumens, natural stone, organic matter, basalt, and slag aggregates, were quantified.

Samples exhibited high diversity and significant anthropogenic material content within their skeletal fractions. Sample No. 1 contained 54.5% skeletal fraction, with glass (4.5%) as the most abundant admixture (total 7.3% anthropogenic). Sample No. 2 (21.0% skeletal fraction) had 15.7% anthropogenic admixtures, dominated by quartz (8.3%) and mortar (3.9%). Sample No. 3 (27.2% skeletal fraction) showed 66.6% anthropogenic admixtures, with natural stone (26.8%), mortar (16.4%), and quartz (14.5%) being most prevalent. Across all samples, natural stone was generally the highest anthropogenic admixture (up to 26.8%), while fabric and bituminous materials were the least abundant.

Soils from tram track areas are under significant anthropogenic pressure. The high quantity of non-porous, heavy admixtures (e.g., glass, metal) negatively impacts soil water retention, reducing infiltration and storage, potentially increasing surface runoff. The diverse composition of these admixtures underscores the varied nature of urban soil modification.

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Properties of differently used soils in the suburban environment

In recent years, special attention has been paid in Europe, including Poland, to the rational management of environmental resources, including soil resources, in accordance with the principles of sustainable development. The intensive development of urban centers entails a number of environmental consequences, the impact of which extends far beyond their administrative boundaries. The aim of the research undertaken was to estimate the diversity of selected parameters of differently used soils (arable land, meadows, forests) of agricultural areas (using the example of the Chmielnik commune) in the immediate vicinity of an urban center (the city of Rzeszów).

The soils studied were characterized by a grain size with a predominance of silty fraction (65-90%), the average content of clay parts was 9%. The pH in the water suspension of these soils was in the range of 4.8-7.7 and was generally slightly lower in the surface layer (0-20 cm) than in the deeper layer (20-40 cm) - medians 6.7-7.0, respectively. The lowest pH coefficient was noted in forest soils, where the minimum values did not exceed 5, while the pH of arable soils did not decreased below 6.4. For comparison, the pH of arable soils located within the administrative borders of the city of Rzeszów was in the range of 5.9-6.4. These results corresponded to the hydrolytic acidity of the soils, which was low in arable soils 0.4-0.8 cmol(+) kg^{-1}, higher in meadow soils, and the highest in forest soils (on average 0.6; 1.1; 4.6 cmol(+) kg^{-1}, respectively). It is worth emphasizing that arable soils located in Chmielnik had on average about 2 times greater sorption capacity, compared to forest soils, with also about twice the content of total phosphorus, but were distinguished by a similar content of organic carbon and total nitrogen. The dominant cation in the ionic composition of the sorption complex was calcium, and its share was the highest in arable soils and the lowest in forest soils. The soils of rural areas studied contained on average more Ca, Mg and total K (the most in arable soils) than the arable soils located in Rzeszów.

To sum up, no clear influence of the nearby city on the basic physicochemical properties of the soils studied was found. Among the analyzed land use methods, the most favorable parameters (primarily the lowest acidification and the highest sorption capacity) were characteristic of arable soils, slightly worse of grasslands and the least favorable of forest soils.

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Municipal solid waste for high-quality syngas production

Municipal solid waste (MSW) gasification has emerged as a promising thermochemical conversion route for sustainable waste management and energy recovery. Unlike conventional incineration, gasification converts heterogeneous waste into a combustible synthesis gas (syngas) under controlled oxygen or steam conditions, offering higher efficiency and lower environmental impact. High-quality syngas, rich in CO and H_2 with reduced impurities such as tars, particulates, and acid gases, is essential for power generation and hydrogen production. This study investigates the relationship between MSW properties and syngas quality through experimental gasification in a fixed bed reactor and advanced characterization techniques. Physicochemical properties of waste samples were analyzed using scanning electron microscopy (SEM) coupled with energy-dispersive spectroscopy (EDS) for microstructural and elemental mapping, and X-ray diffraction (XRD) for crystalline phase identification. Proximate and ultimate analyses provided key fuel data, while bomb calorimetry determined heating values. Thermogravimetric analysis combined with mass spectrometry (TGA-MS) assessed thermal behavior and gas evolution profiles, tracking H_2, CH_4, H_2O, CO, and CO_2. Results revealed a strong correlation between MSW composition and syngas quality. As global waste volumes rise, MSW gasification offers dual benefits of sustainable waste reduction and renewable energy generation, supporting circular economy and climate mitigation goals.

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The Role of Hydrogen Technology in Our Time and the Associated Challenges

In light of the escalating global climate crisis and the increasing global demand for energy, in addition to the urgent need to reduce the carbon footprint in energy systems, hydrogen has emerged as a promising sector in the process of transitioning to clean energy, as hydrogen is distinguished by its ability to be used as a raw material in various industries, and the most important of these is the steel industry (CO_2 emissions ranging from 1.8 to 2.0 tons per ton of crude steel).
However, hydrogen production still faces numerous significant challenges, the most important of which are:

1- The environmental footprint and production costs: Most hydrogen is currently produced from natural gas and coal, resulting in significant CO_2 emissions. Green hydrogen, however, is considered relatively expensive due to the high cost of the electrolysis used.
2- Storage and transportation risks: Due to the low density of hydrogen, this poses a major challenge in the liquefaction process and thus difficulties in the process of transporting and storing it, as consequently, there is a need for very high safety and security measures.
3- Regulation, regulatory standards, and community acceptance: Regulatory uncertainties contribute to many project struggles to secure final investment decisions (FID), with a success rate of just 10-20%.
4- Fourth: Integration with existing and renewable energy systems, as hydrogen production must be compatible with renewable and variable energy supplies, taking into account securing infrastructure and energy sources compatible with hydrogen production plants.

To address these challenges, we need more support for R&D, facilitation, and tax exemptions to make production costs more competitive, in addition to setting clear safety and security standards and strengthening community awareness campaigns regarding hydrogen projects. we can reduce current production costs (6-8 euros/kg)to more competitive costs compared to traditional energy sources, thus moving towards a more sustainable future and achieving the 2050 vision with zero CO_2 emissions.

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The influence of hydrodynamically active sections of mountain rivers on the processes of natural self-purification of water

The urbanization of society, the rapid development of processing and manufacturing industries have negatively affected the environment, in particular the quality of air and water, which has very serious consequences for the health of future generations. Despite a significant list of physicochemical methods for purifying water from various contaminants, there is still no sufficiently effective and universal method suitable for all types of contaminants. Devices for highly efficient water purification from any types of contaminants using hydrodynamic generators have now become widely used. Recent studies have shown that the use of cavitation generators for effective water purification is a new promising, energy-efficient, waste-free cavitation technology. During the operation of hydrodynamic generators, high-energy effects of cold boiling or cavitation occur in water, which not only contribute to effective water purification, but also lead to a change in its structure and an increase in physicochemical and biological activity.

Self-purification is the set of all natural processes in polluted waters aimed at restoring the original properties and composition of water. They include the processes of mixing, sedimentation, decomposition and transformation of substances that pollute water bodies. Hydrodynamically active sections of rivers (HAS) have an important influence on increasing the effectiveness of natural self-purification. This is a local natural or artificial obstacle in the watercourse, namely a waterfall, boulders, rapids, rapids and their cascades. Passing through them, water is disturbed and changes the flow regime from laminar to turbulent, as a result of which cavitation phenomena are activated. For a mountain river basin, HAS are one of the most important ecological and hydrogeochemical factors in the formation of water quality. The hydraulics of mountain streams are characterized by shallow turbulent currents and high relative roughness, which is caused by protruding boulders, rocks and wood debris washed from the slopes. Scientific publications indicate that, unlike rivers with a smaller gradient, these significant roughness elements account for up to 80–90% of the total roughness of the channel of fast mountain river flows. The flow velocity changes over relatively short longitudinal distances due to the unevenness of morphological elements and the presence of thresholds and drops. Experimental modeling has shown that, passing through hydrodynamically active sections of the channels, mountain rivers of the Stryi River basin at different flow velocities maximally saturate water with oxygen, which activates the function of purifying polluted water from unfavorable microorganisms, as well as technogenic impurities.

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Integrating Circular Economy Principles for Sustainable Waste Management and Climate Resilience

The rising increase in global waste generation and greenhouse gas emissions is a serious challenge to sustainable development and climate resilience. The traditional linear waste management model of "take–make–dispose" worsen depletion of resources, environmental degradation, and exposure to climate change impacts. On the other hand, the Integrating of the principles of circular economy (CE) into waste management promote the conservation of resources and advancement of climate mitigation and adaptation. This review assesses current evidence on how CE strategies such as waste prevention, reuse, recycling, and resource recovery can reduce greenhouse gas emissions, conserve resources, and enhance systemic resilience. Findings reveals that the implementation of CE principles in waste management can cut down carbon emissions by up to 39% by 2050 and at the same time create jobs, innovation, and resource security. Nonetheless, successful implementation requires overcoming challenges associated with policy division, technological gaps, financial limitations, and inadequate addition of informal sectors. The review highlights the need for inclusive policy frameworks, actual data integration, and inclusion of informal sector. The paper concludes that the implementation of a well-structured circular economy framework supported by clear policies and technological innovations, can drive a transformative shift toward sustainable waste management and climate change mitigation.

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Heavy metals in sewage sludge from the wastewater treatment plant in Jędrzychowice

The construction and modernization of water supply, sewerage, and wastewater treatment infrastructure is leading to an increase in the amount of municipal sewage sludge produced. Although the amount of sewage sludge produced typically does not exceed 1-3% of the volume of sewage flowing into treatment plants, it is estimated that approximately 580,000 tons of sewage sludge will be produced in Poland in 2022. Sewage sludge generated during wastewater treatment can have significant fertilizing qualities and is therefore often used in agriculture as an organic fertilizer. However, the high content of heavy metals may be an obstacle to their agricultural use.

The municipal wastewater treatment plant for the city and commune of Zgorzelec is located in Jędrzychowice. It is a mechanical-biological wastewater treatment facility with enhanced nutrient removal, with a design capacity of Q=12,000 m^3/d. Based on the design assumptions, the treatment plant's population equivalent (PE) is 62,000. The actual average wastewater flow over the past five years is 6,214 m^3/d. The resulting sewage sludge is subjected to a process of mechanical sludge thickening, mesophilic fermentation, and then mechanical sludge dewatering.

The average amount of metals in the digested sludge was: Chromium - 16 mg Cr/ kg of dry matter, Zinc - 583 mg Zn/ kg of dry matter, Cadmium - 0.77 mg Cd/ kg of dry matter, Copper - 213 mg Cu/ kg of dry matter, Lead - 22 mg Pb/ kg of dry matter, and Mercury - 0.32 mg Hg/ kg of dry matter. It was shown that the amount of heavy metals in digested sludge produced at the Sewage Treatment and Sludge Management Plant is consistent with the Regulation of the Minister of the Environment of 6 February 2015 on municipal sewage sludge (Journal of Laws of 2023, item 23). Therefore, it can be used for agricultural purposes. The dominant heavy metals in the sewage and sludge were zinc and copper.

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An economic and ecological perspective on selected heating options for a single-family house situated in rural Poland

In recent years, the energy efficiency of residential buildings has emerged as a central issue, driven by the imperative to reduce both energy consumption and greenhouse gas emissions. The selection of an appropriate heating system is crucial not only for reducing the operating costs of a property but also for mitigating its adverse environmental impact. In accordance with the climate and energy policy of the European Union, as well as the national WT2021 requirements, contemporary solutions are expected to achieve a sustainable balance between economic viability and environmental responsibility.
This study undertakes an economic and ecological assessment of selected central heating options for a single-family house located in the village of Chrobrów near Żagań. The existing biomass boiler system was evaluated, and alternative configurations were considered, including coal, oil, and LPG boilers, as well as an air-to-water heat pump with the potential integration of a photovoltaic installation. The analyses were conducted using the ArCADia-TERMOCAD 10.0 software, with particular attention given to annual energy demand, pollutant emissions, heating costs and the simple payback time (SPBT) of the investment.
The findings indicate that, in its original state, the property failed to comply with WT2021 requirements, displaying excessive energy demand and substantial heat losses. The implementation of thermal retrofitting measures significantly improved the building's energy performance, while the adoption of renewable energy-based systems enabled a reduction in both emissions and operating costs. The most advantageous option was identified as the air-to-water heat pump, supplemented by a photovoltaic system, which delivered the lowest operational costs and nearly zero emissions. By contrast, solid fuel boilers, despite their lower initial capital requirements, proved less efficient over the long term and imposed greater environmental burdens. In essence, the analysis underscores the critical role of thermal retrofitting and the integration of renewable energy technologies as fundamental strategies for enhancing the energy efficiency of residential buildings, alleviating household expenditures and mitigating environmental impacts.

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Green Infrastructure and Climate-Responsive Urban Revitalization in Saudi Arabia

Revitalization of public spaces in cities is a key element of contemporary urban planning, particularly in the context of balancing cultural heritage preservation with the demands of modern urban life and the challenges of climate change. As part of Saudi Arabia's Vision 2030, the revitalization of districts in Jeddah aims not only to restore their cultural heritage but also to transform them into vibrant spaces that meet the contemporary needs of residents. In parallel, the large-scale "Green Riyadh" initiative demonstrates how modern urban design can counteract the urban heat island effect and desertification. Through extensive tree planting and the creation of green corridors, Riyadh is becoming an example of climate-resilient planning in arid conditions.

The analysis focuses on the transformation of public spaces and their spatial and functional changes, with particular emphasis on the integration of green infrastructure as a response to climate change challenges. The study employed urban analysis, archival research, and field observations to assess the current condition of these spaces. The findings emphasize the need to introduce vegetation into public areas lacking greenery in order to improve user comfort and increase resilience to extreme temperatures.

Both case studies demonstrate that heritage preservation and climate adaptation can be effectively combined through thoughtful public space design, providing valuable insights for cities facing similar climatic challenges.

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The combination of Process Analytical Technology (PAT) and flow chemistry for greener synthesis of active pharmaceutical ingredients

In the pharmaceutical industry, continuous flow chemistry has become a key approach in the synthesis of active pharmaceutical ingredients (APIs), significantly improving the efficiency and safety of chemical processes and supporting the integration of various advanced technologies, particularly Process Analytical Technology (PAT). PAT is now recognized as an essential tool in the synthesis optimization and provides valuable insight into critical parameters such as concentration, impurities, reaction kinetics, which are essential for ensuring the quality of the final product. By conducting real-time analysis, errors and deviations can be promptly identified, allowing timely intervention to uphold process integrity and safety.

In the presented study, various spectroscopic techniques were used as a toolbox for PAT monitoring: benchtop nuclear magnetic resonance (NMR), Fourier-transform infrared (FTIR), and ultraviolet-visible spectroscopy (UV-Vis) in the multistep synthesis of one of the anti-diabetics, specifically sodium-glucose co-transporter 2 (SGLT2) inhibitors. PAT implementation enabled the monitoring of changes occurring in the chemical composition of the mixture and ensured overall control over the stability of the multiple synthetic runs.

Flow chemistry combined with real-time analytics represents a significant and promising advancement in the pharmaceutical industry by enhancing the process stability monitoring and minimizing the reliance on off-line sampling. Continuous flow processes supported by advanced technologies pave the way for safer, more efficient, more sustainable methods for the synthesis of pharmaceuticals.

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Sustainable E-waste collection and recycling models for Urban Ethiopia: A Case study of Addis Ababa

The rapid expansion of electronic consumption in urban Ethiopia particularly in Addis Ababa has resulted in a substantial increase in electronic waste (e-waste). This growing waste stream, which includes discarded phones, computers, batteries, and appliances, is often handled through informal recycling practices or disposed of improperly in landfills. These methods pose serious environmental and public health risks due to the release of hazardous substances such as lead, mercury, and cadmium. Addis Ababa currently lacks a formal, efficient, and sustainable e-waste management system, and the informal sector dominates material recovery without proper safety or environmental standards. To address this, the research proposes integrated technical, institutional, social, and policy-based solutions, including the establishment of formal collection and recycling systems, stronger regulations, and stakeholder coordination such as government bodies, private sector, and NGOs. It also focuses on integrating informal recyclers, raising public awareness, and promoting reuse, repair, and producer responsibility in line with circular economy principles.

Generally, the study aims to create a scalable and sustainable e-waste management system that supports environmental protection, enhances resource efficiency, and aligns with Ethiopia's broader vision for circular and sustainable urban development.

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Carbon dioxide emission during degradation of microplastics in the aquatic environment

The degradation of microplastics (MPs) in aquatic environments can lead to the emission of greenhouse gases, including carbon dioxide (CO_2), representing an insufficiently recognized source contributing to climate change. The aim of this study was to assess CO_2 emissions from microplastics derived from used car tires made of styrene-butadiene rubber. Laboratory experiments were conducted using two granulate fractions (600 µm and 1000 µm) at temperatures of 6°C and 18°C over a period of up to 360 days. The samples were incubated under anaerobic conditions, and CO_2 emissions were monitored using gas chromatography with a barrier discharge ionization detector (BID). The results showed CO_2 emissions in all test variants, with both temperature and particle size having a significant influence. Higher temperatures promoted more intense emissions. A decrease in emission intensity over longer incubation periods was observed, which may indicate depletion of readily available carbon sources in the material. The findings confirm that microplastics can serve as an additional, previously overlooked source of CO_2 emissions in aquatic environments, influenced by external conditions and the physicochemical properties of the plastics.

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Geochemical characteristics of soils developed on MnP-rich metamanganolites and related rocks of Pustków Wilczkowski (Lower Silesia, Poland)

Soils in the vicinity of Pustków Wilczkowski are developed on a geological occurrence that is unique for Poland. Within the arable layer of the local fields there are abundant metamorphic rocksof clearly strongly elevated manganese, phosphorus, iron, copper, calcium, strontium, barium, cobalt, vanadium, zinc, lead, and rare earth elements content (their chemical-mineralogical complexity was determined only recently). As such, these rocks, known as metamanganolites, not only stand for a unique C-level lithotype, but also an important source of numerous micro- and macroelements for plants. This, in turn, poses a unique chance of recognition of pedogenic processes in such aberrant geochemical conditions.
There are numerous extreme enrichment factors (EFs). This, as expected, mosty concerns the PW4 sample, with the EFs – set from the largest to lower values – starting from Ni (90x), followed by Se (34), Cd (28), Mo (14), Ag (10), Au (6), Cu (5), V and Fe (4), and ends with Zn (3). Nickel enrichment is the most persistent (geometric-mean average EF_{soil} = 53), followed by Cd (GM EF_{soil} = 9). The comparison towards the EC levels shows a lesser number of high-to-extreme EFs values; still, in the PW4 case, the row begins with Se (126x), followed by Ag (11), Mo (7), As and Cd (6), and finalny Au, Co and Sb (4). Selenium shows the highest GM EF_{EC} of 28 (n=3).
By studying just 5 soil samples from various BCWRs, collected in the metamanganolite-rich area in Pustków Wilczkowski we can already conclude that these soils have specific properties and should be investigated more deeply.

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The Future of Circular Economy: Challenges and Opportunities

Circular economy is a topic that has been gaining interest with the increase in environmental awareness. It addresses the sustainability issues and emphasizes reusing, repairing, and recycling existing materials and products for as long as possible. It is a regenerative system in which waste, emissions, and energy leakage are minimized. The concept of circular economy is promoted by many nations in the EU and worldwide, with China being the first country to adopt a supporting law in 2008.

