WMCEES 2026

10TH WORLD MULTIDISCIPLINARY CONGRESS ON EARTH AND ENVIRONMENTAL SCIENCES

ABSTRACT BOOK

Czech Republic, Ostrava | 7-11 September 2026

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Preface

This volume presents the Abstract Collection of the 10th World Multidisciplinary Congress on Earth and Environmental Sciences (WMCEES 2026), bringing together abstracts from the oral and poster presentations delivered at the congress in Ostrava, Czech Republic, from 7 to 11 September 2026.

WMCEES 2026 continues the congress's tradition of fostering a multidisciplinary environment in which researchers, academics, professionals, and practitioners can share knowledge and explore new developments in Earth and Environmental Sciences and related disciplines. By connecting diverse fields and perspectives, the congress encourages discussion of contemporary challenges, innovative methods, practical solutions, and emerging directions in research and professional practice.

A central objective of WMCEES is to introduce new perspectives and promote best practices across a broad range of subjects, including atmospheric sciences; blasting and new technologies; climatology; crystallography; engineering geology; geodesy, photogrammetry, and cartography; geochemistry; geophysics and seismology; geology; geomorphology; geosciences; geotechnics; geothermal energy; glaciology; hydrogeology; informatics, geoinformatics, and remote sensing; medical geology; meteorology; mineralogy; mining and mineral processing; modelling and soft computing in Earth Sciences; natural hazards; natural resources; occupational health and safety; oceanography; oil, gas, and coal; physical geography; soil science; stratigraphy, sedimentology, and palaeontology; tectonics and structural geology; urban planning; water resources; agronomy; biodiversity conservation; biogeosciences; ecology; energy, resources, pollution, and the environment; environmental engineering; environmental legislation; forestry; geography; geological heritage and geoparks; green and sustainable science and technology; limnology; marine and freshwater biology; public, environmental, and occupational health; zoology; and urban sociology.

Beyond presenting research findings, WMCEES serves as an international forum for exchanging ideas, experience, and expertise. The congress offers opportunities to establish new professional and scientific connections, strengthen existing collaborations, and encourage dialogue across disciplinary and national boundaries. Particular emphasis is placed on supporting early-career researchers by enabling them to present their work, receive valuable feedback, and engage directly with experienced researchers and professionals from around the world.

We sincerely appreciate the international scientific community's continued interest in WMCEES and thank all authors, presenters, reviewers, session chairs, partners, and participants whose contributions make the congress possible. The diversity of institutions, countries, disciplines, and research perspectives represented at WMCEES 2026 demonstrates the value of multidisciplinary cooperation in addressing the increasingly complex challenges facing the Earth, its resources, and the environment.

We hope that this Abstract Collection provides a valuable overview of the research presented at this year's congress and serves as a source of inspiration for further scientific discussion and collaboration. We also wish all participants an enjoyable and productive stay in Ostrava, together with the opportunity to experience the city's distinctive combination of industrial heritage, culture, and continuing transformation.

We look forward to welcoming you to the next World Multidisciplinary Congress on Earth and Environmental Sciences (WMCEES 2027), scheduled to take place in Ostrava, Czech Republic, from 6 to 10 September 2027. The next edition will continue the congress's tradition of bringing together the international scientific and professional community.

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ANALYSIS OF FLUE DUST FROM HOT-DIP GALVANIZATION

Slavomír Hredzák [1], Marek Matik [1], Lenka Findoráková [1], Anton Zubrik [1], Ingrid Znamenáčková [1], Silvia Dolinská [1], Viktória Kožárová [1]

[1] Institute of Geotechnics of the Slovak Academy of Sciences, Watsonova 45, 040 01 Košice, Slovakia

ABSTRACT

The corrosion of metals is a spontaneous physicochemical process in which metals gradually deteriorate due to their reaction with the surrounding environment. The result is metal degradation and a change in its mechanical and physical properties. The corrosion causes loss on the level of 3% of GDP (gross domestic product) in the EU every year. It is estimated that indirect costs can attain up to 6% of GDP.

So, the zincing (or zinc galvanizing) is one of the most common and effective methods used worldwide to protect steel and iron against rust and corrosion. Then, regarding zinc, more than 50% of zinc world production is consumed in the galvanizing process.

In Slovakia, there are approximately 40 active galvanizing plants in total, ranging from large-scale facilities to small workshop-scale companies. The large-scale sector consists primarily of hot-dip galvanizing plants, represented by approximately 10 companies operating 13 production facilities, 2 companies galvanize only their own products. The remaining about 30 companies perform electro-galvanizing.

The subject of the research was two samples of flue dust, considered hazardous waste, which, alongside bottom dross, salmiac skimmings, zinc ash, spent degreasing bath, spent pickling bath, and spent fluxes, belong among the main wastes from hot-dip galvanizing.

The both dried samples of flue dust were subjected to XRF, ICP-MS, CHNS-analysis, and XRD. So as to major elements the samples 1 and 2 contain mainly 34.88% and 35.79% Cl, 24.91% and 25.38% Zn, 10.35% and 10.78% N, respectively, followed by 3.56% and 4.02% H, 2.79% and 2.68% Mg, 2.42% and 1.59% of C, 0.90% and 1.03% Al, 0.45% and 0.40% of Fe, 0.10% and 0.33% of S, 0.16% and 0.10 % Ca, 0.16% and 0.06% Si, 0.05% and 0.05 % Mn, respectively. Minor elements in samples 1and 2 are represented by 110 ppm and 73 ppm Cu, 110.4 ppm and 49.6 ppm As, 74.7 ppm and 80.3 ppm Bi, 16.3 ppm and 26.1 ppm Ni, and 1.5 ppm and 1.22 ppm Cd, respectively.