Like any change, it comes with many challenges, such as: product design – nowadays most products are not made to be reused; cost – the practice of circular economy might have higher upfront costs than linear alternatives. The future holds new challenges, with scaling being one of them. Expanding the idea to a global chain supply is expensive and complex. The transformation will also require advanced digital tools to track the life cycle of products. Possible global inequality is an issue to look out for as well – high-income countries might advance heavily, widening economic gaps. Lastly, circular economy tech is not mature enough yet to reuse some materials.

On the other hand, there are many opportunities for implementing the new concept. Deriving straight from the definition - environmental sustainability - reduce in waste, pollution, and greenhouse gas emissions. Another significant advantage is resource security - reducing dependency on finite resources. There is also an opportunity for improving operational efficiency in companies - optimizing resource use can reduce operating costs.

The future of circular economy holds great promise, but several emerging and long-term challenges could hinder its global adaptation. Taking them all under consideration, the concept might be the answer to the rising sustainability issues, and the way to slow down the rate of finite resources depletion. This speech will provide a review of the current scientific literature regarding the future of circular economy.

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Pollutants removal efficiency after modernization of the wastewater treatment plant in Międzyrzecz

This article assesses the efficiency of pollutant removal at the Międzyrzecz wastewater treatment plant (Lubuskie Voivodeship) before and after modernization of the technological system. The mechanical-biological WWTP capacity before modernization was Qd - 2100 m^3/day, with a PE= 14 292. The wastewater treatment plant was commissioned in 1995, with only one of the two planned and constructed biological reactors being commissioned. The wastewater treatment plant operates based on low-load activated sludge technology, along with aerobic sludge stabilization and chemical phosphorus precipitation.

The expansion and modernization of the wastewater treatment plant was necessary due to the increasing volume of wastewater entering the plant, increased pollutant loads in the wastewater, and the poor technical condition of the equipment. Modernization of the process system also resulted from the need to use an increasing number of chemical preparations to ensure the appropriate quality of treated wastewater.

The modernization and expansion of the wastewater treatment plant lasted from January 2022 to November 2023. During the modernization, the mechanical section of the treatment plant was rebuilt, introducing a blown-through grit chamber with a degreaser and a dephosphatation chamber. Two biological reactors were commissioned in the biological section of the treatment plant. These changes increased the treatment plant's capacity to 4 200 m^3/day, with a load of 28 304 PE. Energy consumption was also reduced, and the costs of purchasing chemical preparations (PIX and Neutral FB90) were almost halved.

The analysis of the wastewater treatment plant's operation demonstrated very high average removal efficiency for organic pollutants, total suspended solids, total nitrogen, and total phosphorus, both before and after modernization. The removal efficiency from wastewater after modernization of the technological system was in the range of: BOD_5 - 95.09÷99.77%, COD - 88.73÷97.04%, total suspended solids - 87.23÷99.00%, total nitrogen - 77.29÷95.44% and total phosphorus - 87.24÷97.35%.

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The influence of seasonal variability in the composition of landfill leachates on their ecotoxicity to *Aliivibrio fischeri* bacteria

Soil and water are contaminated by leachate, which is a significant source of pollution resulting from the disposal of municipal waste in landfills. Key physical and chemical parameters of leachate, such as COD, BOD5, nitrogen content and pH, can be used to assess the degree of pollution. These parameters can vary significantly throughout the year due to factors such as temperature, rainfall, and the intensity of microbiological processes occurring within the waste. Another important aspect of effluent quality assessment is its toxicity to aquatic organisms, as determined by the luminescence of Aliivibrio fischeri bacteria.

The study aimed to analyse the annual variability of selected physical and chemical effluent parameters and determine their impact on toxicity to A. fischeri bacteria. Samples were collected once a month for a period of one year. Basic physical and chemical parameters (COD, BOD_5, BOD_5/COD, TOC, NKj, NH_4^+, pH and PEW) were determined in accordance with APHA 2023. The effect on luminescent bacteria after 5 and 15 minutes of exposure was also determined in accordance with the PN-EN ISO 11348-3:2008/A1:2019. Spearman's correlation was used to identify correlations between variables and principal component analysis (PCA) was performed using Statistica 13.1.

The toxicity of leachates to bacteria was not found to be correlated with any of the analysed physical and chemical parameters, and the values obtained were low (R below 0.2). PCA shows that the response of A. fischeri bacteria can be explained by a single factor (accounting for 23.24% of the variance), suggesting that this factor represents the overall toxicity of the sample, independent of traditional wastewater quality indicators. The second factor (42.9%) covers all the physicochemical parameters. The results indicate that the toxicity of effluents to A. fischeri is not correlated with any single physicochemical parameter. This is probably due to synergies between different pollutants or the presence of specific toxins not included in traditional indicators.

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Artificial aggregates from metallurgical waste as a potential source of groundwater and soil contamination

Highly developed countries produce huge amounts of industrial waste. Their amount and type is strongly correlated with the characteristics of the industry. Industrial waste can adversely affect the environment, so its disposal and management is a major challenge. A good understanding of the characteristics of a given waste (chemical and phase composition, technical parameters, possibility of releasing components into the water and ground environment) allows for determining the methods of its economic use. One of the simplest ways to utilise mineral waste is to use it to produce artificial aggregates, making them a good substitute for natural aggregates.
Artificial aggregates produced from mineral waste areincreasingly used as a substitute for natural aggregates. In Poland, a large part of artificial aggregates is produced from metallurgical waste from steel and non-ferrous metallurgy. Metallurgical waste may contain numerous components that are potentially harmful to the environment. Depending on the form of their occurrence (mineral composition), they will have a different potential to be released into the water and ground environment. The article presents the results of the mineral and chemical composition studies and leachability tests conducted for aggregates produced from metallurgical waste: blast furnace slag, steel slag, slags from Zn – Pb production, and slags from nickel production.

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The role of biofilters additives on efficiency of grey water treatment

Greywater (GW) constitutes approximately 50–80% of household wastewater and, due to its volume and relatively low contamination, offers significant potential for recycling and conserving water resources. Its reuse can play an important role in addressing water scarcity at both municipal and household levels. In particular, using greywater for irrigation can substantially reduce global water demand.

This paper presents the results of a field mesocosm experiment evaluating the effectiveness of various filter media additives—namely biochar, woodchips, mycorrhiza, crushed bricks, and limestone chippings—in treating greywater. The experiment was conducted over a six-month period during the vegetation season. Biofilters were tested under two saturation levels (30% and 70% of total volume) to determine the optimal conditions for long-term performance.

The treatment efficiency of the biofilters was assessed based on changes in basic water quality parameters (e.g., ions, nutrients, pH, and conductivity), as well as the concentrations of selected pharmaceuticals and personal care products (PPCPs)—specifically benzotriazole (BTA), DEET, diclofenac (DCF), fluconazole (FCZ), and ibuprofen (IBP)—and metals (Cu, Ni, Zn).

The results demonstrated that the biofilters effectively treated greywater during 22-hour retention cycles, with no statistically significant improvement when the retention time was extended to 70 hours. Among the additives tested, biochar showed particularly high efficiency in removing contaminants of emerging concern. The removal efficiency for PPCPs varied considerably across both filter additives and individual compounds, with the highest removal observed for DCF, likely due to its high biodegradability. Over 90% of the monitored metals (Ni, Cu, Zn) were successfully removed by the biofilters.

These findings suggest that biofilters incorporating these additives are cost-effective, easy to construct, and offer a sustainable solution for reducing potable water consumption through greywater reuse. As such, they represent a promising option for decentralized, on-site water treatment applications.

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Reducing synthetic surfactants in concrete: functional and environmental benefits of starch derivatives

The construction industry increasingly faces pressure to adopt environmentally responsible solutions, including the reduction of synthetic surfactants in cement and concrete formulations. This study explores the potential of chemically modified starch hydrolysates as biodegradable, bio-based alternatives, with a focus on their surface activity and relevance to concrete admixture performance.

Starch hydrolysates modified through acetylation, oxidation, and cross-linking were evaluated for their ability to reduce surface tension and adsorb at the air/water interface—key properties for dispersion, wetting, and air entrainment control in cementitious systems. Surface activity was assessed using equilibrium (du Noüy ring) and dynamic (drop shape analysis) methods. The results showed that the degree and type of chemical modification had a direct impact on performance. For example, low-substituted acetylated starch (0.02Ac-H) exhibited higher surface activity than its more heavily substituted counterpart (0.1Ac-H). Additionally, hydrolyzed and ultrafiltered oxidized starches (using an 8 kDa membrane) revealed particularly surface-active fractions.

In mixtures with model surfactants, particularly cationic ones like CTAB, these modified hydrolysates demonstrated strong synergistic effects. The addition of starch derivatives significantly improved interfacial saturation and reduced surface tension more efficiently than surfactants alone. These interactions suggest that starch-based materials can complement or partially replace synthetic surfactants in formulations without sacrificing effectiveness.

The ability of modified starches to enhance interfacial properties makes them highly relevant for concrete admixtures, where surfactants are routinely used to disperse particles, improve workability, and control air content. By partially replacing synthetic surfactants, starch derivatives offer a dual benefit: maintaining technical performance while reducing environmental impact.

This study highlights the functional and ecological value of integrating modified starch hydrolysates into concrete technologies, supporting a broader shift toward more sustainable building materials.

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Environmental engineering and design in the light of the UN decade on ecosystem restoration

According to the "Action Plan for the UN Decade on Ecosystem Restoration 2021-2030", we should define practical steps to work together on the goals and vision of the Decade. We need to mobilize all stakeholders around key priority areas of restoration. This includes decision-makers, businesses, non-governmental organizations, civil society, scientists, educators and donors. There is also a need to constantly recognize the challenges to ecosystem restoration and, above all, prevent their occurrence. A special role here falls to scientists and educators gathered, among others, in the Polish Society of Ecological Engineering. It is also important to develop and constantly improve the way of implementing the action plan, including coordination, communication and finance. Making peace with nature often requires deep changes in the philosophy of life of each person and entire social systems on the way from overconsumption to being the citizen of our Planet.

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The possibilities analysis of using microfiltration to regeneration of acidic copper spent bath

Currently, there are over 1,200 plants associated with the production of metal products registered in Poland, including approx. 330 plants operating in the field of metal processing and application of coatings on metals. According to the data of the Central Statistical Office of Poland from 2017, only 3.6% of all registered plants have systems enabling the complete closing of the technological water cycle. The galvanic industry is associated with a significant demand for water and the generation of significant amounts of wastewater. Two types of wastewater are generated in the processes of galvanic of metal coatings: spent electrolytic baths and wastewater from rinsing coated elements. The composition and amount of wastewater depends on the type of process used, the plant's operating system, the amount of water used to rinse coated elements, etc. The concentration of metal ions in spent baths reaches several g/dm^3, while in water after rinsing it reaches several mg/dm^3. Currently, chemical methods, ion exchange and electrocoagulation are most often used for the treatment of galvanic wastewater. An effective alternative or a solution complementary to the above-mentioned methods is the treatment of galvanic wastewater with the use of membrane processes, which - according to the concept of Best Available Techniques (BAT) - constitute one of the most important elements of clean (waste-free) technologies.

The paper presents the results of study on the possibility of using microfiltration - a low-pressure membrane process for the regeneration of acidic copper plating bath. The microfiltration process on ceramic membranes made it possible to removal of suspended solid particles that could not be removed by other methods, such as sedimentation and coagulation. The obtained results suggest microfiltration may be new approach in the regeneration of electroplating baths and contribute to reducing the consumption of water and chemicals in galvanic industry.

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Effectiveness of water treatment processes in removing organic substances from water determined as ultraviolet absorbance (UV_{254})

The absorbance in the ultraviolet (UV_{254}) makes it possible to determine the fraction of dissolved organic carbon and organic compounds characterised by a high content of aromatic rings, such as e.g. humic acids or phenols, which are precursors of disinfection or oxidation by-products. Due to the correlation of UV_{254} absorbance with the formation of oxidation and disinfection by-products, it is a very important indicator in assessing the effectiveness of water treatment processes. The aim of this study was to determine changes in the value of UV_{254} absorbance in water after successive treatment processes at the Water Treatment Plant (WTP) in Zawada near Zielona Góra, which takes underground and surface water from the Obrzyca River.The subject of the study was a mixture of surface water from the Obrzyca River after microfiltration process and the groundwater after the aeration process from Quaternary formations. Mixed water was characterized TOC reached values of 8.231 mgC/dm^3, DOC 7.827 mgC/dm^3 and UV_{254} absorption—19.338 m^{-1}, which indicates that organic substances containing aromatic rings were present among the dissolved substances in the purified water. The treatment processes at the Zawada WTP include aeration of groundwater, microfiltration of surface water, coagulation of mixed water, sedimentation, filtration on catalytic-oxidative filter bed, filtration on dolomite filter bed and disinfection with chlorine dioxide. During technological studies carried out on a technical scale, the following were tested as coagulant: PAXXL10 with an alkalinity of 70% as well as PAXXL1911 polyaluminium chloride with an alkalinity of 85% which, in its composition, also contained iron. The results obtained showed that in the technological system at Zawada WTP, the coagulation process provided the highest removal efficiency of dissolved organic substances containing aromatic rings (UV_{254}). A lower reduction in UV_{254} was found after coagulation with the coagulant PAXXL1911 with an alkalinity of 85 %, which contained iron compounds in its composition. The reason behind the lower effectiveness of water purification in the coagulation process upon applying PAXXL1911 was the formation of iron-organic complexes, most likely in the form of protective colloids.

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The use of zeta potential measurement as a tool for controlling the coagulation process of a mixture of surface and groundwater

Measuring the zeta potential (ζ) is a parameter that provides important information about the state of the coagulation process and allows for a qualitative assessment of the effectiveness of charge neutralization. In the presented study, we have shown the results of the zeta potential measurement evaluation as a coagulation process control tool in the context of organic substances removal. Raw water was characterized by an increased content of TOC varied in the range from 6.50 to 7.30 mg C/L, DOC from 6.30 to 6.90 mg C/L, UV_{254} absorbance between 14.25 to 16.49 m^{-1} and electrokinetic potential (ζ) from –14.00 to –14.60 mV. As a coagulant, the commercial pre-hydrolyzed polyaluminum chloride PAXXL10 with a basicity of 70% and two classical hydrolyzing coagulants: aluminum sulphate (VI) undergoing acid hydrolysis and sodium aluminate undergoing basic hydrolysis in water during coagulation were tested. Measurement of the electrokinetic potential zeta (ζ) was made in raw water samples and after the coagulation process using the Zetasizer Nano Analyzer. The analysis of the obtained research results showed that the least effective coagulant in both TOC and DOC removal was non-hydrolyzed sodium aluminate undergoing alkaline hydrolysis during the coagulation. In water, after coagulation with sodium aluminate, an increase in the electrokinetic potential (ζ) towards negative values was observed, ranging from –16.0 to –16.7 mV. It has also been shown that the highest degree of destabilization of the colloidal system and the highest efficiency of TOC and DOC removal was obtained in samples of water during coagulation with polyaluminum chloride PAXXL10 in the entire range of tested doses from 1 to 5 mg Al/L. The zeta potential (ζ) for post-coagulation PAXXL10 water samples was lower than that found for source water from –11.4 to –5.3 mV, however, no transition of this potential through the isoelectric point was detected. Analysis of the obtained research results confirms the validity of zeta potential (ζ) measurement in optimizing the coagulation process. This method allows for relatively quick and precise prediction of the most effective coagulant type and dose, which is particularly useful when purifying surface water, which are characterised by significant variability in their physical and chemical composition.

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Use of the hyperspectral method to identify selected species of coastal indicator vegetation

Technological developments in remote research methods using hyperspectral cameras offer increasing opportunities for environmental monitoring, including monitoring of indicator plants. In hyperspectral camera surveys, the basic element is the spectral reflectance curve, which makes the physical and chemical properties of the objects under study visible. In the case of plants, active photosynthetic pigments and cellular structures can be determined from the hyperspectral curve. In hyperspectral studies of plants, the visible range of electromagnetic radiation is characterised by low reflectance and transmittance due to the high absorption of radiation by photosynthetically active pigments. In higher plants, due to the amount of energy processed, the most important role is played by chlorophyll-a, whose absorption maxima occur at wavelengths of 420, 490 and 660 nm. A supporting role is played by chlorophyll-b, whose absorption maxima occur at wavelengths of 435 and 643 nm, as well as carotenoids (α-carotene: 420, 440 and 470 nm and β-carotene: 425, 450 and 480 nm) and xanthophylls (425, 450 and 475 nm). In the near infrared, the absorption of radiation is low and the reflection of radiation is determined by the cellular structure of the leaf, including mainly the palisade and sponge crumb. In plants where the spongy crumb is predominant, the reflected radiation can be as high as 80 per cent. The combination of low visible and high near-infrared reflectance is characteristic of most plants. According to literature reports, the 690-720 nm spectrum as the red edge is a very important spectral range for plant identification, as it combines qualitatively and quantitatively the action of chlorophyll and the internal leaf structure defined by near-infrared reflectance. A laboratory study was conducted to identify selected species of coastal indicator vegetation from hyperspectral imagery. The following plant species were selected for the study and collected on the banks of surface water bodies: *Lemna minor* and *Typha latifolia*. The spectral properties of coastal indicator vegetation were studied using a Lumo 40 x 20 scanner and a Specim FX10e FOV 38° hyperspectral camera in the wavelength range 400-1000 nm. Analysis of the results obtained showed that, based on the spectral curves obtained, it was possible to identify with 100% efficiency all the plant species analysed.

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Polycyclic aromatic hydrocarbons in soil and urban dust from green areas, Piotrków Trubunalski: pollution characteristics, sources and health risk assessment

Polycyclic aromatic hydrocarbons (PAHs) and their derivatives are organic compounds present in all areas of the environment. As mutagens and carcinogens, they have the potential to exert a harmful effect on all living organisms and vegetation.
The study examined the concentration of 16 PAHs in soil and urban dust samples collected from park areas in the city of Piotrków Trybunalski. The total concentrations of 16 PAHs ranged from 2,280 to 13,965.5 µg/kg for soil and from 2,483 to 41,900 µg/kg for urban dust, respectively. The analysis of soil and dust samples revealed the prevalence of 4-6-ring compounds, with the diagnostic coefficients indicating a predominant pyrogenic origin of PAHs. The presence of higher concentrations of PAHs in dust and soil samples collected during the heating season indicates the significant contribution of the municipal sector to the emission of these pollutants.
The TEF for the sum of 16 PAHs in soil was calculated to range from 1753.8 to 2935.4 µg/kg for soil samples and from 466.3 to 1074.7 µg/kg for street dust samples. The values of the Σ7carcPAHs/ΣPAHs ratio ranged from 0.53 to 0.66 for dust and soil samples. The mutagenicity index values ranged from 1998.8 to 3164.8 µg BaP/kg for soil and from 534.0 to 1242.8 µg BaP/kg for urban dust. Following a review of the samples that were analysed, it was determined that 99.41% of the PAH mixture consists of carcinogenic substances.
The cancer risk values for adults and children exposed to PAHs through skin contact and oral ingestion exceeded 1.0 *10-5 in soils from most of the sites studied, suggesting a significant cancer risk associated with human exposure to PAHs through contact with these soils.
Concentrations of PAH pollutants have been observed to increase in urban dust samples during periods of dry weather. The accomplishment of this objective is contingent upon the regular implementation of measures such as frequent flushing and sweeping of streets and pavements.

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Technologies for Capturing and Utilizing Greenhouse Gases at Industrial Facilities: Current Trends and Prospects

The research is devoted to the problem of technological and organizational implementation of decarbonization projects in industry with the involvement of interested partners. The success of technologies throughout the complex decarbonization process — including CO_2 capture from flue gases, transportation, utilization, or storage — depends on the accuracy of methodologies, the depth of research, and the quality of the developed recommendations. Examples of implemented solutions are presented, and the potential for their application in the context of Ukrainian industry is assessed.