The results of the X-ray diffraction analysis can be summarized as follows: in both samples 1 and 2, unnamed minerals, i.e. orthorhombic Ammonium Zinc Chlorides, specifically $(NH_4)_2ZnCl_4$ and $(NH_4)_3ZnCl_5$, respectively, were identified as the dominant phases. As accompanying phases in samples 1 and 2, two variants of an unnamed orthorhombic compound Zinc Ammine Chloride $(NH_3)_2ZnCl_2$ were identified, which differ slightly in their unit cell dimensions, as well as in the position and intensity of their peaks in the diffractogram. All these substantially represented phases, both dominant and accompanying, overlap the peaks of other minor phases that may be present in these samples, e.g. unnamed minerals $NH_3(OH)Cl$ and γ-$ZnCl_2$, followed by simonkolleite $Zn_5(OH)_8Cl_2{\cdot}H_2O$, salammoniac NH_4Cl, zincite ZnO, franklinite $ZnFe_2O_4$, etc.

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Corresponding Author: Slavomír Hredzák

ANALYSIS OF THE INFLUENCE OF SOIL CONDITIONS ON THE DYNAMIC CHARACTERISTICS OF A SELECTED BUILDING STRUCTURE

Mateusz Molenda [1], Alicja Kowalska-Koczwara [1]

[1] Cracow University of Technology, 24 Warszawska Street, 31-155 Kraków, Poland

ABSTRACT

The supporting soil is one of the key factors affecting the behavior of building structures. The mechanical properties of soil can significantly modify the dynamic characteristics of a structure, in particular its natural frequencies and the corresponding mode shapes. This phenomenon is related to soil–structure interaction, which influences the support conditions of the structural system and the manner in which loads are transferred between the foundation and the soil medium.

The aim of this study is to analyze the influence of selected soil conditions on the dynamic characteristics of a selected building structure. In particular, the effect of subsoil parameters on the values of natural frequencies and the mode shapes of the analyzed structure is examined. The study was carried out using a numerical model developed in Autodesk Robot Structural Analysis, which made it possible to represent different foundation conditions.

Three variants of soil models were considered in the analysis, differing in their mechanical properties and in the way the interaction between the structure and the soil was represented. For each analyzed case, the basic dynamic characteristics of the structure were determined in the form of natural frequencies and the corresponding mode shapes. A comparison of the obtained results made it possible to assess the influence of soil parameters on changes in the dynamic characteristics of the considered structural system.

The obtained results indicate that soil conditions can affect both the values of the natural frequencies of the structure and the character of its mode shapes. Changes in soil parameters lead to modifications in the structural support conditions, which directly translate into its dynamic properties. Therefore, the proper consideration of soil conditions in the computational model is an important element of structural analysis in the context of evaluating the response of the structure to a given dynamic excitation.

The presented results may provide a basis for further studies on the influence of soil–structure interaction on the dynamic properties of building structures, as well as for more advanced dynamic analyses that take into account the foundation conditions of structures founded on non-homogeneous soils.

Corresponding author: Alicja Kowalska-Koczwara

APPLICATION OF PROBABILISTIC-BASED WEIGHTS IN PRECISE LEVELLING ADJUSTMENTS

Vasil Cvetkov [1]

[1] University of Architecture, Civil Engineering and Geodesy, Sofia 1046, Bulgaria

ABSTRACT

The selection of observation weights plays a critical role in the reliability of geodetic network adjustment, particularly when the true measurement accuracy is unknown. In such situations, weights are commonly assigned based on assumed accuracy-related factors. In precise levelling, uncertainty is typically modeled as a function of distance, resulting in weights inversely proportional to levelling length; however, this assumption may not be optimal. This study investigates an alternative weighting strategy by adjusting the Third Levelling of Bulgaria (1975–1984) using probabilistically derived weights based on the Pearson distribution system. An iterative reweighting procedure was implemented, whereby the weights of line height differences were updated according to the magnitude of height corrections obtained in the preceding iteration. A total of 100 iterations were performed to assess the behavior of the reweighting process. The results exhibit a repetitive pattern, indicating a lack of convergence. Nevertheless, stable and nearly identical solutions were identified at the 10th, 39th, and 72nd iterations. These iterations were selected as they yielded minimal sums of adjusted benchmark standard errors, while the differences in adjusted benchmark heights relative to the preceding iterations remained below 0.02 mm. A comparison between the classical adjustment and the probabilistic approach at the tenth iteration demonstrates a substantial improvement in accuracy. The mean benchmark standard error decreased from 13.65 mm to 9.65 mm, with consistently lower standard errors observed for all benchmarks under the probabilistic scheme. Statistical testing using t-tests confirms that this improvement is significant at a confidence level exceeding 99%. Additionally, the classical adjustment produced systematically higher adjusted heights for 31 out of 32 benchmarks, with differences ranging from −6.8 mm to 21.4 mm. These findings indicate that probabilistically derived weights offer a more reliable alternative to conventional distance-based weighting in precise levelling adjustments.

Corresponding Author: Vasil Cvetkov

ASSESSMENT OF SLAM-BASED HANDHELD MOBILE LIDAR SCANNING FOR TILT DETERMINATION OF CIRCULAR-SECTION STRUCTURES: A CASE STUDY

Emiliya Ilieva [1], Antonio Angelov [1]

[1] Department “Applied Geodesy”, University of Architecture, Civil Engineering and Geodesy (UACEG), 1 H. Smirnenski Blvd., Sofia 1046, Bulgaria

ABSTRACT

This study presents a comparative assessment of two geodetic approaches for determining the tilt deformation of engineering structures with a circular cross-section, including pylons, chimneys, towers, tanks, etc. The investigated object is a freestanding metal advertising pylon with a height of 9.5 m and a smooth cylindrical surface.