To extract water vapor (present in flue gases at concentrations over 10%), the gases must be cooled to the condensation temperature of water vapor to separate the resulting condensate. This condensate captures fine mechanical impurities and other particulates, thereby purifying the flue gas. We have developed a method for separating liquids and mechanical impurities from gas flows, implemented on a specially designed unit. The cooling principle is based on the application of supersonic throttling of the flue gas through a Laval nozzle. Industrial trials of the method confirmed its high efficiency in capturing water vapor and fine particles from flue gas, with significantly lower energy consumption compared to existing cooling technologies.

A method of using captured CO_2 in oil and gas wellbore cementing during well construction was investigated. The process involves mineralization — converting CO_2 into a more stable carbon form, typically carbonates. When preparing the cement slurry for wellbore casing, water containing dissolved CO_2 is used.

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Radon in Poland: Review of regulations and measurement options

Radon is a naturally occurring radioactive element that is a significant source of ionising radiation exposure for the general public. Its concentration can be analysed in the context of many environments – geological, atmospheric and aquatic – but it is most often discussed in the context of indoor air quality. The importance of this issue stems from the carcinogenic nature of radon decay products. With regard to indoor exposure, the relevant document is the announcement of the Minister of Health of 22 January 2021 entitled 'National action plan for the long-term risk associated with radon exposure in residential buildings and workplaces'. This document shows the growing importance and development of the radon concentration monitoring system in Poland. Currently, in accordance with the requirements of the Atomic Act, the adopted reference level is 300 Bq/m^3. Passive meters are most commonly used for radon measurements in accredited laboratories. In recent years, measurement capabilities have developed and inexpensive active meters are available on the market which, with a properly planned measurement week, can provide an uncertain but acceptable assessment of the average annual radon concentration. Advances in measurement technology can significantly increase the effectiveness and availability of radon concentration monitoring in enclosed spaces. However, it should be noted that with the growing interest in radon-related issues, entities without the appropriate competence to carry out reliable measurements may appear on the market, which is why public education is becoming the basis for the development of knowledge. The presentation will summarise the three years of work on radon research to date.

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The impact of drought on health risk associated with groundwater contamination in Poland

Groundwater in Poland is a key source of drinking water. However, its quality is threatened by climate change, including droughts and anthropopressure. The aim of this study was to assess the impact of drought on health risks associated with groundwater contamination in Poland in the Wielkopolskie, Dolnośląskie, Opolskie and Lubuskie voivodeships. Concentrations of contaminants and health risk indicators (HI and ELCR) were compared during the drought period (2015) and during the reference period (2007-2014). Data were collected at 117 measurement points and analysed using ICP-MS, ICP-AES, and ion chromatography methods by the Polish Geological Institute. The results show that drought increased the health risk index (HI) in all regions: in the Wielkopolskie Voivodeship by 10%, the Dolnośląskie Voivodeship by 25%, the Opolskie Voivodeship by 12% and the Lubuskie Voivodeship by 47%. Arsenic was the main risk factor, while nitrate and manganese showed a decrease in drought period. The health safety threshold (HI > 1) was exceeded at 21 of 117 points during the study period (2007-2015). The highest values were recorded in Szczytna, where the HI was 1.89 during the reference period (2007-2014) and increased to 8.62 during the drought period (2015). In Poniec, the HI exceeded the threshold during both the reference period (4.43) and the drought period (5.05). The carcinogenic risk (ELCR) remained stable (±10%) in both periods at 90 points out of 117. The study highlights the need to monitor groundwater and adapt treatment processes to local conditions, especially during drought periods.

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The impact of anthropogenic changes in soil structure on water retention and the urban microclimate

In the context of ongoing climate change and intensive urbanization, research on the water retention properties of urban soils is of particular importance due to their impact on the water balance and the shaping of the microclimate. The objective of this experiment was to evaluate the impact of soil structure differentiation caused by anthropogenic activity on its retention characteristics and the potential consequences for microclimatic conditions in urbanized environments.
The analysis of the laboratory tests results that water flow in the columns filled with sand characterized the highest water-holding capacity and a stable moisture distribution within the profile, thereby facilitating the maintenance of favorable moisture conditions. In the case of the sand and rubble mixture, lower water retention and a more rapid decrease in moisture were observed, which limited the soil's water storage capacity. The soil with a rubble interlayer exhibited the least favorable retention properties, characterized by rapid water movement through the profile and persistently low moisture content, irrespective of the matric potential. The findings of the present study demonstrate that homogeneous, well-structured soils enhance water retention and potentially mitigate the adverse effects of urbanization on the urban microclimate.

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Analysis of impedance changes in li-ion 18650 cells under operational degradation

With the growing demand for efficient and long-lasting energy storage systems—particularly in the context of e-mobility and sustainable energy management—reliable diagnostic methods for lithium-ion cell health assessment have become increasingly important. This study investigates impedance changes in three types of cylindrical Li-ion 18650 cells (EEMB, EVE, Samsung) subjected to operational degradation through 300 charge/discharge cycles under controlled thermal (30–50°C) and electrical (0.1C–0.5C) conditions.

In-situ impedance measurements were carried out during the discharge phase using an RLC bridge, with particular attention paid to the behavior at a fixed frequency of 100 Hz, chosen as a practical diagnostic point. The results reveal a consistent increase in real impedance values and noticeable changes in phase components, indicating progressive electrochemical degradation. The degradation was especially pronounced under elevated temperatures and higher discharge currents, emphasizing the role of operational stress in accelerating cell aging.

The proposed single-frequency impedance approach offers a simple yet effective diagnostic method for battery management systems (BMS). Due to its low measurement complexity and high repeatability, it may serve as a useful tool for real-time State of Health (SoH) monitoring in applications where long-term reliability and efficient environmental management of energy resources are critical.

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Circular horticulture in practice: A biochar-based model for sustainable chrysanthemum production

Chrysanthemum × morifolium (Ramat.) Hemsl. is one of the most important species in the horticultural market. Nowadays, chrysanthemums are more and more often produced in laboratories through *in vitro* propagation (also known as micropropagation). This method enables the rapid and efficient production of a large number of healthy plants in a short time and limited space. However, a key stage in micropropagation is acclimatization of plants to *ex vitro* conditions (e.g. in a greenhouse), which can be critical for their development. On the other hand, biochar (BC), i.e. a porous material derived from biomass at high temperature, is becoming an increasingly interesting solution in horticultural production. The aim of the study was to verify whether biochar produced from chrysanthemum plant residues can be effectively used during the acclimatization of plants and their further growth in the greenhouse, enabling a closed cultivation cycle. Biochar was produced in low-temperature pyrolysis (400°C) from chrysanthemum stems, inflorescences, and root systems. Obtained BC was added to the cultivation substrate (a mixture of peat and perlite) at the concentrations of 4, 8, and 12%. *In vitro*-derived rooted plants of chrysanthemum 'Richmond' were transplanted into this substrate and cultivated for four weeks. Next, phenotypic traits of the plants, including stem height and leaf number, were analyzed. Leaf planimetric analysis and the architecture of the root system were also described. It was found that the longest shoots grew in the control, while application of BC at the highest concentration, regardless of type, resulted in the shortest shoots. Root BC (4%) stimulated leaf development, i.e., surface area, perimeter, and width. On the other hand, there was no effect of the studied factors on the leaf number. Stem BC (8%) increased the fresh weight of the root system, while leaf biochar at 8% increased the root system area and volume, in contrast to inflorescence BC at 12%. In summary, moderate biochar concentrations, particularly from root systems and stems, can enhance certain aspects of chrysanthemum growth during acclimatization, but at high concentrations, they may inhibit plant growth. Therefore, careful selection of biochar type and dosage is recommended for optimal plant performance.

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Advancing River Water Quality Assessment through a Hybrid Cells Model for Nutrient Fate and Transport in the Msunduzi River

Rivers are important ecosystems that provide habitats for aquatic life and meet human water needs, but they are increasingly threatened by pollution. In South Africa, the Msunduzi River is facing significant nutrient enrichment, leading to eutrophication and deteriorating water quality. As routine monitoring is resource intensive, mathematical models are essential to simulate the behaviour of pollutants and make management decisions. This study presents the development and application of a Hybrid Cells-in-Series (HCIS) model to simulate the transport and transformation of nutrient pollutants in the Msunduzi River. The model considers key processes such as ammonia-nitrite-nitrate transformations, algal uptake and respiration, benthic ammonia inputs and denitrification. The nutrient concentrations predicted at different locations in the river were compared with both field data and the results of the advection-dispersion equation model and showed good agreement.

The results show that the HCIS model can reliably simulate nutrient dynamics during non-monsoon periods in particular. Its relatively simple structure, combined with its ability to model natural river systems, makes it a valuable tool for decision making in water quality management. Compared to conventional models, the HCIS framework offers greater practicality and efficiency and supports efforts to address nutrient pollution and protect river ecosystems.

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Morphometric Characterization of Pores in Cohesive Soils Subjected to Various Freezing Systems Using Numerical Image Analysis (NIA) and Factor Analysis (FA)

Understanding the impact of freeze-thaw (F–T) cycles on the microstructure of cohesive soils is crucial for assessing their durability and behavior under cold climate conditions. Previous studies have primarily focused on changes in macroscopic properties, while alterations in pore microstructure remain less explored. This study aimed to quantitatively determine changes in pore geometry depending on the freezing system applied and to identify key morphometric parameters responsible for these changes. To achieve this, Numerical Image Analysis (NIA) was combined with Factor Analysis (FA), enabling the reduction of dataset complexity and the identification of dominant patterns in microstructural modifications. Five cohesive soils from the Świętokrzyskie region, Poland, previously unfrozen, were analyzed after one F–T cycle under two systems: open (with water migration) and closed (without migration). MANOVA revealed statistically significant differences in most pore parameters between unfrozen and frozen soils, regardless of the freezing system. FA showed that the open system induced larger and more diverse microstructural changes, while the closed system caused more uniform modifications. Additionally, it was observed that after the F–T cycle, the factor significance of pore shape parameters (elongation, roundness, compactness) decreased in favor of geometric parameters such as area and axis lengths.

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Impact of large-scale construction on air quality in the city centre

Ambient air quality in the vicinity of traffic routes is a common topic affecting everyone. In the inner city, where buildings are located directly on traffic routes, this is particularly important for the daily functioning of the residents. Among the factors responsible for the intensity of air pollution are wind speed and direction and the possibility of free airflow. Therefore, the authors decided to investigate the impact of building development in free spaces along traffic routes in the city centre and assess the impact of these activities on the accumulation of pollutants from motor vehicles. As a result of the analysis, two locations for new large-scale developments were identified in the city centre of Lodz (the fourth largest city in Poland in Central and Eastern Europe) near a communication route characterised by intensive traffic. This analysis made it possible to estimate whether newly constructed large-scale buildings filling the space between existing buildings would significantly impair airflow. The analysis was carried out using the ENVI-met software for the simulation of microclimates in both urban and natural environments. The use of a pollution dispersion model allowed the analysis of particulate and gaseous pollutants. In the ENVI-met program, both two-dimensional analysis (map) and three-dimensional analysis are possible. In the present study, first of all, the variable parameter, which is the wind direction, was taken into account, and on this basis the distribution of pollutants PM10 and nitrogen dioxide NO2 coming mainly from car exhaust was studied. The results of the analysis showed that the development of open spaces and the creation of street canyons not only worsens air quality in the lower troposphere (at human height - about 1.4 to 2 m above ground level), but also contributes to the accumulation of pollutants and hinders the inflow of fresh air masses. In conclusion, it is particularly important that, when shaping urban spaces, ventilation corridors are preserved and development is carried out in such a way as to prevent the accumulation of polluted air in spaces where the impact on society is greatest, particularly if air pollution comes from road transport. Particular attention should also be paid to the design of building heights and their location with appropriate distances from traffic routes. It is also important that, when designing new buildings, spatial order and the natural development of associated greenery, which has a beneficial effect on the city's air quality, are preserved.

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A Study on Voyage-Based Emission Units Using AIS Data for the Development of High-Resolution Maritime Emission Inventory

Ships represent a major source of air pollutant and GHG emissions in port areas, making accurate emission estimation increasingly critical as concerns about climate change and urban air quality continue to mount. While ship emission inventories have long served as fundamental tools for air quality management and greenhouse gas mitigation strategies, most existing studies depend on average activity constants that fail to adequately capture the operational nuances of individual vessels. This reliance has raised questions about the accuracy and reliability of current inventories.

The use of Automatic Identification System (AIS) data offers a promising solution for more detailed and dynamic ship emission estimation. Nevertheless, applying AIS-based methods at national scales presents significant technical and methodological hurdles. AIS data often contain inherent errors and temporal gaps, while processing large-scale ship movement data at the national level involves considerable complexity. Despite these limitations, differences in sailing distance, berthing time, and maneuvering patterns across voyages by vessel—even using the same port—make it essential to account for the operational characteristics of individual ships for more accurate and detailed emission estimation.

This study addresses these limitations through a voyage-level case study utilizing AIS data to develop voyage-based emission units that reflect actual operational characteristics. Using these units, we construct a spatially-resolved ship emission inventory for a targeted port area. By identifying and applying key variables affecting fuel consumption patterns—including vessel speed, engine type, and port operation duration—this research seeks to enhance the reliability of emission estimates beyond what conventional approaches can achieve.

The findings from this work are expected to improve the accuracy of ship emission inventories at the port level and establish a scientific foundation for developing targeted air quality management policies specific to individual ports.

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Integrated workflow with BIM and DFMA for MEP system design in data centers: Optimization and prefabrication

Data centers are critical components of digital infrastructure, and the efficiency of their MEP (Mechanical, Electrical, and Plumbing) systems is crucial to ensuring continuous operations. This study aims to implement prefabricated modular solutions for electrical systems in the electrical rooms of data centers, integrating the methodologies of Design for Manufacture and Assembly (DfMA) and Building Information Modeling (BIM). The research proposes the creation of electrical containment modules (such as LV Ladder, ELV Trunking, and Fire Alarm Tray) designed using Autodesk Revit, with validation conducted in close collaboration with construction teams to ensure feasibility and adaptation to the site conditions.
The analysis of the results demonstrated that the combination of DfMA and BIM brought significant benefits, including cost and schedule reduction, improved installation quality, and the creation of scalable solutions that facilitate future data center expansions. Additionally, the validation of modular solutions with construction teams highlighted the importance of iterative adjustments to technical drawings to align with real-world construction conditions.
However, the implementation of these methodologies was not without challenges. Resistance to change from stakeholders and the need for specialized training were critical points for the success of the project. Regarding future developments, emerging technologies such as Digital Twin may offer new avenues for real-time simulation and monitoring of systems, while artificial intelligence can optimize operations and predict failures. The research also suggests expanding these methodologies to other types of critical infrastructure projects and continuing the validation process in the field for the ongoing refinement of solutions.

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The role of hazard analysis in ensuring the safe and responsible mining of mineral resources

Occupational safety in mining plays a key role in the responsible and sustainable management of mineral resources. The paper outlines the importance of systematic hazard analysis, with a focus on the event tree method (ETA), which enables the detailed identification of potential initiating events and their consequences. The ETA method allows the identification and assessment of complex hazard scenarios, which are particularly relevant in a mining work environment. By visualising the chain of events and critical points, the ETA supports the planning of effective preventive, technical and organisational measures to minimise the risk of accidents and the negative impact on the environment.

The use of the event tree method in hazard assessment has a positive impact on the safety of mining processes. This approach enables risks to be anticipated and mitigated more effectively, which not only promotes the protection of workers' health, but also supports the implementation of the principles of sustainability - by integrating measures for worker safety, environmental protection and responsible management of natural resources.

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Analysis of indoor air quality in a collective residential building

People spend up to 90% of their time indoors. Ensuring thermal comfort and proper indoor air quality is one of the most important tasks in residential construction. Air quality in multi-family buildings is also very important. Indoor air contains chemical pollutants and bioaerosols. Microbiological control of the air is important, especially when there is a problem with mould growth on building partitions in rooms.

Air quality studies were carried out in a collective residential building at the University of Zielona Góra due to concerns reported by students about an increased number of moulds in the air. The residents of the dormitory considered the building to be sick, according to the definition of SBS – *Sick Building Syndrome*. Moulds were removed from the building partitions. Air quality analysis was carried out in rooms where mould had previously appeared, and the air in rooms without traces of mould was also tested. In addition, microbiological tests of the outside air (background) were performed. Air samples were collected using two methods: sedimentation and impaction (using a MAS 100 ECO sampler). The humidity and temperature of the air in the tested rooms were measured using a hygrometer.

The results showed an increased amount of moulds and bacteria in the air, but these amounts did not exceed the recommendations of biological agents experts. The number of microorganisms in the air indicated a moderate level (according to Report No. 12). The effectiveness of the mould removal was also checked. The air samples taken in the building contained, among others, moulds of the following genera: *Penicillium*, *Cladosporium*, *Aspergillus*, *Acremonium*, and *Mucor*. The results obtained from the outside air showed mould species identical to those in the indoor air, which was confirmed by the test results. It was also shown that the air quality improved thanks to the residents' intervention. The previous mould removal was also effective. The research clearly shows that an increased number of microbial colonies in the air reduces the comfort of room occupants. Microbiological analysis of indoor air quality is important and justified.

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The stability of uranium in soil after assisted phytoremediation: Use of *Brassica napus* L. and fungal biomass

Uranium (U) is a naturally occurring element. Increased concentrations of U in soil (up to 630 mg kg^{-1}), water (up to 50 µg L^{-1}) and air (up to 500 pg m^{-3}) are the result of human activities, (e.g. the improper disposal of industrial and mine waste, nuclear leakage and the production and use of fertilisers). Soils with high levels of U are considered degraded post-industrial wastelands. However, phytoremediation can restore the area's appearance and improve soil health overall. U-tolerant plants can also limit wind and water erosion by stabilising U through uptake, adsorption and precipitation in the rhizosphere (phytostabilisation). This study investigated the effect of supplementing the soil with fungal biomass (post-production waste) and cultivaing of *Brassica napus* L. on the mobility of U introduced into the soil (silty loam, pH 6.5) in the form of uranyl acetate (0.04% U). The potential bioavailability of U was characterised using sequential extraction in four leaching steps: (1) extraction with 0.1M sodium nitrate (the exchangeable fraction considered as bioavailable); (2) extraction with 1M hydroxylamine hydrochloride in 25% acetic acid (the reducible fraction stable under aerobic conditions); (3) extraction with 30% hydrogen peroxide in 0.02M nitric acid (the stable organic fraction); and (4) extraction with concentrated nitric and hydrochloric acids (the most stable residual fraction). The U concentration in each fraction was determined using the Arsenazo III method.

Seventy-two days after the addition of U to the soil, the metal was distributed between the four fractions as follows: exchangeable (7%), reducible (53%), organic (33%), and residual (7%). Plants cultivated in soil without fungal biomass altered amounts of U in the residual fraction (decreasing to 3%) and the organic fraction (increasing to 39%). When plants were cultivated in soil supplemented with fungal biomass, a significant increase in the amount of U in the organic (54%) and residual (8%) fractions was observed, while a decrease in the amount of U in the exchangeable (4%) and reducible (34%) fractions was seen. Therefore, it can be concluded that supplementing soil with waste fungal biomass and cultivating *B. napus* L. can stabilise U and reduce its bioavailability.