In geodetic observations, a classical approach with angle-length measurements was applied as a reference method, along selected cross-sections and by using an alignment circle to derive the center and radius of these sections, as well as the spatial position of the structural axis and its deviation from the vertical.

In parallel, the structure was surveyed using a SLAM-based handheld mobile LiDAR system (FJD Trion P1). Two independent mobile laser scanning surveys were performed and processed separately to evaluate the repeatability of the method. The tilt deviations determined from the point clouds were compared with the corresponding results obtained from the classical geodetic measurements. The comparison showed differences of 0.6–0.9 cm in the determined tilt magnitude, demonstrating a high level of agreement between the two approaches.

The obtained results indicate that SLAM-based handheld mobile LiDAR scanning can provide reliable tilt estimates for the investigated circular-section structure and shows potential for application to similar structures with smooth continuous surfaces.

Corresponding Author: Emiliya Ilieva

A TOPO-BATHYMETRIC DATA INTEGRATION APPROACH TO STUDY THE DYNAMICS IN THE DANUBE DELTA

Iordache Gabriel [1], Duțu Laura [1], Duțu Florin [1], Dragoș Andrei Gabriel [1,2]

[1] National Research and Development Institute for Marine Geology and Geoecology, GeoEcoMar, Romania; 23-25 Dimitrie Onciul Street 024053, Bucharest, Romania;
[2] Doctoral School of Geology Faculty of Geology and Geophysics, University of Bucharest, Romania

ABSTRACT

The accurate acquisition of topographic data at the land-water interface is a fundamental stage in bridging the gap between terrestrial and hydrographic datasets. In the complex fluvial environment of the Danube Delta, achieving a unitary representation of the riverine relief is challenged by dynamic morphological features and significant water level fluctuations. This study presents a robust methodological framework for the seamless integration of high-precision GNSS terrestrial measurements with bathymetric data to generate continuous topo-bathymetric cross-sections. The terrestrial component involved surveying the riverbanks and the immediate shoreline interface using professional-grade GNSS technology. Trimble geodetic receivers (R980, R12, and R4 models) were utilized in Real-Time Kinematic (RTK) mode, connected to the ROMPOS Romanian Permanent Stations Network. This setup ensured high-accuracy coordinates, directly referenced to the national geodetic systems. To guarantee data integrity, a rigorous observation protocol was implemented, consisting of triple measurement sessions for each point, with extended sampling in areas of suboptimal satellite geometry. Furthermore, systematic validation was performed by surveying established benchmarks from the National Geodetic Network and the Lower Danube River Administration (AFDJ), with results consistently falling within the admitted tolerances for both horizontal and vertical positioning. Concurrently, bathymetric measurements were carried out using a vessel-mounted echosounder to determine water depths along predefined profiles, as well as an ADCP system that performs high-accuracy 3D measurements of velocities and discharges using the Doppler effect. The critical phase of this research involves harmonizing these distinct datasets. Measured depths were converted into topographic elevations by referencing them to the land-water interface elevation captured during the GPS survey. This transformation facilitates the unification of submerged riverbed data with emergent bank topography into a single, coherent coordinate system (STEREO '70 and the Black Sea 1975 Vertical Datum). The resulting integrated topo-bathymetric profiles provide a comprehensive and high-resolution visualization of the Danube's cross-sectional morphology. This integrated geospatial approach not only ensures a coherent and continuous representation of the land–water interface, but also significantly enhances the understanding of complex fluvial processes. By accurately correlating topographic and bathymetric data, it enables a detailed analysis of riverbed morphological evolution and the interactions between flow dynamics, sediment transport, and terrain configuration. Furthermore, the resulting digital models provide essential support for hydrodynamic simulations and informed decision-making in water resource management. Consequently, the proposed methodology becomes a valuable tool for applied research and for implementing effective strategies aimed at the conservation and sustainable management of ecosystems within the Danube Delta.

Corresponding Author: Iordache Gabriel

A TUNNEL SEISMIC ADVANCE PREDICTION SYSTEM BASED ON WIRELESS ACQUISITION

Hao Luo [1,2,3], Yao Wang [4], Jian Zeng [5], Zhi Li [4], Kairun Wang [4], Wu Yanqing [1,2]

[1] School of Resources and Safety Engineering, Chongqing University, Chongqing ,China
[2] State Key Laboratory of Coal Mine Disaster Dynamics and Control, Chongqing University, Chongqing , China
[3] Sichuan Jintong Engineering Test and Inspection Co., Ltd., Chengdu, China
[4] School of Integrated Circuits, Chongqing University of Posts and Telecommunications, Chongqing, China
[5] Yunnan Aerospace Engineering Geophysical Detecting Co., Ltd., Kunming, China

ABSTRACT

Conventional tunnel seismic advance prediction systems are often hindered by cumbersome cabling, limited deployment flexibility, inadequate synchronization accuracy in multi-node acquisition, and spatially ambiguous imaging under small-aperture conditions. To overcome these limitations, a wireless-synchronized tunnel seismic advance prediction system integrating three-dimensional Fresnel volume migration imaging is proposed. The system comprises a master unit, a slave units, and a trigger module, and implements distributed synchronized acquisition via a wireless ad hoc network. A high-precision timing module provides time stamps and PPS pulses to dynamically discipline the sampling clocks in real time, thereby effectively mitigating record-time drift induced by clock-source discrepancies. For imaging, a 3D Fresnel volume migration approach is introduced, in which polarization analysis of three-component data is used to estimate the incidence direction of reflected waves, and migration energy is confined to the intersection of the equal-travel-time surface and the first Fresnel volume, thus reducing spatial smearing and enhancing anomaly localization. Field validation in a tunnel in western China demonstrates that the proposed system enables stable wireless synchronized acquisition and robust identification of a fractured zone ahead of the tunnel face, with predictions in good agreement with subsequent excavation results. These findings indicate that the proposed method offers high synchronization precision, flexible deployment, efficient data transmission, and improved 3D imaging resolution, providing a reliable tool for tunnel advance prediction in complex geological settings.