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Analysis of water consumption trends in the Wolsztyn commune

Analysing current water consumption and its trends over time is very important for planning the expansion of the water supply system and making operational decisions. When planning water distribution systems, it is very important to understand parameters such as per capita consumption. However, it should be noted that changes in water consumption can be due to various reasons, as they are directly related to the habits of the building's residents. It is also important to have individual water consumption measurement systems, where lower consumption is observed compared to a grouped water consumption measurement system. The urban-rural municipality of Wolsztyn in the Wielkopolska Province, with a population of less than 30,000, was selected for analysis. The municipality is experiencing a slow decline in population between 2014 and 2023. At the same time, an increase in water consumption is observed both in global terms, for the entire municipality, and per capita. The change in the downward trend previously observed on a national scale may be the result of the disproportionate increase in water prices in relation to inflation and the increase in other costs of goods and services, including municipal services. This ''loosening up' of water-saving habits in a country with fairly limited water resources may have a negative impact on residents' finances, e.g. in the event of a sudden increase in the costs of the water supply plant and a sharp rise in tariffs. It is noticeable that in the analysed municipality, the unit water consumption is significantly higher than the standard and typical for facilities of this size. On the other hand, the unevenness coefficients are significantly lower than those recommended for design and observed in other facilities with similar characteristics.
A positive sign is the gradual reduction of water losses in the network, which indicates that the facility is being operated correctly.

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Rural architecture design trends in the 21st century in the context of sustainable development principles

Buildings designed in rural areas have long been simple, easy-to-construct solutions using local materials. The structures were designed according to the principle of the tri-unity of construction, form and function, and their spatial layout allowed for natural ventilation and ensured maximum thermal comfort for users.
The aim of this article is to define current trends in the design of rural architecture in the context of contemporary sustainable solutions, with reference to past methods of designing simple facilities. The subject of the study are buildings located and constructed in rural areas around the world, completed within the last twenty years.
Based on tabular data collected by students of the Faculty of Architecture at Poznań University of Technology, a multi-criteria analysis was conducted, which allowed for the identification and description of trends. The results of the research, presented in the form of graphs, represent the most commonly used practices and tools in the process of designing buildings in rural areas.
The results of the analyses were used to prepare a simplified assessment of the sustainability level of individual projects, showing a return to historically developed spatial arrangements with the use of modern materials, systems and technologies. The research conducted can be used by architects to create new designs in rural areas.

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The Role and Challenges of Neighborhood Green Spaces in Multi-Family Housing: Insights from Olsztyn

Neighborhood greenery, especially within multi-family residential areas, plays a crucial role in the urban green infrastructure, significantly influencing residents' quality of life and urban ecosystem functions. It provides essential recreational spaces, improves the microclimate, and supports biodiversity. In densely built residential areas, neighborhood green spaces also serve as buffers, mitigating noise and air pollution while counteracting the urban heat island effect.

A well-considered and sustainable integration of neighborhood greenery is exemplified by the city of Olsztyn, where projects focus on revitalizing green spaces within housing estates. The introduction of green courtyards, pocket parks, and pedestrian-cyclist corridors contributes to enhancing the urban environment and social cohesion.

However, contemporary urbanization presents significant challenges for planning neighborhood greenery. On new housing estates, the role of green spaces is often marginalized, limited mainly to lawn areas or low, uniform vegetation cover, which raises concerns from the perspective of urban ecology and residents' well-being. Compared to estates developed in the 1970s to 1990s, where green spaces exhibited greater structural and functional diversity including trees, shrubs, and recreational areas modern housing developments frequently feature simplified and monotonous green layouts.

These limitations negatively affect the capacity of such spaces to effectively fulfill ecological, social, and climatic functions. Therefore, conscious urban planning efforts are necessary to design neighborhood greenery with greater complexity and multifunctionality, which is essential for sustainable urban development and climate change adaptation.

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Novel Electrode Materials for Electroanalytical Detection of Thallium in Environmental, Water and Wastewater Samples

Thallium is one of the most environmentally hazardous heavy metals, known for its high toxicity and ability to bioaccumulate in aquatic ecosystems. Even at trace concentrations, it poses a serious threat to drinking water quality, aquatic life, and human health. Accurate monitoring of thallium in environmental, water, and wastewater samples is therefore essential for effective pollution control and regulatory compliance. However, its determination remains analytically challenging due to its low abundance and the complexity of natural matrices.

This study addresses the need for safer and more sustainable electrochemical methods for thallium detection by developing and testing novel electrode materials. Glassy carbon electrodes modified with selected nanomaterials were investigated as mercury-free alternatives for voltammetric analysis. Mercury-based electrodes, although historically effective, are increasingly restricted due to their own environmental and health risks, creating an urgent demand for greener technologies.

The developed electrodes were evaluated for their sensitivity, selectivity, linear response range, and detection limits in environmental samples, including surface water and treated wastewater. The nanomaterial-modified electrodes demonstrated high analytical performance, with strong thallium ion preconcentration and precise quantification at ultra-trace levels. Their robustness, non-toxicity, and ease of fabrication support their use in routine environmental monitoring.

From an environmental perspective, the elimination of mercury in electrode materials significantly reduces the ecological footprint of trace metal analysis. The proposed sensors enable more sustainable assessment of thallium contamination in water systems, contributing to safer water management and the implementation of environmental protection policies.

This research highlights the critical role of green electrochemical technologies in modern environmental analysis. By combining nanotechnology with voltammetric techniques, it offers practical tools for early detection of toxic metals and supports broader efforts to minimize the chemical burden of analytical practices.

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Assessing the effect of data interpolation on unsupervised learning results in country-wide air quality studies

Atmospheric particulate matter (PM) poses a persistent threat to both environmental quality and public health, particularly in Central and Eastern Europe. To inform large-scale air quality strategies, it is essential to understand not only local, but also macroregional patterns of PM variability. This study investigates the spatio-temporal distribution of PM across the entire territory of Poland, utilizing data collected from a nationwide network of air quality monitoring stations between 2015 and 2023. To enable a continuous representation of PM concentrations over space and time, the raw observations were interpolated onto a regular spatio-temporal grid using advanced geostatistical and machine learning techniques. Subsequently, K-means clustering combined with Dynamic Time Warping (DTW) was applied to delineate macroregions characterized by similar temporal dynamics of PM levels. Clustering was performed independently on both gridded and raw datasets to assess the influence of data preprocessing on the results. The comparison revealed notable differences in computational performance, spatial coherence of clusters, and interpretability. The findings underscore the dominant role of topography and urbanization in shaping PM distribution, and highlight how methodological choices affect the identification of coherent macroregional air quality zones. These insights are crucial for designing regionally adapted mitigation policies and long-term air quality planning at the national and transboundary scale.

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Unlocking Nigeria's Urban Mining Potential: A Data-Driven Exploration of E-Waste and Municipal Waste Streams

Nigeria, as Africa's most populous nation and its largest economy, experiences high levels of resource consumption. This, combined with a strong market for second-hand products, contributes significantly to the generation of electronic waste (e-waste) and municipal solid waste (MSW). The Global E-Waste Monitor 2020 reported that Nigeria generates approximately 290 thousand tonnes of e-waste annually, yet only a small fraction is recovered or recycled through formal systems. Given this context, there exists a crucial opportunity for urban mining to capitalize on these waste streams. This study examines the untapped potential of urban mining in Nigeria, particularly in key areas such as Lagos and Abuja. Drawing on recent data from sources such as NESREA, EPRON, the Global E-Waste Monitor, and the UN Environment Programme, the findings highlight the importance of an integrated waste management strategy. The research assesses current policy frameworks, notably Nigeria's Extended Producer Responsibility (EPR) program, revealing significant institutional gaps and presenting opportunities for structured investments. By adopting a circular economy approach, Nigeria can achieve a balance between economic growth and environmental safety.

The study underscores that targeted policy interventions, improved infrastructure, and the formalization of the informal sector could position Nigeria as a regional leader in urban mining. This transformation can turn waste challenges into opportunities for sustainable livelihoods and green industrialization, fostering climate resilience.

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Ecological Aspects of Active Microreservoirs for Drug Delivery Systems

The development of advanced drug delivery systems (DDS) has increasingly turned to micro- and nanostructures for targeted, controlled release of pharmaceuticals. Among these, active microreservoirs have emerged as promising carriers due to their ability to respond to specific physiological stimuli such as pH, temperature, or enzymes. However, while their biomedical potential is widely explored, the ecological implications of their production, usage, and disposal remain underexamined. These systems often incorporate synthetic polymers, nanomaterials, or bioactive compounds that may pose risks to ecosystems if improperly managed. The environmental persistence of such materials, particularly nanoparticles, raises concerns about bioaccumulation, toxicity to aquatic organisms, and interference with microbial communities.

The study highlights the importance of evaluating the full life cycle of active microreservoirs—from synthesis and clinical application to degradation or environmental release. Biodegradable and bio-based materials are identified as more sustainable alternatives, offering reduced ecological footprints. The main conclusion is that while active microreservoirs hold great promise for improving human health, integrating ecological risk assessment and green chemistry principles into their design is crucial. A sustainable approach to DDS development not only ensures patient safety but also protects environmental health in the long term.

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Environmental Impact of Drug Consumption

Wastewater is a complex mixture of substances, including human waste, food scraps, and chemicals, originating from various sources such as domestic, industrial, and storm sewage. The wastewater analysis provides a wealth of information, including identification of specific chemicals such as pharmaceuticals and drugs, their quantity and concentration, and their metabolites. This analysis can be used to estimate the consumption patterns of the local community. Beyond its role as a source of statistical data and information regarding potential assistance needs, such as public health initiatives, wastewater also serves as a barometer for water quality. The presence of contaminants, including drugs, in wastewater is an unavoidable environmental concern that necessitates diligent monitoring to ensure the continued supply of clean water to communities. The statistical data obtained from wastewater monitoring facilitates the tracking of trends in drug and prescription abuse within these communities. This paper provides a comprehensive literature and statistical review of the latest trends related to drugs and pharmaceuticals in wastewater, with great attention to the topic at issue.

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The food sharing and food banks in Poland as a strategy for mitigating food waste

The issue of food waste represents a significant challenge for contemporary food systems. In Poland, as in other EU countries, approx. 5 million tonnes of food are wasted annually, which corresponds to an average of 126 kg per capita. Households are responsible for the largest share of this waste, but significant surpluses also arise in trade and catering. In response to this problem, two complementary models for reducing waste have emerged: the grassroots food sharing movement (food sharing initiatives, community fridges, fruit and vegetable collections) and professional food bank structures. The objective of the research was to analyse the role of both forms in reducing waste, assess their impact on a local and national scale, and indicate directions for development in the perspective of a circular economy. Statistical data, reports from public institutions and case studies from Warsaw and Wrocław demonstrate that food banks play a dominant role in terms of the scale of food recovery. The Food Bank in Wrocław has been estimated to save approximately 1.5 million kg of food per year, thereby supporting approx. 45,000 people. A review of nationwide data reveals that in 2024, public benefit organisations received 25,045 tonnes of food as a result of a law that obliges retailers to donate unsold products. However, between 2022 and 2024 there was a significant decrease in the volume of donations (from 53,700 to 25,000 tonnes), which may indicate both an improvement in stock management in trade and barriers in redistribution logistics. Conversely, food sharing, despite its operation on a comparatively reduced scale with regard to the amount of food conserved, fulfils a distinct social and educational function. The example of Warsaw demonstrates that food sharing initiatives achieve an average annual saving of approx. 13 tonnes of food, while campaigns organised at marketplaces enable an additional 15 tonnes of fruit and vegetables to be recovered during a single season. Whilst these quantities are significantly smaller than those saved by food banks, grassroots initiatives engage residents, raise their environmental awareness, promote prosumer attitudes and allow for the direct exchange of resources within local communities. The findings highlight the need for enhanced integration of food recovery efforts, including expanding networks of food sharing initiatives, standardising food distribution monitoring, and fostering stronger cooperation between NGOs and the private sector.

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Using organic waste Using organic waste in a circular economy strategy in a circular economy strategy

Organic waste contributes significantly to greenhouse gas emissions, soil degradation and water pollution, requiring immediate mitigation strategies for sustainable waste management. Effective management of the organic waste is a key element of sustainable development strategies and the adaptation and mitigation of climate change. The Circular Economy (CE) involves transforming current linear models towards circular systems that prioritize renewable and limitless resources, while non-renewable resources are reused and recycled. A fundamental premise of CE is the cascading use of materials in a way that maximizes their utility value and minimizes resource losses.
The aim of this study was to analyze the current state of knowledge regarding organic waste management in the context of implementing a CE strategy. Based on a systematic review of scientific literature available in reputable databases, the potential and challenges associated with circular management of this waste fraction were assessed. The results indicate that improper organic waste management generates significant environmental threats, including greenhouse gas emissions and the degradation of natural resources. An increasing number of countries are implementing the principles of the circular economy as a response to the growing environmental pressure resulting from the intensification of organic waste generation. Implementing CE models in organic waste management allows for the reduction of primary raw material use, a reduction in waste streams, and an increase in the efficiency of material and energy recovery. In the long term, this contributes to the development of ecologically and economically resilient systems based on closed material cycles.

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Using soil properties to predict Zinc speciation in degraded soils: A tool for sustainable soil management

Soil contamination with zinc chloride ($ZnCl_2$) is a common issue in industrial and degraded areas, contributing to the increased mobility of zinc (Zn) and posing environmental risks. This study investigates the combined influence of soil type, physicochemical properties, and $ZnCl_2$ contamination on the distribution of Zn fractions in soil. Eighteen soils with varying textures, pH, organic matter (OM), specific surface area (SSA), and chloride ion (Cl^-) content were analyzed using a modified BCR sequential extraction method. Concentrations of Zn, Cu, Ni, and Pb were determined via atomic absorption spectroscopy (AAS). The effect of soil properties and contamination levels on metal fractionation was assessed using MANOVA and ANCOVA, while nonlinear least squares regression (NLSR) was used to develop predictive models for Zn mobility. Results showed that Zn exhibited the highest mobility (Zn > Ni > Cu > Pb). The proportion of mobile Zn fractions (FI + FII) increased with total Zn concentration, while soil type and properties such as SSA, clay content (CLY), and pH significantly influenced Zn distribution. Although Cl^- enhanced Zn mobility, its effect was secondary to that of total Zn. Developed models based on total Zn concentration and soil sorption properties such as SSA and CLY accurately predicted Zn speciation ($R = 0.92–0.98$), providing a valuable tool for assessing environmental risks and supporting sustainable soil management and reclamation strategies in contaminated or degraded lands.

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Urban soil indicators under climate change and sustainability challenges

Urban development encompasses numerous social, economic, and environmental dimensions that demand careful consideration during planning. While focusing on sustainability, a diverse array of concepts emerges. To some extent, these concepts can obscure the true aim of sound urban planning: to create healthy living spaces that support a fulfilling life, both socially and economically. Achieving this necessitates implementing environmental services in urban and peri-urban areas.

Urban soils offer immense potential for boosting a city's resilience to climate change and fostering healthy environments. We define urban soils as any soil within city perimeters, subject to urban planning, and designated for buildings, infrastructure, and public spaces. These soils are characterized by significant human alteration and limited ecological function. To effectively measure their potential, using environmental indicators for urban sustainability is crucial, as they provide specific insights into the state of the urban environment. Recognizing this, urban planners, policymakers, and citizens must all acknowledge the inherent value of urban soils.

One fundamental indicator of urban health is *public green space per inhabitant*. This metric quantifies the square meters of publicly accessible green areas available for each city resident. Furthermore, the *3-30-300 rule* has recently gained prominence, suggesting that individuals should be able to see at least three trees from their home, that 30% of their neighborhood should have tree canopy cover, and that no one should live more than 300 meters from a green space of at least one hectare.

Another vital indicator is the *percentage of urban soil that maintains its natural infiltration capacity*, or whose capacity is facilitated by sustainable urban drainage systems. Both positively influence the reduction of urban heat island formation. Consequently, we must recognize cities as mosaics of diverse landscapes. In this context, utilizing indicators such as the *landscape diversity index* can be highly beneficial. Moreover, the most sustainable cities implement connection strategies *through green corridors*, applying the principle of connectivity between spaces.

In essence, the set of indicators used for urban management should be reasonable and can expand over time with practical application, leading to improved city governance. Embracing these indicators will not only help us mitigate the impacts of climate change but also cultivate greener and more livable cities for future generations.

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Decommissioning of a lignite mine combined with the development of a pumped-storage power plant: a preliminary feasibility assessment

The subject of this article is the potential construction of a pumped-storage power plant (PSP) in post-lignite mining areas. To illustrate the issue, the Turów lignite mine, located in the Bogatynia municipality in southwestern Poland, was selected as a case study. Several variants of constructing the upper reservoir of the PSP on the mine's former external spoil heap were analyzed. Prior to the construction of the upper reservoir, a specific volume of overburden must be removed to level the area and create a suitable platform. Based on a digital terrain model, calculations were performed to estimate the volume of material to be removed from the spoil heap for different upper reservoir configurations. Using reference data from existing Polish PSP facilities, the theoretical power capacity of the Turów PSP was estimated depending on the assumed reservoir variant. The construction of the power plant should be coordinated with the decommissioning process of the open-pit mine. The article presents arguments supporting the synchronization of these two processes. It is recommended that mining machinery decommissioned from the mine be used for earthworks related to the construction of the upper reservoir on the external dump. The excavated material should be reused in preparing the ultimate pit to serve as a future water body. Integrating the PSP development with mine closure could accelerate both processes and significantly reduce costs. This topic is forward-looking in nature. According to the current mining license, lignite extraction is expected to cease no later than 2044. Preparing the excavation site to function as a reservoir and filling it with water may take up to four decades. Due to the limited water availability from the transboundary Lusatian Neisse River, this process cannot be accelerated. Consequently, electricity generation from the pumped-storage plant may not commence before the 2080s. The article draws a general conclusion: post-lignite mining areas, where the pit can function as a lower reservoir and the external dump is located nearby, offer potential sites for the development of pumped-storage power plants. The paper also proposes other locations suitable for similar future applications.

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Sustainable Phosphate Removal in Wastewater Treatment Using Activated Carbon Derived from Brewery Wastewater Sludge

Phosphate pollution is a growing environmental concern, particularly in regions where industrial and municipal wastewater is discharged with minimal treatment. Among the industries contributing to nutrient loads in surface waters, breweries play a notable role, especially in developing countries with limited wastewater infrastructure. Excess phosphate leads to eutrophication—accelerated growth of algae and aquatic plants—which disrupts ecosystems and degrades water quality. This calls for low-cost, effective, and locally adaptable solutions for phosphate removal.

In this study, sewage sludge from the Dashen Brewery in Gondar, Ethiopia, was repurposed as a raw material for producing activated carbon (AC) for phosphate adsorption. The sludge was chemically treated with phosphoric acid (H_3PO_4) or sodium hydroxide (NaOH), then thermally activated to enhance surface properties. The materials were characterized using FT-IR spectroscopy, BET surface area analysis, point of zero charge (pHpzc), and proximate analysis. The H_3PO_4-modified carbon showed a higher surface area (427.32 m^2/g), increased porosity, and functional groups favorable for phosphate uptake.

To optimize performance, adsorption experiments were designed using Response Surface Methodology (RSM). The best results were achieved at pH 3, with 120 minutes of contact time and 2.6 g of adsorbent, yielding 80.3% phosphate removal and an adsorption capacity of 13.6 mg/g. Kinetic analysis indicated pseudo-second-order behavior, suggesting chemisorption as the dominant mechanism. Regeneration tests showed that the adsorbent retained over 50% efficiency after three reuse cycles.

The results confirm that sewage sludge from brewery operations, often considered a waste management problem, can be transformed into a valuable material for water treatment. This approach not only addresses the issue of nutrient pollution in aquatic environments but also supports circular economy principles by converting waste into functional products. Given its low cost and good performance, this material has the potential for real-world application in decentralized wastewater treatment systems, particularly in regions facing both environmental and resource-related constraints.

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Environmental risk assessment of heavy metals in sewage sludgepipe

In order to reduce the risk of heavy metals from sewage sludge entering the environment, analyses are made using indices, indexes or coefficients that facilitate environmental risk assessment. The aim of this study is to present and analyze environmental risk indicators resulting from the presence of heavy metals in sewage sludge, based on selected scientific publications. The analysis is the basis for assessing the environmental risk caused by the release and introduction into the natural cycle of high concentrations of heavy metals contained in sewage sludge from wastewater treatment processes.

Comparing the individual heavy metals in the sludge from the selected wastewater treatment plants, a significant risk was found to be associated with the presence of cadmium, which, taking into account the geoaccumulation index, heavily contaminates nearly 57% of all sludge. The environmental risk from cadmium, is also confirmed by the potential risk factor, the environmental risk index and the RAC assessment code. Also mercury, despite its low concentrations in the sediments compared to other elements, poses a high environmental risk in Silesia. This is evidenced by both the results of the geoaccumulation index and the potential risk factor.

It is worth noting that even despite satisfactory results of the analysis of the tested sludge samples, the risk associated with long-term biotoxicity of metals should be taken into account. Sewage sludge, thanks to its fertilizing properties, can be used as an additive to soils, but it is necessary to control its quality and conduct additional studies on its dynamics in the environment. Only a combination of quality control of sewage, sludge and soil will ensure the safety of the natural environment.

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Recycling of mining and metallurgical wastes for sustainable construction materials

With increasing generation of mining and metallurgical wastes, such as slag, tailings, fly ash, and red mud, poses significant environmental and health challenges. The traditional disposal methods often lead to land degradation, groundwater contamination, and greenhouse gas emissions. In response, this study explores innovative approaches to recycling these industrial by-products into sustainable construction materials.
The research focuses on evaluating the potential of selected mining and metallurgical wastes to be used as raw materials in the production of eco-friendly cement, bricks, and road base aggregates. It examines the chemical and physical characteristics of the wastes, the treatment or processing methods required, and the performance of the final construction products in terms of strength, durability, and environmental safety.
Additionally, the study highlights successful case studies where circular economy principles have been implemented in mining regions to transform waste into value-added products. The environmental benefits, including reduced carbon emissions, conservation of natural resources, and reduced landfill use, are analyzed.
By integrating environmental engineering techniques with sustainable design practices, this work contributes to the advancement of green construction and supports the global shift towards more responsible resource management. The findings underscore the importance of innovation and collaboration in turning industrial waste into a tool for sustainable development.

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Initial insights into the phosphorus sorption capacity of biochars from tomato (*Solanum lycopersicum* L.) and cup plant (*Silphium perfoliatum* L.) residues under different pyrolysis temperatures

Phosphorus (P) is considered as a critical resource (due to the depletion of phosphate rock reserves), whose excessive use in fertilizers contributes to the eutrophication of surface waters. A promising solution to these challenges is the application of biochar (BC), produced from waste biomass, as a sorbent material and a potential source of plant nutrients.

The aim of this study was to evaluate the effect of pyrolysis temperature (400 and 650°C) on the P sorption capacity of BCs derived from tomato (*Solanum lycopersicum* L.) and cup plant (*Silphium perfoliatum* L.) residues. Sorption experiments were conducted in aqueous KH_2PO_4 solution (200 mg P/L, pH 7.0) for 2 hours. P concentrations were determined spectrophotometrically. Sorption kinetics were described by the pseudo-second order model, while equilibrium data were fitted to Freundlich and Langmuir isotherms.

The highest P sorption capacity was observed for BC from cup plant produced at 400°C, reaching 22.62 mg P/g BC. Cup plant BC pyrolyzed at 650°C also exhibited relatively high sorption capacity (15.36 mg P/g BC), compared to tomato-derived BCs, which showed lower values at both temperatures (9.31 and 10.72 mg P/g BC, respectively). The results indicate that cup plant-derived BC, particularly at the lower pyrolysis temperature, may serve as a promising sorbent for P within a circular economy framework.

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Development of well-dry jet pump designs to improve the environmental safety of the oil and gas complex

Given the global focus on decarbonization of the world economy enshrined in the 2015 Paris Agreement, international oil and gas companies are forced to use unconventional energy generation technologies that ensure compliance with new environmental standards in their industrial activities. Considering that a significant part of the oil and gas production complex at all stages of the life cycle is a source of increased environmental hazard, improving environmental pollution prevention technologies is an urgent research task. Despite a significant number of studies devoted to the application of ejection technologies in the development of hydrocarbon deposits, the issue of using downhole jet pumps to increase the level of environmental safety in oil and gas fields has not been studied sufficiently. The choice of rational design and operating parameters and schemes for using a jet pump is determined by the nature of individual production processes, the implementation of which is carried out with the involvement of ejection technologies. Insufficiently justified choice of geometric dimensions and hydrodynamic parameters of downhole jet pumps does not allow ensuring the required level of environmental safety when using ejection technologies for the exploitation of hydrocarbon deposits.

The purpose of the research is to establish the design features and operating modes of downhole ejection systems designed to reduce environmental pollution during the implementation of individual technological processes for the development of oil and gas fields. The goal is to

– establish design and operating parameters that characterize the working process of a downhole jet pump;
– determine rational design and operating parameters of the jet apparatus of the system for the utilization of low-pressure petroleum gas in the free space of the reservoir for the accumulation and storage of well products;
– establish the design features and operating mode of the ejection system designed for reagent-free prevention of hydrate formation in the well;
– determine the main directions of development of metering jet pumps of the system for introducing reagents into technological pipelines of oil fields.

The design features of structures and operating modes of downhole jet devices intended for reducing environmental pollution during the implementation of individual

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technological processes of oil and gas field development are considered. The design of a downhole jet pump is determined by the ratio of the geometric dimensions of its flow part and the possibility of installing inclined guide elements for swirling mixed flows. The operating mode of the jet device is determined by the ratio of the dimensionless relative pressure and the injection coefficient. When using an ejection system for the utilization of low-pressure petroleum gas, it is advisable to use a high-pressure jet device, the injection coefficient of which is taken in the range from 0.6 to 0.8, the diameter of the working nozzle, and the flow rate of the working flow are calculated under the condition of preventing the occurrence of cavitation, and the guide elements for swirling mixed media must be installed in the working flow. In the case of reagent-free prevention of hydrate formation in the well, the main geometric parameter of the jet pump should be equal to 2 at zero flow rate of the injected flow, and the guiding elements for twisting the mixed flows should be installed in the working nozzle. The injection coefficient of the dosing jet pump during the introduction of inhibitors into the moving flow should not exceed 0.001, and when choosing the diameter of the working nozzle, the maximum standardized value should be taken.

The task of further research is to establish the design features of ejection systems designed to increase the efficiency of cleaning and secondary use of oil field wastewater.

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Microplastics research trend analysis: The case of tire and road wear particles (TRWP)

Tire and road wear particles (TRWP) are a significant source of microplastics pollution in the environment. These particles are formed mechanically by tires rubbing against the road surface, which enter the air, soil, and water systems. Their impact on the environment and health is still insufficiently researched. Currently, there is a growing scientific interest in this research, and therefore the research question is formulated: what are the main trends in TRWP research? This study is based on an analysis of academic literature, a detailed bibliometric analysis, and a science mapping analysis.
Keyword coexistence analysis revealed the most commonly used terms associated with TRWP research: microplastics, tire wear, particulate matter, toxicity, sediment, and zinc. The co-authorship network identified two dominant clusters of researchers – one oriented towards toxicological risk assessment, and the other oriented towards particle identification and environmental transport. "CiteSpace" clustering identified eight main thematic clusters characterized by strong silhouette values (> 0.76), reflecting high thematic coherence. These clusters covered topics such as TRWP source identification (n = 25), health risk assessment (n = 19), urban environmental research (n = 16), TRWP environmental dispersion and mitigation strategies (n = 16), fine particle classification (n = 11), TRWP chemical composition transformations (n = 10), TRWP monitoring in marine environments (n = 9), new methodological and experimental aspects (n = 7). Citation count analysis showed that the most influential publications in the network had high structural importance (centrality > 0.10), but did not show citation bursts (bursts = 0.00), which indicates a long-term, rather than sudden, impact on the research field. Several publications exhibited high degree centrality as the main links in the network, and all top-ranked articles had a sigma value of 1.00, highlighting their important role in connecting established, but not emerging, research directions.

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Optical properties of interstitial waters as an indicator of the progress of lake restoration

As a result of lake restoration, a decrease in organic matter is observed, especially easily decomposable matter, which is an important supplier of nutrients to the water column.
The study of how the share of organic compounds with different susceptibility to degradation changes can be carried out using the DOC absorption spectrum (dissolved organic carbon after a 0.45 µm filter).
The optical properties of DOC were used to investigate the effect of restoration using the phosphorus inactivation technique with the coagulant PAX 18 supported by biomanipulation on dissolved organic compounds in the interstitial waters of two lakes. For the selected wavelengths (203, 250, 254, 285, 365 nm) the following parameters were determined: SUVA_254, SUVA_285, A_254/A_203 and A_250/A_365.
Based on these results, a decrease in the content of easily degradable organic matter in the DOC pool was observed, along with a simultaneous increase in the share of macromolecular compounds (changes in the ratio of fulvic and humic acids). DOC concentration decreased significantly in deeper sampling sites, where thermal and physicochemical gradients prevailed during periods of intensive production in the lake water. Changes in the studied parameters were not statistically significant in the shallow, polymictic stand, influenced by the catchment (organic matter supplied by river water).
The molecular size and chemical structure of organic matter significantly influence processes such as biodegradation, flocculation, and adsorption, thus indirectly impacting lake production. When the availability of readily biodegradable organic matter is limited, bacteria activate other carbon sources. By observing changes in the parameters examined above, we can quickly and easily estimate the direction of organic matter transformation during lake restoration.

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The influence of microstraining on the efficiency of removing precursors of chlorinated organic substances from surface water in the coagulation process

During water disinfection, admixtures and organic contaminants present in the water can react with chlorine or other disinfectants, leading to the formation of undesirable disinfection by-products. Among the most dangerous of these are trihalomethanes and halogenated organic acids, considered to be potentially carcinogenic and dangerous to human health. For this reason, the removal of chlorinated organic precursors is a very important step when treating drinking water. The aim of this study was to determine the effect of microstraining on the efficiency of removal of chlorinated organic precursors from surface water by coagulation. The subject of the study was surface water from the Obrzyca River, obtained at the Zawada Water Treatment Plant, characterised by a high content of organic substances, the concentration of which was determined on the basis of water quality indicators such as: oxidisability, total and dissolved organic carbon, absorbance in the ultraviolet UV_{254} and UV_{272}, and specific absorbance in the ultraviolet ($SUVA_{254}$). It was assumed that the microstraining process of raw water, due to its effect on reducing the concentration of organic pollutants, would have an impact on the efficiency of removal of oxidation by-product precursors and disinfection in the coagulation process. In order to verify the assumptions made, a volumetric coagulation process was carried out under laboratory conditions, using the iron coagulant PIX-111 and the highly alkaline aluminium coagulant FLOKOR 1.2A. Analysis of the results showed that the microstraining process when using PIX-111 ferric coagulant resulted in a significant reduction in the removal efficiency of chlorinated organic precursors in the coagulation process. In the case of the use of Flocor 1.2A coagulant, microstraining had a useful effect on the removal of oxidation and disinfection by-products. Analysis of the $SUVA_{254}$ index values showed that significantly lower values were found in water after the coagulation process with the aluminium coagulant Flokor 1.2A, ranging from 0.994 to 1.769 m^2/gC, indicating that water treated with this coagulant is characterised a low potential for the formation of oxidation and disinfection by-products.

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Microbiological pollution of waters in urban environments: sources and remediation

Having access to clean and safe drinking water is essential to preserve health and well-being. In fact, it was recognized as a human right in 2015 by the United Nations as one of the Sustainable Development Goals. Microbiological contamination of water resources in urban environments represents a growing challenge and it is essential to identify the sources of microbial pollution in order to minimize it and, if it is already a fact, to be able to recover the source of water through remediation and decontamination systems.

Climate change has a significant impact on the microbial contamination of drinking water sources. The National Oceanic and Atmospheric Administration showed that 2024 was the warmest year since global records began with an average increase of 1.27ºC. It leads to higher water temperature associated with more frequent and extreme weather events, heat waves and changes in precipitation patterns, leading to critical issues regarding the accessibility and quality of water resources. Frequent flood and storm events can increase runoff of water from fields, transporting microorganisms into rivers, lakes, wells, and any flow of water. Moreover, the warmer conditions, between 30 to 50ºC, can promote the growth of pathogen microorganisms and harmful algal blooms as cyanobacteria in aquatic environments. In addition, an increase in water temperature can impact in distribution systems favouring biofilm growth, which interferes with the effectiveness of water disinfection.

The main microorganisms in drinking water include bacteria such as Salmonella, Shigella, Escherichia coli, Vibrio cholerae, Giardia, Pseudomonas, Legionella spp., Cryptosporidium, Clostridium perfringens, Aeromonas and Campylobacter. The presence of viruses such as adenovirus, hepatitis A, and norovirus has been also frequently detected, as well as several types of parasites. Although consumption of contaminated drinking water represents the greatest risks, other routes of transmission can also lead to disease, that is the case of inhalation of aerosol. Because of that, the risk of pollution is growing exponentially, as the behaviour of microorganisms.

There is evidence that, if there are not adequate disinfection protocols, contaminated water sources can lead to outbreaks that must be effectively managed by healthy authorities. Identifying the pathogen and determining the origin of the contamination is essential to face the resolution of the outbreaks.

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Identification of pathological manifestations in a public building: a case study in Brazil

The preservation of public heritage is essential to preserve the history and culture of a society. In Brazil, the Federal Constitution, in article 23, establishes that the Public Authorities are responsible for protecting and preventing the deterioration of public assets with historical, artistic or cultural value. In addition to historical preservation, it is necessary to guarantee the functionality and useful life of buildings, which makes preventive maintenance indispensable. This practice allows identifying and correcting pathologies in their early stages, to ensure that buildings meet the needs of their users. These pathologies can have various causes, such as design errors, use of low-quality materials or inadequate construction practices. Mapping this damage is essential to diagnose the cause of the appearance of the pathologies and plan appropriate interventions. This study analyzed the Teotônio Vilela Municipal Theater, built in 1983, in the city of Sorocaba/SP. After a technical visit to the site, damage maps of the facades were prepared with the aim of documenting the pathological manifestations identified. These manifestations were assessed according to their severity (mild, moderate or severe) and frequency of occurrence.

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Geogenic pollution of natural resources – mineralogical and geochemical studies

The open-pit mining of contributes to the accumulation of significant amounts of rocks, called associated minerals. The sustainable management of natural resources in this case requires research to predict their deposition and identify potential geotoxic substances released from rock formations into the environment. The extraction, use of minerals, their processing, use in construction, land improvement, and storage all lead to the strengthening of processes that initiate the remobilization of geotoxins. These processes are particularly amplified in the presence of rock raw materials that undergo secondary mineralisation processes, such as pyritization. The aim of the work was to identify secondary mineralization processes, including pyritization, in rock raw materials and to determine trace elements in them.The pyritization process was identified during mineralogical studies in limestones, rocks, and sandstones. This iron sulphide appeared both as crystals with idiomorphic outlines and in a granular form, exhibiting no crystalline features. The typical form in the identified rocks was framboidal pyrite. Studies of the isotopic ratios (32S/34S) of pyritic sulphur confirm that framboidal and idiomorphic forms are enriched in the 32S isotope. Varieties derived from clastic rocks show lower enrichment compared to sulfides separated from carbonate rocks. The geochemical results revealed anomalous levels of Pb, As, and Cd in the studied rocks and confirmed their geogenic origin. Lead and arsenic were shown to be associated with pyritization. Cadmium is also associated with clay minerals. The research indicates geogenic sources of anomalous concentrations of trace elements, which pose an environmental threat on a local, regional, and national scale. Pyritized rock formations constitute a geoanthropogenic source of pollution resulting from the exploitation and processing of abiotic natural resources.

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Computational and experimental approaches to assessing the biochemical methane potential (BMP) of organic substrates for biogas plants

The biochemical methane potential (BMP) is a crucial parameter for estimating methane production from anaerobic digestion (AD) of organic substrates. Accurate BMP assessment supports feedstock selection, energy yield modelling, and optimising biogas plant performance. This paper reviews the main computational and experimental methods for determining BMP, focusing on agricultural and agro-industrial substrates.

Experimental approaches, based primarily on batch anaerobic digestion assays, remain the most reliable method for direct BMP determination. These tests typically follow standardised procedures (e.g., VDI 4630, ISO 11734, or ASTM D5210), which involve inoculating a known quantity of substrate with anaerobic microbial consortia under controlled mesophilic or thermophilic conditions. Key parameters influencing experimental accuracy include inoculum-to-substrate ratio, particle size, temperature stability, gas measurement techniques, and test duration. Despite their widespread use, experimental BMP assays are time-consuming, labour-intensive, and require careful calibration to ensure reproducibility and comparability of results. To complement and accelerate the BMP assessment process, various computational approaches have been developed. These include empirical regression models, mechanistic models based on biochemical kinetics, and machine learning algorithms. Empirical models, often derived from compositional data, provide rapid estimates but are limited by their site-specific calibration. Mechanistic models simulate hydrolysis, acidogenesis, acetogenesis, and methanogenesis steps in AD, offering greater flexibility and predictive capability across diverse substrates. AI techniques, such as neural networks and support vector machines, show strong predictive performance using multi-dimensional input data.

In conclusion, combining computational tools with laboratory tests enhances BMP assessment and supports biogas plant decision-making. Future research should advance hybrid methods that integrate modelling with experimental validation to improve reliability, scalability, and standardisation in BMP prediction.

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SmartRiver2 – innovative system for surface water monitoring

Climate change has intensified environmental risks in the Słubice–Frankfurt (Oder) cross-border region, including extreme rainfall, droughts, and ecological incidents such as the mass fish die-off in the Oder River. These events demonstrate complex interdependencies between environmental factors that are still poorly understood, making prediction and response challenging. Effective action requires continuous monitoring, advanced data analysis, public awareness and coordinated preventive or corrective measures.

Building on the achievements of the original SmartRiver initiative, the SmartRiver2 project aims to create a comprehensive digital platform for integrating, storing and analysing environmental data. The system will generate reliable insights into environmental conditions, with a particular focus on water, by combining wireless sensor networks, satellite observations and AI-based analytics. A pilot installation in the twin-city area will facilitate the collection, processing and presentation of data for experts and local communities alike.

A key scientific objective is to develop a non-invasive, cross-border monitoring system for flood embankments and riverbanks. This solution is based on Internet of Things (IoT) communication, wireless sensor technologies, data analysis algorithms and early warning mechanisms. This system will enable the continuous and precise monitoring of flood defence infrastructure and dynamic river processes, all the while protecting ecosystems. The fact that it is jointly operated by Polish and German authorities makes it a pioneering transboundary approach in Europe.

In the long term, SmartRiver2 is conceived as the first module of a broader Smart Twin City concept for Słubice and Frankfurt (Oder). The platform is designed to be modular and scalable, allowing integration of future subsystems such as transport management, energy efficiency, water and waste systems or crisis response. The project also strengthens research collaboration between the University of Zielona Góra and the IHP Institute, encouraging knowledge exchange, joint development and student involvement in further technological and environmental research.