Corresponding Author: Wu Yanqing

BIOREMEDIATION ROLES AND CARBON SEQUESTRATION EFFECTS OF SEEWEEDS IN COASTAL WATERS

Yufeng Yang [1]

[1] Southern Marine Science and Engineering Guangdong Laboratory (Zhuhai), China

ABSTRACT

Seaweeds are significant primary producers and play crucial roles in marine ecosystems. They provide habitats and shelter grounds for marine organisms, thereby supporting and conserving the biodiversity in marine ecosystems. China is the largest seaweed producer, with an impressive share of over 50 % of the production of the global seaweed cultivation. The country is endowed with extremely abundant wild seaweed resources. The recent results show that cultivated seaweed such as *Gracilaria* and wild *Sargassum* bed can improve DO, pH, decrease N, P concentrations and then purify water quality and improve coastal environment. The growth and decay of seaweeds significantly influence C cycle. Seaweed cultivation in China has led to a significant reduction in CO_2 emission by 35.49–72.93 Tg from 2003 to 2021, through the sequestration of recalcitrant dissolved organic carbon （RDOC） and the accumulation of sedimentary organic carbon, accounting for 17.43–35.72 % of the initially photosynthetically fixed carbon by seaweeds. In *Sargassum* bed, the seaweed decomposition increased the sources and molecular species of organic matter in the adjacent sediments and stimulated microbial decomposition of organic matter. *Sargassum* decay enhances RDOC accumulation and sedimentary carbon sequestration. Our findings demonstrated that the supplementation with 2% *G. lemaneiformis* to cattle feed effectively reduces CH_4 emissions by 27.5% ($p < 0.05$). Large-scale seaweed cultivation and wild seaweed bed enhancement is very effective approach for developing low-carbon economy, increasing marine C sequestration, solving marine environmental problems and maintaining coastal ecology safety.

Corresponding Author: Yufeng Yang

CALCITE–DOLOMITE GEOTHERMOMETRY OF THE PORTORO FORMATION (NORTHERN APENNINES, ITALY): CONSTRAINTS ON METAMORPHIC GRADE

Marco Lezzerini [1], Tiziana Ciomei [1], Marco Tamponi [1]

[1] Department of Earth Sciences, University of Pisa, Via S. Maria 53, 56126 Pisa, Italy

ABSTRACT

Portoro is a highly prized ornamental limestone characterized by a black carbonate matrix crossed by distinctive golden-yellow or silver dolomite veins. It is quarried mainly in the western sector of the Gulf of La Spezia, Northern Apennines. This study provides a quantitative estimate of the metamorphic temperatures recorded by the Portoro Formation through calcite–dolomite geothermometry. Calcite and dolomite grains in direct or close microstructural contact were analysed by scanning electron microscopy coupled with energy-dispersive X-ray spectroscopy in samples representative of the four principal commercial varieties: Scalino, Banco, Sottobanco, and Silver. The $MgCO_3$ contents of calcite coexisting with dolomite were used to calculate apparent equilibrium temperatures according to the calibration of Anovitz and Essene. The 60 analysed calcite–dolomite pairs yielded temperatures predominantly between 250 and 300 °C, with a mean value of 260 ± 48 °C. The dispersion of the results is interpreted as reflecting variable degrees of local equilibration, recrystallization, compositional resetting, and fluid-mediated re-equilibration in the naturally deformed carbonate rocks. For comparison, calibrated Kübler-index data from the metapelitic Grotta Arpaia Layers immediately underlying the Portoro Formation indicate upper anchizonal conditions close to the anchizone–epizone transition. These phyllosilicate data are compatible with, but independent from, the temperature estimates obtained directly from the Portoro carbonate assemblages. The geothermometric results indicate an advanced very-low-grade to incipient low-grade regional metamorphic overprint. These thermal conditions promoted recrystallization of the carbonate matrix and partial reorganization of the dolomite veins while preserving carbonaceous matter and elements of the original sedimentary fabric. The results provide new quantitative constraints on the thermal evolution of the Portoro Formation and contribute to explaining its distinctive petrographic characteristics.

Corresponding Author: Marco Lezzerini

CHLORINE DECAY KINETICS IN SURFACE WATERS OF ANGOLA

Ramiro Martins

[1] Technology and Management School, Bragança Polytechnic Institute, 5300-253, Bragança, Portugal

ABSTRACT

Chlorine is the most common disinfectant used in drinking water treatment. During chlorination, chlorine reacts with organic matter present in water and is consumed over time. Knowing how fast this decay occurs is important for designing contact tanks and selecting the right chlorine dose.

This study investigated chlorine decay in raw water from the Bengo River, Angola, collected at the intake of the Kifangondo Water Treatment Plant. Experiments were carried out at 25 °C using the bottle test method. The initial chlorine concentration was varied between 0.65 and 4.7 mg Cl_2 L^{-1}, while the organic matter concentration was kept constant at an oxidability of 4.6 mg O_2 L^{-1} (pH 7.5–7.6). Residual chlorine was measured at fixed time intervals over 20 minutes.

Four kinetic models were tested: first-order (P1), pseudo second-order (P2), limited first-order (PL), and parallel first-order (PP). The models were fitted to the experimental data using non-linear optimisation. The quality of each fit was evaluated using the coefficient of determination (R^2), the estimated variance (S^2), and the F-test at a 95% confidence level.