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Assessment of wastewater biodegradability at the Gubin-Guben WWTP based on COD fraction analysis

The effectiveness of biological processes leading to the decomposition of organic compounds depends on the susceptibility of organic compounds to biochemical decomposition. Indirectly, such information is provided by determining the value of the COD to BOD_5 ratio, and it is assumed that for $COD/BOD_5<2$, wastewater is considered susceptible to decomposition. A more detailed characterization of organic compounds is provided by the COD index divided into fractions. The basic division of COD distinguishes four basic fractions: dissolved organic substances, easily biodegradable (S_S fraction), dissolved organic substances, non-biodegradable (S_I fraction), organic substances in suspension, slowly biodegradable (X_S fraction), and organic substances in suspension, non-biodegradable (X_I fraction). The aim of the study was to characterize the raw, mechanically treated and treated wastewater streams from the Gubin-Guben wastewater treatment plant, taking into account the susceptibility of pollutants to biochemical degradation. The WWTP Gubin-Guben is a facility designed using activated sludge technology to treat wastewater from both border towns. The research showed that the pollutant indicators in raw wastewater supplied to the WWTP from Guben were higher than from Gubin by approximately 10% for COD and BOD_5 and 15% for total suspended solids.The share of biodegradable pollutants in both wastewater streams was approximately 88%, with the Ss fraction (74%) dominating in wastewater from Gubin, while it share in wastewater from Guben was approximately 10% lower. The proportion of the X_S fraction was 26% for Gubin and 37% for Guben. The susceptibility of raw wastewater to biodegradation was also confirmed by the $COD/BOD_5 = 1.9$. The share of non-biodegradable fractions was respectively X_I=5% and S_I=7% in wastewater from Guben and X_I=3% and S_I=9% from Gubin. As a result of mechanical treatment the percentage of biodegradable fractions was 67% (S_S=47%, X_S=20%), and non-biodegradable 33% (X_I=23%, S_I=10%). The treated wastewater was dominated by non-biodegradable fractions, accounting for 91% of the total COD (S_I=76%, X_I=15%), and the COD/BOD_5 ratio was above 2.5, which confirms the correct course of the treatment processes. The remaining 9% of total COD consisted of X_S fraction.

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Mechanism for Leasing Rainwater Retention Capacity through Individual Stormwater Tanks

Recent changes in urban land use—especially the development of formerly permeable areas—have significantly disrupted local hydrological cycles. As a result, cities are increasingly facing extreme weather events such as urban flooding and prolonged droughts. In response to these challenges, a variety of strategies are being implemented, including nature-based solutions that emphasize the role of water retention within urban drainage infrastructure. One approach to increasing the retention capacity of urban catchments is the use of smart stormwater management systems based on forced retention. These systems enable the collection of rainwater from private properties and its controlled use—for example, for garden irrigation or discharge into the municipal network. They are also equipped with retention structures designed to lease their storage capacity for use in municipal drainage systems.However, the high initial costs of constructing such installations often pose a barrier to their widespread adoption. Therefore, this study focused on developing a stormwater management model based on leasing the retention capacity of private facilities and evaluating its financial viability.
The analyses demonstrated that a leasing model for retention capacity can be effectively implemented in urban drainage systems while ensuring high hydraulic efficiency. The study also highlighted the need to introduce an appropriate financial model based on a leasing mechanism to make such investments more attractive. The results helped determine lease pricing levels that could reduce the investment payback period to as little as 5–6 years. Introducing this type of mechanism not only improves the financial performance of drainage infrastructure but also represents a forward-looking solution that supports urban adaptation to environmental challenges driven by human activity.

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Profile of volatile fatty acids in the dark fermentation of rhododendron with the addition of cattle manure

The composition of volatile fatty acids (VFAs) formed during dark fermentation plays a crucial role in determining the downstream usability of the fermentation products and the overall efficiency of biowaste utilisation. Rhododendron silage, which is characterised by a high organic carbon content and low nitrogen availability, is a difficult substrate for microbial conversion. In this study, the effects of co-digestion with cattle manure — a nitrogen-rich and well-buffered organic input — on the profile of VFAs, biogas production and the main physicochemical indicators under controlled fermentation conditions are investigated.

Four series of dark fermentations were carried out at 39°C, each with a constant organic loading rate of 3 g VS/dm3·d and a hydraulic retention time of 15 days. The feedstock varied in its composition: 100% rhododendron silage, 100% cattle manure and mixtures with 6.25% or 12.5% manure of volatile components. The concentrations of individual VFAs — including branched-chain acids (e.g. iso-butyrate, iso-valerate, iso-caproate) — as well as biogas production, pH, ammonium nitrogen, orthophosphates and alkalinity were monitored.

The fermentation of rhododendron silage alone led to a dominance of straight-chain VFAs, especially acetate and propionate, which correlated strongly negatively with ammonium nitrogen. The addition of cattle manure (6.25–12.5%) significantly changed the metabolic profile, favoured the accumulation of branched-chain VFAs and increased the B/A ratio (branched/straight-chain acids). The B/A ratio showed strong positive correlations with ammonium content in all series, reaching its maximum correlation in the 6.25% cattle manure series ($\rho = +0.89$), while the highest average B/A value was observed in the 100% cattle manure series. These results indicate an intensification of the amino acid fermentation pathways with improved nitrogen availability. Moderately positive correlations of alkalinity and orthophosphates with branched-chain VFAs (e.g. iso-C4, iso-C5) in the 6.25–12.5% manure series indicate that buffered and phosphorus-rich conditions favour amino acid fermentation and a more diverse VFA profile. In contrast, the fermentation of cattle manure alone resulted in an acetate-dominated profile with less VFA diversity. The most diverse VFA profile was observed with medium manure doses.

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Possibilities of removal microplastics from the aquatic environment using natural methods

Microplastics defined as plastics less than 5 mm in size, can originate both from direct emissions (primary microplastics) and from the degradation of larger plastic fragments (secondary microplastics). These particles pose an increasing threat to freshwater ecosystems, including rivers and canals, that play an crucial role in the spreading of the aforementioned pollutants into the seas and oceans. Conventional wastewater and surface water treatment methods are effective under laboratory conditions or in wastewater treatment plants, however they are often expensive, require energy and technical infrastructure and they can generate additional secondary waste. Therefore, prove inadequate in removing small polymer particles, prompting researchers and engineers to seek for alternative, sustainable solutions. Recently, there is growing interest in Nature-Based Solutions (NbS), which use biological and ecological processes to treat water. Their main advantages are low operating costs, a positive impact on biodiversity and the possibility of integration with other treatment technologies.

The aim of the article is to review current research into the feasibility of using Nature-Based Solutions (NbS) materials, organisms and systems in the remediation of aquatic environments contaminated with microplastic The paper takes into consideration the effectiveness of the following materials: biochar, natural sorbents, plant beds and microbial biofilms in the capture and retention of microplastic. Particular attention is given to the role of restoration wetlands, buffer zones and integrated green-blue infrastructure systems in reducing the microplastic transport in catchments. Examples of field implementations in several countries are also presented, highlighting their effectiveness, technological challenges and opportunities for scaling.

It can be concluded that natural methods can significantly support the protection of water from microplastics, especially in urbanized and agricultural catchments. However, further research on the mechanisms of microplastic removal, their sustainability and integration with water policy and spatial planning requires special concern.

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Microplastics in water samples collected from urban fountains

There is a lack of information of microplastic studies in publicly exposed fountains. Therefore, the aim of the studies was to evaluate concentrations of the afore mentioned micropollutants in samples originating from several fountains in Polish (Gliwice) and Germany (Halle) cities with a similar population. The aspect of the sources of the occurrence of microplastics in the fountains water was also considered. It should be highlighted that so far microplastics, was not monitored in these places and remain as one of the unidentified concerns. Microplastics fractions were found in each studied fountain, however they varied in the concentrations and fractions. The most dominant microplastic fraction present in fountain water samples tested were fibers, followed by micro pellets, fragments and foils. Type of microplastics was not typical for the city but for individual fountains. In was concluded that German fountain water contained fewer microplastics than those coming from the Polish cities. The probable explanation of that fact is that the less dust and soil particles were present on the surface of German pavements. It was found that the concentration of dust was significantly higher in Poland. Microplastic concentrations in fountain water were in a wide range.

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(Un)forgotten Spaces. Revitalisation of Former Psychiatric Hospitals as Reclaiming Degraded Areas and a Tool for Urban Transformation

Reforms in psychiatric care and a shift in the approach to treating people with mental health disorders have led to the closure of many psychiatric hospitals across Europe, leaving extensive areas and valuable buildings as degraded and socially stigmatised spaces. These "(un)forgotten" sites, often with high architectural and landscape value, located both in cities and in peripheral areas, offer potential for reclaiming and circular economy activities, aligning with strategies for sustainable land use and climate change adaptation. The scale of these areas presents a challenge for spatial planning and environmental management, while their future is crucial for preserving cultural heritage and fostering social integration.

The aim of the study was to identify trends in the revitalisation processes of former psychiatric hospitals in Europe. A case study analysis was conducted, covering 59 examples of revitalisation across 17 countries. The paper presents selected best practices in Europe, representing eight identified new functional types. These examples demonstrate how the sites of former hospitals can support community development and the effective use of degraded resources while preserving heritage values and green infrastructure. The analysed cases applied solutions conducive to climate change adaptation, such as rainwater management, the development of green corridors, the use of renewable energy sources, and measures to protect biodiversity.

The findings confirm that reclaiming and revitalising former psychiatric hospitals can become an important tool for transforming degraded spaces, supporting the circular economy and sustainable development in various locations. Transformed psychiatric hospitals not only bring forgotten areas back to life but also act as catalysts for social, environmental and economic change, allowing these sites to regain their significance within the spatial and social structure.

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Comparative BIM-based environmental impact assessment of a construction project using reinforced concrete, steel, and engineered bamboo

The use of operational energy has been minimized through recent technological advances that have allowed the design of high-performance buildings. However, this has led to an increase in embodied energy and greenhouse gas emissions associated with material production, effectively displacing the environmental impact to other stages of the building life cycle. As the construction sector remains one of the largest contributors to global emissions, the present work focuses on evaluating different structural systems to reduce the embodied impact of a building. The aim is to identify the structural system with the lowest environmental impact among traditional reinforced concrete, steel structures, and the innovative alternative of engineered bamboo. The use of computer models has increasingly become a valuable decision-making tool, offering the ability to manage and coordinate construction across all project phases by integrating relevant information into a unified environment. The procedure involves modeling each project on a BIM platform, quantifying the materials used in each system, and calculating the greenhouse gas emissions and the global warming potential based on equivalent coefficients published in environmental product declarations. The assessment was carried out through the BIM application with the carbon database ICE, limiting the analysis to the contribution activities in the materials production chain. The results indicate that the engineered bamboo structural system is a viable alternative, as it results in the lowest greenhouse gas emissions. It was observed that steel and cement-based materials account for a significant proportion of the embodied impact. Therefore, to improve environmental performance, buildings must be designed to minimize the use of these materials, which can be reached using high recycled content and incorporating substitutes derived from construction and industrial waste.

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Urban environments and technosols making: strategies to increase urban resilience

Urban environments worldwide face escalating threats from climate change, particularly extreme weather events such as heatwaves and floods. These impacts are intensified by widespread soil sealing, a practice that covers land with impermeable materials and degrades vital ecosystem services. This leads to aggravated urban heat island effects, increased flood risks, diminished water infiltration for aquifer recharge, and negative consequences for biodiversity and the carbon cycle.

The global population continues to grow, projected to reach 9.8 billion people by 2050. Over 56% of the population, specifically 4.353 billion people, already resided in urban environments in 2020. This growing concentration of population in cities places additional pressure on natural resources and infrastructure, as cities are major contributors to global environmental impacts. Urban environments emit more than 70% of global CO2 and consume 60-80% of the energy produced. Despite being the areas most likely to suffer from climate change consequences, they are also the least prepared to face them.

Given this scenario, there is an urgent need to develop sustainable solutions that enable cities to enhance their resilience against the consequences of climate change. Technosols, engineered from urban and agricultural wastes, offer crucial solutions for urban resilience. Since they can be formulated to solve and prevent problems in a customised way for each area. They effectively mitigate the urban heat island effect through improved heat absorption and support for vegetation, also enhancing air quality and energy efficiency in buildings. Crucially, technosols reduce flood risk by enabling water infiltration and aquifer recharge. They significantly contribute to carbon sequestration, storing more organic carbon than natural soils, and promote a circular economy by valorizing waste. In conclusion, technosols are vital for creating sustainable, resilient urban environments against climate change, aligning with Green Deal and circular economy principles.

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Energy efficiency of intercropped maize cultivations

Intercropped maize cultivations could improve the efficiency of energy use. However, due to climate change, in Lithuania, the precipitation rates decreased by up to 50-60 percent during vegetative seasons. Lack of moisture during germination of intercrops forms uneven crop density and can decrease the biomass yields. This drastically disbalance energy indices in intercropped maize cultivations.

To reveal these problems, research and calculations were carried out at the Experimental Station of Vytautas Magnus University, Lithuania. Maize was intercropped with Fabaceae and Poaceae family crops. Inter-rows weeding and inter-row mulching with weeds were as control treatments.

The intercropping and row-cutting operations increased fuel consumption by about 10 l ha-1 compared to the control without intercropping. In arid vegetative conditions, when growing maize with intercrops, total energy consumption increased by almost 50 percent compared to the control without intercropping.

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Engineering inverse cobalt catalysts for efficient hydrogen-based fuels production

Hydrogen is considered one of the most promising energy carriers for the transition to sustainable and carbon-free energy systems. However, the widespread deployment of hydrogen-based energy technologies is still hampered by challenges in hydrogen storage, transportation, and distribution. Among various hydrogen storage media, ammonia has emerged as a leading candidate due to its high hydrogen density, ease of liquefaction, and compatibility with existing infrastructure. Its reversible conversion to hydrogen offers a viable pathway for chemical energy storage and long-distance hydrogen transport.

Herein, we report the development of an efficient inverse cobalt-based catalyst for ammonia synthesis reaction, aimed at enabling more sustainable hydrogen-based fuel technologies. The catalyst was engineered by dispersing neodymium oxide (Nd_2O_3) and barium oxide (BaO) species on the surface of bulk cobalt, creating a unique inverse oxide/metal configuration. The optimized $5BaO/15Nd_2O_3/Co$ catalyst exhibited outstanding activity in ammonia synthesis under mild reaction conditions (470 °C, 6.3 MPa), outperforming the benchmark commercial fused iron catalyst. The strong electronic interactions at the oxide–metal interface contributed to the activation of nitrogen and enhanced hydrogen adsorption, as confirmed by extensive characterization techniques (XRD, BET, H_2-TPD, STEM-EDX).

Beyond ammonia synthesis, the catalyst also showed excellent performance in plasma-assisted ammonia decomposition, achieving high conversion at moderate discharge power, and in CO/CO_2 hydrogenation, with nearly full CH_4 selectivity at elevated temperatures. These findings demonstrate the versatility and robustness of the inverse $BaO/Nd_2O_3/Co$ catalyst, positioning it as a promising material for integrated hydrogen production, storage, and conversion systems.

This work provides new insights into catalyst design strategies that leverage interfacial oxide–metal interactions, enabling efficient catalytic processes for green ammonia synthesis, hydrogen release, and CO_x valorization – all crucial steps in building a circular, low-emission energy economy.

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Methane fermentation of sheep manure – economic and environmental justification

Methane fermentation is the process of biological decomposition of organic matter under anaerobic conditions that leads to the production of biogas - a mixture mainly containing methane (CH_4) and carbon dioxide (CO_2). The use of sheep manure for biogas purposes makes it possible to manage organic waste in a sustainable way, while bringing economic and environmental benefits. As the produced gas has high methane content burning it in a CHP engine enables the production of electricity and heat for the farm's own purposes. This allows farmers to reduce energy costs and the expense of disposing of farm waste. In addition, the by-product is a digestate - a valuable organic fertiliser that can replace artificial fertilisers and reduce crop costs. The environmental benefits of fermentation primarily include a reduction in greenhouse gas emissions, especially methane, which otherwise would be released into the atmosphere during uncontrolled manure decomposition. The process also reduces odour emissions, reduces the risk of groundwater and surface water contamination and improves soil structure by using the digestate as a fertiliser.

The fermentation of sheep manure is less common than other substrates such as cattle slurry, maize silage, food waste or sewage sludge. The main reason for the lower contribution of sheep manure to biogas production is lower availability compared to, pig or cattle slurry. Sheep manure has a lower biogas yield than the substrates mentioned above; however, it can be used as a complementary substrate in cofermentation to improve the fermentation process parameters and increase the efficiency of the biogas plant.

In conclusion, the methane fermentation of sheep manure provides a valuable solution from an environmental and ecenomic point of view. The use of sheep manure for biogas purposes allows for efficient management and reduction of greenhouse gas emissions and odours.

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Evaluating the impact of building height on solar access and shadow patterns in an urban neighborhood, with the aim of optimizing urban design in terms of climatic comfort and environmental sustainability

In recent years, the integration of climate-responsive principles in urban design has gained increasing attention as an effective approach to enhancing environmental quality and urban sustainability. Among the key factors in this context is the provision of natural sunlight and the control of shadow patterns in urban spaces, which directly influence thermal comfort and the quality of public spaces. Building height, as a fundamental element of urban form, plays a critical role in determining solar access and shadow distribution within urban fabrics. Therefore, analyzing the effects of building height on sunlight exposure and shading can assist urban designers in selecting appropriate spatial forms and configurations that foster environments with improved comfort, reduced energy consumption, and greater adaptation to local climatic conditions.

The main objective of this study is to investigate the role of building height in solar access and shadow distribution at the neighborhood scale. Considering the significance of natural sunlight in enhancing the quality of public and semi-public spaces, this research aims to assess how varying height configurations affect sunlight exposure and shading throughout the day and across different seasons..

Furthermore geometric modeling of the urban form will be conducted using available data from platforms such as OpenStreetMap (OSM). Solar radiation simulation and shadow pattern analysis will be performed using the Ladybug plugin within the Grasshopper environment, enabling the evaluation of solar energy reception across different seasons. In the final stage, the Galapagos evolutionary solver will be applied to optimize building heights, striking a balance between solar access and climatic comfort. This integrated process forms the methodological framework of the study and supports the generation and assessment of multiple urban design scenarios.

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Problems associated with heavy rainfall and urban flooding, as exemplified by the city of Białystok

Urban areas are increasingly exposed to the impacts of climate change, particularly the growing frequency and intensity of torrential rainfall events. The problem of urban flooding is further exacerbated by dynamic urbanization, which in recent decades has significantly altered land-use patterns and spatial organization within cities. An additional factor compounding flood risk is suburbanization — the migration of populations from urban centers to surrounding suburban areas — which leads to spatial dispersion and increased surface sealing.

One of the key challenges in the context of urban climate adaptation is the development of sustainable stormwater management systems. In recent years, so-called Green-Blue Infrastructure (GBI) has become an increasingly prominent concept in this field. GBI serves as a counterbalance to traditional grey infrastructure solutions, such as stormwater drainage networks, underground collectors, reservoirs, and flood barriers, by integrating natural processes into urban water management.

This review examines the effectiveness of green-blue infrastructure in mitigating urban flood risk, particularly under conditions of suburban expansion and evolving rainfall regimes. The analysis synthesizes interdisciplinary data — hydrological, spatial, social, and institutional — from a diverse set of cities, including Copenhagen, New York, Beijing, Berlin, Warsaw, Prague, and Ljubljana. Special attention is given to hybrid systems that combine natural and engineered solutions within local urban planning frameworks.