Chlorine decay was fast in the first few minutes and slowed down afterwards, stabilising at approximately 20 minutes. The fraction consumed within this period ranged from 60% for the highest initial concentration to 97% for the lowest. The first-order model gave a poor fit for higher concentrations (R^2 = 0.72–0.74). The pseudo second-order model performed better at lower doses. The limited first-order model gave a good fit across all conditions (R^2 = 0.975–0.997). The parallel first-order model gave the best overall fit (R^2 = 0.985–0.999) and was statistically superior to the other models at C_0 = 4.7 mg Cl_2 L^{-1}. A practical example of contact tank sizing was also presented using the pseudo second-order model for the Kifangondo Water Treatment Plant.

Corresponding Author: Ramiro Martins

CLIMATE CHANGE RESHAPES VINEYARD DISEASE–PEST PRESSURE AND GRAPE YIELD LOSSES IN ROMANIA

Cecilia Șerban [1], Carmelia Mariana Bălănică Dragomir [1], Mirela Crețu [1]

[1] Dunărea de Jos" University of Galați, Domnească Street, no. 47, 800008, Galați, Romania

ABSTRACT

Climate change is increasingly constraining Romanian viticulture by intensifying biotic stress and destabilizing grape yields. Across Europe, rising temperatures, altered precipitation seasonality, and more frequent extremes are reshaping grapevine–pest–pathogen interactions: downy and powdery mildews remain dominant phytosanitary threats, while chronic decline syndromes linked to grapevine trunk diseases and the spread of invasive organisms expand risk profiles and management costs. In Romania, producer reports and surveillance outputs consistently highlight recurrent pressure from *Plasmopara viticola* (downy mildew), *Erysiphe* (*Uncinula*) *necator* (powdery mildew), *Botrytis cinerea* (bunch rot), *Pseudopeziza* spp., and key pests including *Lobesia botrana* and eriophyid mites (*Eriophyes*/*Colomerus* spp.), with implications for yield stability and intervention intensity.

Here we propose a reproducible, country-level framework for Romania (2015–2025) that integrates three open-data pillars: (i) official crop statistics for grape production and yield (INSSE/TEMPO and harmonized EU reporting), (ii) publicly posted phytosanitary warning bulletins as an operational proxy for disease–pest pressure, and (iii) reanalysis-based climate descriptors suitable for viticulture risk assessment. A national Warning-Bulletin Pressure Index (WBPI) is constructed by systematically collecting, filtering to vineyard-relevant advisories, removing duplicates, and aggregating annual counts by territory; where possible, WBPI is also normalized to account for reporting effort (e.g., bulletins per issuing unit/year) and tested for sensitivity to changes in bulletin volume. Climate covariates are derived from ERA5-Land/ERA5 products using standardized growing-season indicators aligned with vine phenology (e.g., heat accumulation, hot-day frequency, and precipitation regime metrics including seasonal totals and dry-spell structure), spatially aggregated to the territorial scale used in statistical reporting.

We outline an attribution strategy that links interannual production and yield anomalies to climate and WBPI signals using trend–cycle decomposition and regression models with lagged sensitivity windows, emphasizing interpretability for risk management rather than purely predictive skill. As an empirical anchor, official series indicate that Romania reached approximately 1,069 kt of grapes for wine in 2018 and declined to ~668 kt by 2024 (≈37.5% contraction), underscoring the magnitude of recent volatility and motivating integrated climate-biotic assessments. The resulting pipeline supports rapid annual updates as new statistics and bulletins become available and provides actionable evidence for adaptation planning (cultivar/clone choice, canopy and irrigation strategy, forecast-informed spray timing, and integrated pest management), while explicitly recognizing that warning bulletins capture both biological pressure and surveillance/reporting intensity.

Corresponding Author: Cecilia Șerban

CO_2 EMISSION INTENSITY, GHG DYNAMICS BY ECONOMIC SECTORS AND THE IMPACT OF NATURAL DISASTERS ON POPULATION HEALTH IN ROMANIA

Carmelia Mariana Bălănică Dragomır [1], Cecilia Șerban [1], Mirela Crețu [1], Marian Tiberiu Coadă [1], Alina Mihaela Ceoromıla [1], Maricica Stoıca [1]

[1] "Dunărea de Jos" University of Galați, Domnească Street, no. 47, Galați, 800008, Romania

ABSTRACT

Climate change and the risks associated with natural disasters exert simultaneous pressures on the economy and public health. This study leverages the statistical series of the National Institute of Statistics for Romania, analyzing three dimensions: (i) CO_2 emission intensity relative to value added, (ii) greenhouse gas (GHG) emissions by economic sectors, and (iii) public health outcomes expressed as the number of deaths and injuries attributed to natural disasters.

Overall, the intensity of CO_2 emissions decreased from 0.12 thousand tons CO_2 equivalent / million lei in 2008 to 0.06 in 2023 (a halving of the intensity) — suggesting efficiency gains and/or structural changes in the economy. In parallel, total GHG emissions decreased from 136,004.23 thousand tons CO_2 equivalent (2008) to 82,745.26 thousand tons CO_2 equivalent (2023), which corresponds to a reduction of ~39%. In 2023, the largest sectoral contributions came from Agriculture, forestry and fishing (20,003.03), Manufacturing (18,465.06) and Production and supply of electricity, heat, gas, hot water and air conditioning (16,395.37 thousand tons CO_2 equivalent); Cumulatively, these three sectors accounted for approximately 66% of total emissions in the economy. In terms of health impact, the indicator of deaths and injuries attributed to natural disasters per 100,000 inhabitants remained at very low levels, with higher point values in 2012 (0.08) and 2018 (0.067), respectively 0.052 in 2024; these values indicate a relatively low but persistent burden, potentially influenced by the frequency and severity of natural phenomena and the institutional response capacity. Methodologically, the study combines trend analysis (2008–2024), assessment of sectoral contributions and descriptive correlation between performance in reducing the intensity/volume of emissions and the consequences on public health. The results motivate the strengthening of sector-targeted decarbonization policies, together with investments in adaptation and disaster risk management, to mitigate human and economic losses in a changing climate context.

Corresponding Author: Carmelia Mariana Bălănică Dragomır

COMPARISON OF A SEMI-PHYSICAL MODEL AND AN ARTIFICIAL NEURAL NETWORK FOR SIMULATING GROUNDWATER LEVELS, IN A KARST AQUIFER IN SOUTHERN FRANCE

Sayane Jouanneau-Couvret [1, 2], Anne Johannet [2], Sébastien Morilhat [1], Jose-Manuel Tunqui Neira [2], Séverin Pistre [3]

[1] CEA, DES, IRESNE, Nuclear Technology Department, Cadarache, F-13108, Saint Paul les Durance, France
[2] HSM, Univ. Montpellier, IMT Mines Ales, CNRS, IRD.Ales, France
[3] HSM, Univ. Montpellier, CNRS, IMT, IRD - 163 rue Auguste Broussonnet, 34090 Montpellier, France

ABSTRACT

Because of their strongly heterogeneous permeability, karst aquifers exhibit nonlinear relations between their outputs (discharge or groundwater level) and inputs (rain, temperature, etc.). Three main types of models are commonly used to simulate karst aquifers: physical models, pipe-flow models and conceptual models. The Méthode d'Évaluation des Crues karstique (MECK) (K. Najib, 2007) was implemented to perform the simulation of Cadarache's (south of France) and fractured karst aquifer's level. It relies on a semi-physical model that conceptualizes the functioning of the aquifer, to simulate a piezometer considered as representative of the area. Even though it simulates a continuous daily time series, the model's optimization focuses on high levels for enhanced flood representation.

Although MECK shows good performances on high groundwater levels, it encounters difficulties under specific conditions. The model struggles to accurately reproduce level variations caused by close rainfall events, as well as variations occurring when water flows through zones with significantly different hydrogeological properties. Despite having a large number of parameters, this semi-physical model is not able to reproduce the complex phenomena that govern the response of a karst aquifer. Artificial Neural Networks, however, are able to learn the system's behavior directly from the data. The implementation of an Artificial Neural Network model would therefore allow for a better reproduction of groundwater levels than a semi-physical model. Most neural networks developed in the field of hydro(geo)logy are used to simulate discharge based on rain. Fewer studies focus on simulating groundwater levels, and among those, only a small subset specifically addresses karst aquifers.

The aim of this study is to compare the performance of MECK against a Neural Network in simulating past groundwater level of a fractured karst aquifer, with a particular emphasis on high levels related to flooding. Daily groundwater levels are simulated from 1960 to 2025, using meteorological data.

The data are pre-processed based on cross correlation analysis and stationarity tests. The neural network, here a MultiLayer Perceptron, is then developed focusing on the high levels of the groundwater. Its architecture is selected through a trial-and-error approach, and the hyperparameters are optimized by maximizing cross-validation metrics. Simulated groundwater levels of MECK and the developed Neural Network for one piezometer are finally compared using classical hydrological metrics (NSE, RMSE, etc.), both for the entire time series and for high levels. Threshold exceedance probabilities are also calculated and compared for measured and simulated groundwater levels.

Results show that the Neural Network performs overall better than the semi-physical model. Whereas the levels simulated by the semi-physical model are mostly higher than the measured ones, the Artificial Neural Network shows good performances on both high and low levels but struggles to reproduce intermediate levels. The Neural Network requires further improvement to better reproduce intermediate levels, as these may be considered as floods depending on the selected threshold.

Corresponding Author: Anne Johannet

CONCENTRATION AND EXPORT OF DISSOLVED CARBON IN A STREAM THAT DRAINS AN AGROFORESTRY CATCHMENT: A FIRST APPROACH

M. Mercedes Taboada-Castro [1], M. Luz Rodríguez-Blanco [2], M. Teresa Taboada-Castro [3]

[1] ETSIIAA, Area of Soil Science and Soil Chemistry, University of Valladolid, 34004 Palencia, Spain
[2] Physical Geography Area, History, Art and Geography Department, GEAAT Group, University of Vigo, Campus As Lagoas, 36310 Ourense, Spain
[3] Faculty of Sciences, University of A Coruña, 15071 A Coruña, Spain

ABSTRACT

Riverine carbon transport is a significant, yet poorly understood, component of the global carbon cycle. In this study, we explored the concentration of dissolved carbon (TDC), organic (DOC) and inorganic (DIC) in an Atlantic headwater catchment located in the NW Spain. Monthly to biweekly (mostly) water sampling and discharge measurements were conducted at the catchment outlet over two consecutive years. Stream data were mostly acquired under base flow conditions and only occasionally during hydrological events. We found that TDC showed a flow-weighted mean concentration of 4.94 mg L^{-1} (range 2.77 – 10.19 mg L^{-1}) dominated by the inorganic fraction which accounted for 63% of the total, while DOC contributed the remaining 37%, highlighting the predominance of the inorganic fraction within the stream. The notable variability of TDC concentration appears to be strongly influenced by DOC dynamics (flow-weighted mean 1.82 mg L^{-1}), whose range (0.87 – 6.77 mg L^{-1}) was much broader than that of DIC (1.90 – 4.47 mg L^{-1}). The interannual distribution of DIC and DOC concentrations, analyzed through boxplots, showed a greater fluctuation in the usual baseline concentrations (baseflow) of both fractions in the second year, registering only a higher outlier in DOC. In contrast, the first year exhibited greater stability in the baseflow hydrochemical regime for both DIC and DOC. However, DOC showed several higher row outliers that reflect the influence of rainfall runoff episodes and seasonality processes on the input of DOC (mostly allochthonous sources) into the stream. The DIC recorded a single lower outlier conditioned by hydrological dilution processes. During the overall study period, the daily mean TDC load was 93.18 kg d^{-1}, equivalent to a specific export of 5.82 kg km^{-2} d^{-1}.