The study proposes a four-dimensional assessment model for evaluating the effectiveness of hybrid GBI systems and applies it in a comparative analysis of central and suburban urban zones. Results indicate that policy coherence, spatial integration, and multifunctionality are key determinants of urban water system resilience. Cities with long-term strategic planning and institutional alignment, such as Copenhagen and New York, demonstrate significantly higher effectiveness than those employing fragmented or reactive approaches.

The article concludes with a set of operational recommendations and analytical frameworks for scaling up adaptive, climate-resilient stormwater management strategies in urban and peri-urban environments.

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Assessment of the effectiveness of the modernisation of the technological system of the Żagań Water Treatment Plant

The corrosivity of water is an indication of its chemical instability and is a characteristic that causes the destruction of materials in contact with it. The effect of corrosivity is not only the destruction of water distribution system materials, but also the danger of secondary water contamination by corrosion products. In addition, the presence of corrosion products in the water supply system promotes the secondary growth of micro-organisms and poses a potential threat of microbiological contamination of water supplied to consumers. The aim of the study was to assess the effectiveness of the modernisation of the technological system of the Water Treatment Plant (WTP) in Żagań and its impact on the quality of water intended for consumption, with particular reference to the corrosivity of the water. In Żagań, where the source of water supply is underground intakes, a comprehensive modernisation of the WTP was carried out between 2013 and 2016 in response to numerous operational problems, including mainly the corrosive nature of the treated water and the ineffective removal of iron and manganese compounds. The modernisation of the WTP mainly consisted of replacing the białostock nozzles with cascade aerators and the sand bed with a catalytic bed. The evaluation of the effectiveness of the measures carried out was based on a comparative analysis of the physico-chemical composition of the water quality before and after the modernisation, with particular emphasis on corrosivity. The Langelier (IL), Ryznar (IR) indices and the Tillman diagram were used to assess water corrosivity. The analysis of the obtained test results showed that the modernisation of the technological system of the WTP in Żagań increased the effectiveness of the removal of iron and manganese compounds and the reduction of turbidity and colour. Thanks to the use of filter material coated with manganese (IV) oxide, the removal of iron and manganese compounds now takes place efficiently, according to catalytic oxidation processes. The use of cascade aerators significantly increased the efficiency of the aeration process. However, the nature of the water still remained corrosive, indicating the need for further action, in particular the introduction of chemical deacidification methods into the technological system.

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Refrigeration Systems of Supermarkets – a review with a focus on Europe, the Baltics, and Lithuania

Supermarkets represent one of the most energy-demanding segments of the commercial sector, with refrigeration systems typically responsible for the largest share of electricity use. This high energy intensity is driven by the need to ensure continuous preservation of chilled and frozen products, regardless of outdoor conditions. In cold-climate regions such as Northern Europe and the Baltic States, including Lithuania, low ambient temperatures improve the coefficient of performance of vapor-compression systems; however, refrigeration still dominates the overall energy balance. This is reinforced by long heating seasons, extended operating hours, and high product turnover rates.

In recent years, European supermarkets have undergone a technological transition away from high-global-warming-potential hydrofluorocarbon (HFC) systems toward natural-refrigerant solutions such as carbon dioxide (CO_2, R744) transcritical booster systems and propane (R290) water-loop units. These modern systems, when combined with advanced supervisory controls, parallel compression, ejector technology, and heat recovery functions, have achieved notable reductions in electricity consumption and improved environmental performance.

This paper reviews the main refrigeration system architectures and energy-efficiency measures applied in European and Lithuanian supermarkets. Using Lithuanian chain data and European benchmarks, the study estimates that a typical 2,500 m² Lithuanian supermarket rejects about 2 GWh of heat per year, with national totals across large chains reaching hundreds of GWh/year. The results indicate that supermarkets should be regarded not only as major electricity consumers but also as significant urban heat sources. Integrating this surplus heat into district heating networks could substantially support national energy-efficiency and decarbonization objectives. Future work should focus on developing techno-economic models and control strategies to enable large-scale implementation of supermarket–district heating integration.

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Assessment of the parameters of the water supply subsystem in Zielona Góra

The task of water supply systems is to ensure uninterrupted delivery of water to all consumers, in sufficient quantities and at the appropriate pressure. The analysis of the water supply system parameters is based on calculations performed using a simulation model developed in the EPANET 2.2 program.

The analyzed “Zacisze” water supply subsystem in Zielona Góra supplies approximately 22,000 residents. The water supply network is a mixed system consisting of 33 closed circuits, 471 nodes, and 510 sections, with a total length of 33.6 km. The area is significantly varied in terms of elevation – the difference between the elevations of individual nodes exceeds 31 m.

The calculations were performed for various patterns of uneven water distribution, and the parameters analyzed were: water pressure in the nodes, flow velocity in individual sections of the network, and the time it takes for water to reach consumers.

Calculations for maximum distribution showed that the large variation in terrain elevation is reflected in a significant variation in pressure – the lowest pressure was 31.06 m and the highest was 59.53 m. Taking into account the height of buildings in the analyzed area, it was found that the pressure is sufficient to ensure water supply to all consumers. The highest water flow velocity was 0.96 $m \cdot s^{-1}$, while at the extreme ends of the water supply network it reached 0.01 $m \cdot s^{-1}$, which may indicate water stagnation in the pipelines. Another parameter analyzed was the time it took for water to reach consumers. In the 24-hour simulation, the longest water retention time in the pipeline was 22.7 hours, which may have a negative impact on water quality.

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Reclamation of green areas in the centre of Lublin - case studies, contemporary solutions

In the 21st century, in an era of widespread climate change, greenery plays a major role. It is a key element of public space increasing the comfort of living in built-up areas. Paradoxically, in Poland trees are tendentially cut down in city centres, public spaces are concreted over. In contrast to this there are smaller scale activities which provide thriving green spaces. Examples of such solutions can be found, among others, in the city centre of Lublin.

The aim of the study is to identify good practices applied in the process of revitalisation of green areas of the city, which result from listening to the needs of residents and satisfying them. It is also supposed to show what elements are an indispensable part of such areas, which consequently influence their quality and frequency of use, as well as which age groups they concern.

The research method is deduction with analysis of selected examples of green areas in the city centre of Lublin (micro and macro scale). The exemplifications include areas after revitalisation and degraded areas with untapped potential.

Recently, green squares have been created in strategic locations in the centre of Lublin. Park Ludowy, which was not used more, was revitalised, in line with contemporary trends of highly developed countries. After the metamorphosis, the park is a much more frequently used territory.

The green squares are an important area on a micro scale, allowing relaxation. The green areas in question are popular and inclusive. They are needed especially in compact inner-city developments the buffer between them being the green squares contrasting with the ubiquitous concrete. The exemplifications provide a reference point for degraded green spaces in the city.

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Elimination of Construction Hazards in Post-Mining Areas Leveled with Mining Waste

The primary directions for managing mining waste from hard coal extraction involve its use as rock material for the reclamation of waste dumps, abandoned open-pit workings, and land leveling. Given the vast areas degraded by underground mining operations, as well as the presence of numerous old industrial waste sites and open-pit excavations requiring technical reclamation, hard coal mines have the potential to fully utilize coarse mining waste formally classified as rock masses. However, the use of Carboniferous rocks for terrain leveling results in geotechnically uncontrolled embankments that do not meet the criteria for construction-grade subsoil. At the same time, such areas are often located within already urbanized zones and represent potentially attractive investment sites.
This paper presents examples of structural hazards that may arise from insufficient or improper ground preparation for planned construction projects. It also explores methods for eliminating risks to buildings erected on land leveled with rock masses from hard coal mines. In particular, the study analyzes the potential for reinforcing uncontrolled embankments through injection of water–fly ash mixtures derived from hard coal combustion by-products. Laboratory test results of various fly ash–water mixtures are presented, confirming their effectiveness in improving subsoil bearing capacity and thus restoring the full value of post-mining areas leveled with rock masses from coal mining operations.

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Integrated research on the use of solar and wind energy waste in cement technology

Due to the increasing importance of renewable energy and the challenges associated with disposing of used photovoltaic and wind turbine components, this study examines their potential application in cement production.
The aim of the study was to identify the potential of recycled materials from photovoltaic panels (mainly glass) and wind turbine blades (composites based on glass fibre and epoxy resins) as additives to cement clinker or substitutes for natural raw materials. In this study, the properties of cullet and fibres recovered from wind turbines were analysed in terms of their impact on reducing the carbon footprint and the physicochemical parameters of the bonding materials. Detailed phase composition analyses, microscopic studies (SEM/EDS), and thermal analysis (DTA/TG) were conducted to evaluate the suitability of these components for cement technology.
The potential for additional energy to be extracted during the utilisation processes of these wastes has also been demonstrated, which can significantly reduce the exploitation of lignite in the energy industry. The results indicate that appropriately processed solar and wind energy waste can successfully serve as ingredients in cement technology, contributing to a reduced carbon footprint, reduced waste, and lower consumption of natural resources. This aligns with current trends in sustainability and the integration of recycling solutions in the building materials industry.

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Transformation of toms' effect in flow of water with hydrodynamically active additives through a narrowing of the pipe

Currently, the generation of energy from renewable sources has gained great attention. The biogas generated within anaerobic digestion process (AD) is known as a versatile energy carrier that might be applied for both electricity and heat generation. AD is a widespread technology applied at many wastewater treatment plants (WWTPs) for sewage sludge (SS) stabilisation. However, its mono-digestion indicates a low methane production related with its unfavourable C/N ratio, lack of organics, and presence of heavy metals. One way to overcome these difficulties is to introduce an additional substrate with complementary composition to SS. This strategy is known as co-digestion, in the last decades gained a great importance and has been successfully implemented at many WWTPs. However, a crucial factor is selecting an adequate component. Taking into account the assumptions of circular economy an application of wastes should be a priority solution. From various residues the food processing wastes might be be a source of many valuable components e.g. nutrients, organic compounds, vitamins that might enhance the methane production at WWTPs.
The main aim of the study is selection of food processing wastes that might be applied to SS to improve methane production at WWPs. The following materials were analysed: brewery spent grain, cheese whey, ice-cream processing wastes, apple and orange pomaces in two- and three-component mixtures. The experiments were conducted under mesophilic conditions at batch mode. The obtained results of methane production indicated that the most beneficial additives for SS are: brewery spent grain, cheese whey and ice-cream processing wastes. In these cases, as compared to SS mono-digestion, methane production was enhanced by 16-19%. In turn, the use of apple and orange pomaces resulted in reduced methane production.

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Residential estate structures and the implementation of green filter and regulator systems

Opportunities for mitigating the effects of climate change and the impact on the quality of living in residential estates in Poznan in the era of building resilient cities are among the most important aspects in the field of urban design. In order to obtain answers on how urban structures should be modeled in order to achieve the best possible results in the studied issues, quantitative analyses (using the case study method) of selected residential estates were performed. Twenty-seven parameters were checked and evaluated, including such quantities as the number of residents, the total area of the estate, the total area of greenery, the area of paved areas, the number of trees, the parameters of high greenery, the number of buildings, the distances between buildings, the year the estate was built, and the ratios: the area of greenery per inhabitant per area of buildings / per area of the settlement / per area of paved areas. Using the method of linear comparative analysis, the relations between the above-mentioned values were established for the studied examples and illustrated in tabular form.

The results indicate that residential estates built in the second half of the twentieth century, with structures that are less compact and more open, are characterized by a much higher proportion of greenery and high landscape values resulting from the more complex form of greenery and its pronounced intensity compared to modern estates. The rationale behind this situation is the application of a functional, landscape and utility regime based on the old urban planning norms that operated until the end of the 20th century. Thus, older residential estates show a greater potential for adaptation to climate change, and their spatial structures allow the use of a system of green filterers and regulators, which positively affects the cleanliness of the air, energy intensity of heating buildings and comfort of pedestrian traffic between buildings. These parameters can be shaped with the use of appropriate layouts and intensities of greenery. In order to summarize and illustrate these relationships, models of green intensity and changes in the indicators of the system of green filterers and regulators were made.

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Electrochemical synthesis of organophosphorus compounds

Dialkyl H-phosphonates are chemicals that are commonly used in the chemical industry as starting materials for making organophosphorus compounds. These can be biologically active compounds like medicines and plant protection products, or functional compounds like flame retardants, plasticisers, and more. Methods for the preparation of dialkyl H-phosphonates with the formula H-P(O)(OR)2 are technologies primarily from the 1950s/60s.

In this work, we present a novel, green electrochemical method for synthesising dialkyl H-phosphonates in aqueous medium. The reaction is performed under mild conditions using low voltage and graphite electrodes, with no need for additional chemical oxidants or catalysts. The process is simple, scalable, and environmentally friendly, producing minimal waste and offering the possibility of recycling the reaction medium. Preliminary experiments have confirmed high selectivity and good yields. The method opens up a sustainable alternative to classical synthesis routes and has strong potential for industrial application, especially in the context of green chemistry and circular economy.

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Characteristics of water consumption in the municipality of Międzyrzecz

Water consumption indicators are the basis for designing individual elements of water supply systems, and their correct selection affects the maintenance of proper operating parameters and the reliability of water supply.
The analysis of water consumption in the municipality of Międzyrzecz was performed on the basis of data from 2016-2022. Due to the different characteristics of water consumption, separate calculations were made for the rural and urban parts of the municipality. The values of the unit water consumption indicator as well as the hourly and daily unevenness coefficients were determined. The average value of the unit water consumption index for the urban part was $q = 165\ dm^3 \cdot M^{-1} \cdot d^{-1}$, while for the rural part it was $q = 97\ dm^3 \cdot M^{-1} \cdot d^{-1}$. The values of the daily unevenness coefficient in the rural part ranged from $N_d = 1.92 \div 5.08$, while the hourly coefficient ranged from $N_h = 1.47 \div 2.32$. For the urban part, the corresponding values were: $N_d = 1.44$, $N_h = 1.64$.
The characteristics of consumption in different time intervals showed that the highest values in the rural and urban parts of the municipality were recorded in the summer months of June, July, and August, and the lowest in the winter, mainly in February. In both the rural and urban parts of the municipality, the highest consumption during the week was recorded on Saturdays, and the peak in water consumption in the morning is more noticeable than in the afternoon and evening.
The calculated water consumption indicators in the urban part are within the ranges specified in the Guidelines, while in the rural part they are lower, which may be due to the use of household wells by residents. Values that deviate in terms of consumption and unevenness from the ranges adopted in the standards correspond to tourist attractions in the analyzed area, where the number of users during the season is sometimes significantly higher than the number of permanent residents included in the calculations.

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Perlite application in eco-materials

Perlite is a natural volcanic rock that, due to its unique properties, has found wide application in the creation of eco-materials, thus responding to the contemporary challenges of sustainable and low-emission construction. Increasing environmental awareness among investors and designers, as well as legal requirements to reduce energy consumption and greenhouse gas emissions, have contributed to intensified research on materials with high insulation parameters, low self-weight, and minimal environmental impact. One of the innovative directions for perlite application is the production of perlite concrete, where expanded perlite replaces traditional mineral aggregates, enabling the manufacture of structural-insulating blocks with a density of approximately 600 kg/m³ and compressive strength ranging from 0.9 to 1.1 MPa. Research has shown that these blocks meet the requirements for single-layer load-bearing walls in passive and energy-efficient buildings, achieving a thermal transmittance coefficient $U < 0.20$ W/(m²K). However, a significant limitation in their use is their sensitivity to moisture – the thermal conductivity coefficient of perlite concrete blocks in an air-dry state is 0.0956 W/m·K, while at 50% humidity it more than doubles to 0.215 W/m·K. Therefore, it is necessary to protect this material against atmospheric moisture during transport, storage, and building operation. Despite this characteristic, the use of perlite concrete blocks eliminates the need for additional insulation layers, thus shortening construction time and reducing the use of synthetic insulating materials.

Expanded perlite is also used as a highly effective insulating material in industrial installations, particularly in cryogenic tanks for storing liquefied natural gas (LNG). Due to its low thermal conductivity (<0.04 W/m·K), non-combustibility (class A1), and resistance to microorganisms and chemicals, perlite ensures safe storage of LNG at temperatures around -165°C, where the gas occupies 600 times less volume than under normal conditions. Thanks to these properties, perlite is a material of the future, meeting the needs of construction aligned with the idea of a circular economy, reducing the negative impact of investments on the natural environment, while ensuring durability and safety of structures. Both perlite concrete and expanded perlite used in cryogenic LNG installations confirm the potential of this raw material in creating eco-materials that can replace traditional solutions in residential, energy-efficient, and industrial construction, reducing energy consumption and CO_2 emissions throughout the building or facility's life cycle.

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The influence of the method of parking a car in a single-car garage on the concentration of carbon monoxide

The study examined the influence of the method of parking a car in a garage on the concentration of carbon monoxide in a single-car garage in a single-family building. Two parking methods were adopted: backwards and forwards to the rear wall and with a cold and hot combustion engine. The tested garage was equipped with stack ventilation. Measurements of carbon monoxide concentration and flow through stack ventilation were taken. Based on the applicable standards, the concentration of carbon monoxide in the garage was assessed after 15 minutes, 1 hour and 12 hours. Additionally, based on the balance of carbon monoxide concentration generated by the combustion engine and the number of air exchanges in the garage, a simplified model for estimating the concentration of carbon monoxide in the garage was developed. The research results indicate significant values of carbon monoxide concentration when parking the car backwards and with a cold combustion engine.

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Mechanical and structural properties of injection molded biodegradable polymer compositions with organic fillers

The growing demand for sustainable materials drives research into biodegradable polymers and their use in eco-friendly composites. A key challenge is robust processing using conventional methods when incorporating natural fillers such as wood flour. This study combines a literature review with preliminary experiments to identify biodegradable polymer systems suitable for further development. Several commercially available biodegradable polymers were screened for compatibility with organic fillers and to evaluate processing behavior. Wood flour served as the organic filler.

In the final stage, standard test specimens were injection molded from polylactic acid (PLA, Ingeo 3251D), poly(3-hydroxybutyrate) (PHB, Biomer P304), and PLA/PHB blends with 5% wt. and 10% wt. wood flour. Optical microscopy (Nikon Eclipse LV100ND) was used to assess microstructure and filler dispersion in the molded parts. Basic tensile tests were performed on a Zwick Z010 universal testing machine to determine tensile strength and elastic modulus.

The results confirmed satisfactory processability of PLA-, PHB-, and PLA/PHB-based systems during injection molding and support their selection as promising matrix materials for further doctoral research.

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Impact of Urbanization on Soil Enzymatic Activity

Urbanization, defined as the concentration of population, industry, and infrastructure, has a significant impact on soil environments. One of the key indicators of soil quality is enzymatic activity, which reflects biological status, fertility, and the degree of degradation. Soil enzymes, originating from microorganisms, plant roots, and soil fauna, play essential roles in fundamental biogeochemical cycles and in the decomposition of organic matter, making them sensitive markers of environmental change.

The enzymes most commonly studied in urban soils include dehydrogenases (indicators of microbial activity), ureases (linked to the nitrogen cycle), phosphatases (regulating phosphorus cycling), β-glucosidases (involved in the carbon cycle), and sulfatases (associated with the sulfur cycle). Studies from various European countries indicate that enzymatic activity in urban soils is often reduced, particularly along roads and in industrial areas, due to heavy metal contamination, salinization, or soil compaction. Conversely, in park soils rich in organic matter, the activity of some enzymes is frequently higher than in suburban soils.

Future research should investigate the relationships between enzymatic activity, heavy metal contamination, soil compaction, and organic matter content. Seasonal analyses and comparisons across different types of urban areas (parks, lawns, roadside soils) will provide deeper insight into the impact of urbanization on soil functioning. Enzymatic activity thus represents a valuable diagnostic tool for assessing soil degradation and the potential for recovery in urban environments.