Corresponding Author: M. Teresa Taboada-Castro

CONCEPTUAL HYDROLOGIC DESIGN OF ADAPTATION MEASURES IN THE CITY OF TRNAVA

Marek Sokáč [1], Yvetta Velísková [1], Márta Koczka Bara [1], Natália Gašparíková [1]

[1] Institute of Hydrology, Slovak Academy of Sciences, Dúbravská cesta 9, Bratislava, Slovakia

ABSTRACT

Climate change has been shown to necessitate adaptation measures in urban drainage systems. The increased intensity of rainfall necessitates greater hydraulic and storage capacity in such systems, thereby enabling more effective management of increased stormwater flows and volumes.

In the absence of amendments to the prevailing concept of urban drainage in the Slovak Republic, the probability of flooding in urban areas due to increased rainfall intensity will remain high. This is because the current sewerage network cannot accommodate the increased demand. Moreover, climate change will result in increased pollution being transported from sewerage networks to surface waters (receiving waters) due to more frequent hydraulic overflows through combined sewer overflow structures. Furthermore, the larger volumes of such water will reach the receiving waters directly without any treatment.

The present paper analyses the design of various adaptation measures for an urban catchment of the city of Trnava, with a focus on the legislative, hydraulic, and environmental aspects of urban stormwater management. The estimated required range and composition of adaptation measures, along with their effects on overall urban stormwater management, are described in terms of achieving the required goals. The results show that blue-green measures (such as blue-green infrastructure) alone cannot eliminate all the negative impacts of climate change.

The findings indicate that, to the greatest extent possible, implementing blue-green infrastructure does not ensure the attainment of the objectives outlined in the recently adopted EU Directive 3019/2024. The analysis presented in the paper demonstrates that the extensive combined approach (blue-green and grey infrastructure, including stormwater tanks) is the only strategy capable of ensuring the requisite 2% of the annual pollution load is addressed, with the pollutants being conveyed directly to surface water through the CSO.

A further significant issue is the technical versus financial effectiveness of the implemented measures, that is, determining the optimal solution to achieve the required parameters. It is likely to be a combination of green and grey infrastructure, with the proportions and extent of each type determining the total costs (investment plus maintenance). Nevertheless, it is assumed that such an optimal solution will be highly case-specific and must be determined for each individual case.

Corresponding Author: Natalia Gašparíková

CREEP EQUATIONS IN UNIAXIAL TENSION OR COMPRESSION: AN OVERWIEW

Victor Rizov [1]

[1] Department of Technical Mechanics, University of Architecture, Civil Engineering and Geodesy, 1 Chr. Smirnensky blvd., 1046 – Sofia, Bulgaria

ABSTRACT

It is known that in practice the mechanical behavior of engineering materials in many situations is characterized by creep. In essence, this type of behavior represents an increase in strain over time under constant external loading. Time-dependent deformation of structures and structures is also observed with increasing temperature. The creep processes have a great influence on the performance of engineering structures and facilities. These processes are of essential importance for reliability and safety. Creep has also a huge effect on structural durability. It is clear that taking into account creep is a necessary condition for obtaining realistic results when analyzing the performance of structures and facilities if they are loaded for a long period of time. The processes of creep in various materials are characterized by great diversity. This is the reason for the development of a large number of theoretical models for describing creep and for analyzing structures in the presence of creep. The key element in this analysis is the creep equation. The latter represents the relationship between stress, strain and time parameter usually under uniaxial tension or compression. The creep equations are divided into two large groups, namely linear and nonlinear. In this review paper, the basic linear creep equations are first reviewed. The corresponding linear rheological models are presented. More attention is paid to nonlinear creep equations. In these cases, the dependence between stress, strain and time is nonlinear. To describe this dependence, more general equations than those provided by linear creep models are used. Equations of stress relaxation are presented too. Both linear and nonlinear relaxation models are considered. This review paper can be used by engineers and researchers in the analysis of viscoelastic structures and facilitates.

Corresponding Author: Victor Rizov

DETERIORATION OF THE ENVIRONMENT BY WATER AND SOIL POLLUTION

Viera Kováčová [1]

[1] Institute of Hydrology Slovak Academy of Sciences, v.v.i., Dúbravslá cesta 9, 841 01 Bratislava, Slovakia

ABSTRACT

This study has focused Danube Lowland, a region that is vulnerable to long duration droughts that have substantial impacts on groundwater resources, and which is facing increasing pressures on water management. Surface water resources dependent on very irregular rains become increasingly limited, because of climate change resulting in decreasing precipitations, rising temperature and consequently higher evaporation. The pollution of the environment is spreading throughout the world due to the global industrial and agricultural progress. Due to the increase in pollution, rapid urbanization, industrialization and agriculture the essential elements of life such as air, water and land are constantly getting contaminated.