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Energy mixes and electricity prices in europe: a comparative analysis of trends and interdependencies

The energy landscape in Europe is undergoing a profound transformation driven by decarbonization goals, geopolitical tensions, and the increasing integration of renewable energy sources. This article presents a comparative analysis of national energy mixes across selected European countries and examines how the structure of these mixes affects electricity prices for both consumers and industry.

The study covers data from recent years, with particular attention to the impact of coal phase-out, the growth of solar and wind energy, and the role of nuclear and natural gas in ensuring grid stability. Using publicly available datasets from Eurostat, ENTSO-E, and national energy regulators, the paper explores correlations between energy source composition and electricity market prices. Special emphasis is placed on differences between Western and Central-Eastern European countries and on how energy import dependency and policy frameworks influence pricing.

The findings highlight significant disparities in energy pricing across Europe, influenced not only by generation costs and energy policy but also by infrastructure capacity and market integration. The paper concludes by outlining the challenges and opportunities facing EU member states in balancing affordability, sustainability, and energy security in the context of the ongoing energy transition.

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Organic micropollutants in surface waters of Ukraine, Belarus and Russia

The paper reviews concentrations and sources of organic micropollutants in surface waters of Ukraine, Belarus, and Russia. Trends in pollution are also indicated. The review is based on a national monitoring system and research reports. It focuses on the main waters of these countries, such as e.g. Dnieper, Dniester, Volga, Neva, or Pripyat. The results indicate that in Ukraine, the real problem is pollution by pharmaceuticals such as diclofenac or carbamazepine), nonylphenols (NPs), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and such pesticides as DDT (dichlorodiphenyltrichloroethane). The pollution from these micropollutants is particularly evident near urban and industrial centers, as insufficient treatment of wastewater can be identified as a key source. In Belarus, relatively low levels of pollution by organic micropollutants are observed, with sources identified as obsolete pesticide stockpiles, pharmaceutical residues, and agricultural runoff. The situation in Belarus cannot be overstated enough, given the limited published data. In Russia, pollution of surface waters is well-documented near major cities such as St. Petersburg and Moscow. There are, however, territories for which the data are limited. Based on the available data, the presence of pharmaceuticals and personal care products (PPCPs), phthalates, organochlorine pesticides, PCBs, PAHs, dioxins, and furans was confirmed. Across all three countries, contaminants from Soviet-era industry are present in surface water sediments. The collected results indicate that a wider monitoring system is of special interest in these three countries. Also, improvements in wastewater treatment infrastructure are of high interest, as well as policy integration to mitigate the risks posed by organic micropollutants to aquatic ecosystems and public health.

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Bioelectricity Generation in a Microbial Fuel Cell Using Stainless-Steel Cathode

The development of microbial fuel cell (MFC) technologies represents a key direction in improving wastewater treatment methods. This approach allows for simultaneous wastewater pre-treatment and energy recovery in the form of bioelectricity. However, one of the primary obstacles to the broader application of MFCs is their limited electricity output. As a result, increasing the efficiency of this process remains a central research objective. In this study, a carbon-based electrode (carbon felt – CF; carbon fiber - CFi) was used as the anode in MFCs. For the cathode, stainless steel - SS (non-precious metal catalysts) was employed. The experiments were conducted in glass MFC reactors, with sintered glass serving as the chamber separator. Several electrode configurations were tested: CF/CF, CFi/CF, CF/SS and CFi/SS. Experiments were conducted using a glass reactor (glass MFC). To reduce costs, a foamed glass membrane was used as the separator. The study evaluated both electrical performance and chemical oxygen demand (COD) reduction time. Bioelectricity generation was observed in all tested configurations. Among them, the CF/SS system demonstrated the best overall performance, providing faster start-up, higher power density, and shorter COD reduction time.

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Substrate Utilization in Microbial Fuel Cells: A Case Study with Brewery Wastewater

As the global population continues to grow, so does the volume of wastewater generated worldwide. Among the technologies capable of utilizing wastewater as a resource for energy production are microbial fuel cells (MFCs). Although MFC technology is steadily advancing, further improvements in efficiency are required to enable its broader application. Strategies to enhance MFC performance include the development of novel electrode materials, innovative reactor designs, and the use of wastewater from diverse sources. This study presents an analysis of MFC performance (e.g., COD reduction, cell voltage, and power output) when fed with brewery wastewater. Experiments were conducted using a simple two-chamber glass MFC. Carbon-based material was used for the electrodes, and foamed glass served as the membrane. The feasibility of generating bioelectricity from brewery wastewater (sourced from a small-scale installation) was confirmed. The cell start-up exhibited difficulties with repeatability and a tendency toward a prolonged initial start-up time. However, after a successful first start-up, subsequent operation proceeded smoothly. Additionally, a significant reduction in COD was observed, particularly when brewery wastewater was blended with municipal wastewater.

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Application of nanomaterials in the removal of micropollutants from wastewater

There is currently a growing interest among scientists and technologists in micropollutants present in water and wastewater. They often occur in low concentrations, but their presence in drinking water and surface water, groundwater and wastewater is important from the point of view of human health. This is because some of them are endocrinically active EDCs (endocrine disruptors), carcinogenic, mutagenic and/or teratogenic. In addition to previously repeatedly analyzed such as pesticides, PAHs, the group of these compounds includes organic polymers called microplastics, pharmaceuticals (antibiotics, hormones, analgesics, antidepressants, lipid-regulating agents and others), PCP cosmetic ingredients (fragrances, disinfectants and others), per and polyfluorinated PFAS compounds. The main source of these micropollutants in the aquatic environment is inadequately treated wastewater, as the removal efficiency of conventional wastewater treatment processes is insufficient. Therefore, it is now important to introduce such processes for wastewater treatment that will increase removal efficiency and thus reduce the concentration in treated wastewater entering the environment. The solution to the problem may be the use of nanomaterials, such as carbon nanomaterials (carbon nanotubes, fullerene, graphene), metal/metal oxide-based nanomaterials, nanocomposites, nanosorbents, nanomembranes, nanofibers and nanocatalysts, etc. Nanomaterials have unique physicochemical properties (shape, size and structure, surface morphology, crystallinity and others), which can be used to remove the aforementioned micropollutants by adsorption, membrane separation or photocatalytic degradation. In addition, nanosensors and contaminant-specific detectors can be used for contaminant detection.

This paper examines the potential of nanomaterials in the removal of micropollutants and the impact of nanomaterials on the environment (including human health), the latest trends in wastewater treatment using nanotechnology, and the challenges and prospects associated with it.

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Seasonal variability of physicochemical parameters in stormwater sediments as indicators of urban environment

Despite the growing awareness of the impact of storm runoff on the environment, the data concerning the composition of storm sewer sediments in seasonal and spatial terms remains limited. The objective of the present study was to assess the seasonal variability of selected physicochemical parameters of sediments and to determine their potential as indicators of the urban environment. Sediment samples were collected during four seasons at five locations (W14, W43, W51, D79, D82). The following parameters were examined in the sediments: pH, electrolytic conductivity (EC), total suspended solids (TSS), turbidity (NTU), chemical oxygen demand (COD), total carbon (TC), inorganic carbon (IC), dissolved organic carbon (DOC) as well as forms of nitrogen and phosphorus. The data were then subjected to statistical processing and principal component analysis (PCA). The results demonstrated a distinct differentiation of the sediment composition, contingent on spatial location and the prevailing season. The highest levels of contamination were found in the sediment from point D82 (e.g. COD: 679.5 mgO2/kg, TSS: 600 mg/kg, NTU: 356), particularly during the spring and autumn months. The sediment collected from point D79 exhibited the lowest and most stable values. PCA analysis demonstrated that TSS, NTU, COD, P-PO43-, EC and DOC are the variables that contribute the most to the PCs and therefore the samples can be differentiated on the 2-dimensional PCA mapping. The stormwater system sediments can serve as an effective tool for monitoring the quality of the urban environment and as a source of information on anthropogenic pressure.

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Screening study of Lewatit ion exchangers for the removal of selected heavy metal ions

Globally, contaminated water poses a serious threat to human health and the environment. The main sources of water contamination are industrial effluents and municipal waste. Numerous industrial sectors are responsible for the release of heavy metals into the environment among others mining, petrochemicals, electroplating, textiles, fertilizers, and plastics etc. Heavy metals are particularly hazardous due to their toxicity, resistance to biodegradation, and ability to bioaccumulate in living organisms, which may lead to their entry into the human food chain. For this reason, heavy metals are now considered among the most serious environmental pollutants and their effective removal from wastewater is essential to protect both human health and the environment.

The adsorption technique using ion exchangers is considered a very promising method for heavy metal removal from aqueous solutions due to its low cost, easy handling and high affinity of sorption materials towards heavy metal ions. Therefore the aim of this study was screening test of Lewatit ion exchangers for V(V), Cu(II), Ni(II), Zn(II) ions removal from aqueous solutions.

The obtained results indicated that the Lewatit ion exchangers (TP220, SR7, S5428, S5528, AF5) showed different abbility for heavy metal ions removal. Moreover, the sorption of heavy metals depend on the properties of the sorbent, the characteristics of the metals and the experimental conditions (pH, mass of adsorbent, initial concentration, contact time). Such studies enable identification of the most effective Lewatit ion exchangers, providing baseline data for practical wastewater treatment applications, and contributing to the development of environmentally friendly remediation technologies.

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Developing Asian Air Quality Management Program

Air pollution is a critical environmental and public health issue in Asia, driven by rapid urbanization, industrialization, and increasing energy demands. PM2.5, ozone, and other criteria pollutants have significant impacts on morbidity and mortality across the region. The transboundary nature of air pollution necessitates coordinated regional responses. However, many developing countries in Asia face substantial challenges due to limited air quality monitoring infrastructure, insufficient emission data, and fragmented governance structures, which hinder the formulation and implementation of effective control policies.

To overcome these challenges, there is an urgent need to establish an integrated framework for air quality management that bridges scientific knowledge, policy development, and stakeholder engagement. Such a framework should address existing information gaps by strengthening monitoring networks and harmonizing air quality data collection across countries. The integration of ground-based measurements with satellite remote sensing can provide comprehensive understanding of spatial and temporal pollution patterns. Additionally, fostering regional collaboration and information sharing will support the development of coordinated strategies to reduce emissions from key sectors such as energy, transport, and agriculture.

Comprehensive policy scenario analysis shows substantial PM2.5 concentration reduction potential. Using the LEAP model to evaluate ten unified policy scenarios from 2021 to 2030, the comprehensive accumulating scenario proves most effective in reducing greenhouse gas emissions, air pollutants, and associated social costs across all three countries.

This study highlights the necessity of building a scientific and institutional foundation for air quality management in Asia. It underscores the importance of capacity building, data transparency, and cross-border cooperation as cornerstones of sustainable air pollution mitigation efforts. Advancing these priorities will enable countries in the region to transition toward cleaner air and improved public health outcomes.

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Can artificial intelligence explain air pollution drivers to support sustainable urban development?

Artificial Intelligence (AI) is increasingly transforming diverse scientific and applied fields by enabling the analysis of large-scale, heterogeneous datasets and uncovering complex, non-linear relationships. In the domain of urban air quality, classical statistical models and physics-based atmospheric simulations have long provided valuable insights into pollutant dispersion and meteorological interactions. These approaches remain foundational but often struggle to integrate behavioral, environmental, and spatial data simultaneously. While there is growing interest in understanding how human activity and socioeconomic factors shape pollution patterns, these influences are difficult to quantify and explain directly using classical methods. Explainable Artificial Intelligence (XAI) offers a promising extension by not only modeling these complex dynamics, but also making their internal logic transparent.

In this study, we apply ensemble-based machine learning models—XGBoost and Extra Trees—to high-resolution PM2.5 air quality data collected from a dense network of low-cost sensors in a Central European urban region. To interpret model outputs, we use SHAP (SHapley Additive exPlanations), a method grounded in cooperative game theory that attributes each model prediction to individual input features in a consistent and locally accurate way. SHAP allows us to assess both local explanations (i.e., how specific features influence a single prediction) and global feature importance (i.e., which variables are most influential across time and space). By aggregating SHAP values seasonally and spatially, we identify key drivers of pollution, such as temperature, wind speed, and relative humidity, whose importance varies with seasonal meteorological regimes and likely emission behaviors.

This combination of predictive accuracy and interpretability enables a more nuanced understanding of air pollution dynamics. By bridging physical models, data-driven methods, and interpretable AI, the study supports evidence-based planning and policy aimed at achieving healthier and more sustainable urban environments.

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Iron removal from groundwater by the simplified aeration method

Groundwater in many regions of the world, including Ukraine, contains elevated levels of iron compounds, which leads to an unpleasant metallic taste, clogging of pipelines and fittings, and may contribute to liver cell damage. Therefore, such water must undergo deferrization.

In the western region of Ukraine, water is supplied from underground sources containing ferrous iron Fe^{2+} primarily in the form of bicarbonate, which remains stable only in the presence of a significant amount of carbon dioxide and in the absence of oxygen [1].

The most widespread methods of deferrization are based on the oxidation of ferrous Fe^{2+} to ferric iron Fe^{3+}, forming poorly soluble ferric hydroxide, $Fe(OH)_3$, which precipitates. The deferrization of surface water typically requires reagent-based methods that disrupt the colloidal structure of some iron compounds [2], and groundwater is usually treated using reagent-free methods. The existing reagent-free deferrization technology based on simplified aeration [3] is the most cost-effective and relies on the ability of water containing Fe^{2+} and dissolved oxygen to release ferric hydroxide (III) onto the surface of granular filter media during filtration, due to the formation of a catalytic film. This film accelerates the oxidation of Fe^{2+} and its removal from the water.

The rate of Fe^{2+} oxidation is limited by the rate of oxygen diffusion into falling droplets. As the drop lets fall, oxygen oxidizes iron within a diffusion layer surrounding the droplet. Clearly, the ratio of the diffusion layer thickness to the droplet radius and the deferrization efficiency increases with smaller droplets. Depending on the height from which the droplets fall, there are two stages of Fe^{2+} oxidation:

- rapid oxidation, when droplets fall from a height of 4-5 m;
- slower oxidation, when falling at a further height of 5-20 m.

Simplified aeration is carried out in structures by flowing water from a height of up to 1 m into the filter basin or by bubbling water with air. The disadvantage of such facilities is their large size (due to the need for substantial volumes of granular media and low filtration rates), long construction time, and high cost. Therefore, in recent years, simplified aeration systems in the form of cylindrical units 4-6 m high have been successfully introduced, with tanks at the top from which water flows through perforated plates. The jets break into fragments, which then form droplets under the influence of surface tension.

This technology is used at the Pluhivskyi water intake facility to supply water to the city of Lviv. However, there are no available recommendations for calculating the diameter of the perforation holes in the sprayers or their installation height, nor for assessing the

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impact of the granular layer on the iron removal efficiency. Therefore, the aim of our work is to determine the optimal conditions for iron removal in the simplest treatment facilities.

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Green energy for sports – towards energy independence of sport facilities (case study of WOSiR Drzonków)

Introduction

The study presents the concept, development, and implementation of an integrated hybrid energy system aimed at achieving energy independence and zero emissions in the WOSiR Drzonków sports and recreation center (Poland). The project responds to the European „Fit for 55" package and Poland's energy policy goals by transforming a large public sports facility into a model of sustainable and climate-neutral energy management. The methodology combines energy audits, dynamic simulation of generation and consumption profiles, and multi-source energy system optimization using MATLAB and Python environments. Renewable technologies – photovoltaic systems, heat pumps, cogeneration (CHP), and hydrogen production – are integrated through a smart monitoring and control system (SCADA + Expert System) enabling real-time data analysis and automated decision-making based on cost, emission, and efficiency criteria. Implemented solutions include innovative heat storage tanks with electric heating elements allowing full utilization of photovoltaic overproduction, modernization of the heat and cooling infrastructure, and the introduction of hydrogen as a long-term energy storage medium.

Conclusions

The results demonstrate over 40% reduction of CO_2 emissions, substantial improvement in energy efficiency, and a significant increase in renewable energy self-consumption. The proposed hybrid system proves that full energy independence of sports and recreation facilities is technically feasible with current technologies. The integration of PV, CHP, heat pumps, and hydrogen storage ensures high reliability, operational flexibility, and low running costs. Moreover, the WOSiR Drzonków project establishes a replicable model for the sustainable transformation of public infrastructure, fully aligned with the European climate neutrality agenda.

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Impact of abiotic aging of tire microparticles on the environment

Microplastics (MPs) are a global environmental threat. Microplastics originating from vehicle tire wear (tire wear particles - TWPs) are a widespread example of microplastic pollution, accounting for a significant portion of total microplastic release worldwide. The main aim of this research was to investigate how abiotic factors (specifically UV irradiation) influence the migration of harmful substances from tire microparticles. The second goal was to assess the toxicity of the leachates and to examine changes in the surface structure and chemical composition of the microplastics. Microplastic samples in the form of shredded tires were subjected to abiotic (UV) aging in an accelerated aging test chamber. The samples were incubated for 1, 2, and 4 weeks in deionized water, deionized water with 2% NaCl, and surface water from Nowa Wieś Reservoir. The observed changes in pH and TOC confirmed the release of compounds from the tire matrix. Chromatographic analysis detected in leachates such substance as dibutyl phthalate, diethyl phthalate, CPPD-Q, IPPD-Q, DPP, 6PPD-Q, 2-ABTH, and DPG. Ecotoxicological tests with Daphnia magna and Lemna minor confirmed the toxicity of the leachates. Although no visible changes were observed on the surface of the microplastics, alterations in the intensities of some bands were noted in the FT-IR spectra.

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Properties of Humus compounds of soils developing on the reclaimed ash dump

Energy generation in coal-fired power plants is accompanied by the production of coal combustion byproducts, which can be both a resource and a disposal problem. Over 75% of combustion byproducts are fly ash, which is typically disposed of in landfills. Environmental protection requirements and regulations indicate that fly ash storage facilities should undergo remediation. A common practice in the reclamation of ash dumps is the direct introduction of vegetation cover. Fly ash does not contain organic matter to initiate soil-forming processes and the proper development of plant cover. Therefore, in the reclamation of fly ash landfills, an integrated approach is required, including the introduction of exogenous organic matter into the top layer of ash. This study assessed changes in the content and quality of organic matter in soils developing on a reclaimed fly ash landfill. This study included reclaimed areas without the introduction of EOM (RV_1—the direct introduction of plants) and with the introduction of EOM (RV_2—surface humus and RV_3—sewage sludge). The study results showed that the use of exogenous organic matter (EOM) in the reclamation of the ash dump significantly increased the content and improved the quality parameters of organic matter and thus influenced the initiation of the process of organic matter accumulation. In RV_1 soil, the accumulation of carbon resources was only found in the topsoil. An increase in carbon resources in the 15–40 cm layer was only noted in the variants in which EOM was introduced (RV_2 and RV_3). Carbon management indices showed that organic matter transformations covered only the top layers of these soils and were closely related to the EOM inflow. In the soil reclaimed with sewage sludge, the carbon management index (CMI) had a value above 100, which indicates the initiation of the soil-forming process. Significant differences between the assessed reclamation variants were confirmed by means of PCA based on organic matter quality indicators. The organic matter content and quality indicators were the most favorable in the soil of variant RV_3. The obtained results confirmed that the introduction of EOM into the top layer of fly ash has a beneficial effect on the accumulation and quality indicators of organic matter and thus on the development of the soil-forming process in Technosols developing on a reclaimed fly ash landfill.

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