Especially the presence of total nitrogen and total phosphorus, as well as the presence of heavy metals, leads to a deterioration in the status of surface waters. Nutrient ions (N, P) lead to undesirable overgrowth of the canal network of the Danube Lowland and heavy metals threaten humans, animals and plants. Generally, the physical and chemical evaluation parameters were used to assess water deterioration, mainly temperature, pH, nutrient concentration (N and P), algal chlorophyll-a, conductivity, total dissolved soils, water transparency and dissolved oxygen. We used total parameters status index (TPSI) to assess the status of surface water. During the years 2010 – 2025 the surface water quality on the Danube Lowland (Slovakia) was evaluated. The calculation of total parameters status index on Danube Lowland showed value 0,35.

Corresponding Author: Viera Kováčová

DETERMINATION OF SATURATION DEGREE OF POROUS MEDIUM BY ULTRASOUND WAVES APLICATION

Radoslav Schügerl [1]

[1] Institute of Hydrology, Slovak Academy of Sciences, Dúbravská cesta 9, 841 04 Bratislava, Slovakia

ABSTRACT

Velocity of ultrasound waves through the porosity media is determine of physical-mechanical properties these medium. The presence and movement of water in porous media are determined porosity thereby medium, system of cracks and fractures. This is turn the basis of methods for determining the properties of the environment based on changes in velocity of the ultrasound (longitudinal) waves (v_p). Water content (varying degree of saturation) in rocks, these features significantly affects. The object of this article is to present specific results for the application of ultrasound wave transition through the porous medium and their change as a result of different water content in this environment, thus evaulate the impact of changes in water content – saturation – on the transition rate of ultrasound (longitudinal) waves in laboratory specimens. Measurement was practise on the sandstones from *Hubová – Ivachnová (Slovakia).* Velocity of propagation longitudinal – ultrasound waves oneself measure on the dry samples and then on the saturate samples after various time (after 15 minutes; 30 minutes; 1 hour; 2 hours; 4 hours and 24 hours). Exam was execution on the samples with cylinder form. Exams were accomplish in the laboratory, a savior that velocity of ultrasound waves is higger than in the in - situ conditions. Cause is various ruptures, cracks in the rocks, which are in the massif. On the other side, presence ground water in massif influence velocity of ultrasound waves. Velocity of ultrasound waves is higger in the saturation rocks than in the dry rocks. This fact be needed take into the account.

Corresponding Author: Radoslav Schügerl

DICLOFENAC REMOVAL WITH MORINGA OLEIFERA SHELL BIOSORBENT

Ramiro Martins [1], Agustina De Oliveira [2]

[1] Technology and Management School, Bragança Polytechnic Institute, 5300-253, Bragança, Portugal
[2] LSRE-LCM, Rua Dr. Roberto Frias s/n, 4200-465, Porto, Portugal

ABSTRACT

The presence of drugs in the environment has become a global issue as, even at very low concentrations, their excessive use could lead to a resistant gene, thus rendering the use of drugs ineffective. Wastewater treatment plants still lack the necessary technology to remove low concentrations of these pollutants and therefore, a series of removal methods capable of reducing the presence of drugs in the environment have been developed. This work is aimed at studying the biosorption process. Biosorption is an adsorption process that employs biodegradable materials as adsorbents. On this occasion, Moringa oleífera shells (MO) were chosen due to their coagulant, anti-microbial and nutritional properties in order to remove residues of Diclofenac (DCF) found in the water. Studies of the pH effect of the drug solution, a determination of the adsorbent surface charge as well as a process kinetic trial have been carried out so as to determine the likely action mechanism that controls the interactions between the adsorbate and adsorbent material. It has been discovered that the pH exerts a great influence on the removal percentage of DCF (88% at pH 2), the surface of the MO shells are positively charged for pH < 6 and negatively charged for the alkaline zone. In addition, the experimental results of the kinetic adsorption showed a better fit to the Pseudo-second order model (R^2 > 0.998), thus indicating that the mechanism of action controlling the interaction between DCF and MO could possibly be the chemisorption mechanism.

The adsorption capacity obtained was 0.37 mg g^{-1} for an initial concentration of 1 mg L^{-1} at pH 2. The removal increased with contact time and equilibrium was reached after about 90 min. FTIR analysis confirmed the presence of functional groups such as hydroxyl, carbonyl and aromatic groups, which are involved in the adsorption process. These results show that Moringa oleífera shells can be used as a low-cost and effective biosorbent for the removal of Diclofenac from water.

Corresponding Author: Ramiro Martins

EFFECT OF MUD ADDITIVES FORMULA ON RHEOLOGICAL PROPERTIES OF ECO-FRIENDLY WATER-BASED MUD USED IN FANG OILFIELD, THAILAND

Chanapol Charoentanaworakun [1], Patcharaphol Tokaw [2], Peangnapa Nakchuea [3], Rinrada Paleeta [4], Waritsara Ngammoh [5], Bhanubhong Silla [6]

[1] Department of Mining and Petroleum Engineering, Faculty of Engineering, Chiang Mai University, Chiang Mai District, Chiang Mai 50200, Thailand

ABSTRACT

Water-based mud (WBM) is a more environmentally friendly drilling fluid than oil-based mud (OBM), and is commonly used in underground oil and gas wells to avoid serious environmental consequences. However, the effective use of WBM requires the addition of mud additives to adjust its rheological properties to specific drilling conditions. This study aims to assess the impact of mud additive formulations on the key rheological properties of WBM utilized in the Fang oilfield, situated in the onshore northern region of Thailand. Initially, WBM was prepared by blending various concentrations of eco-friendly mud additives, such as Xanthan gum, CMC, and Dextrinized Starch, along with 3 wt% KCl to prevent clay swelling in shaly sand formations. Subsequently, different WBM formulas were tested using a FANN Model 50SL Rheometer to analyze essential rheological properties including plastic viscosity (μ_p) and yield point (τ_y) for the Bingham Plastic model, as well as flow consistency index (K) and flow behavior index (n) for the Power-law model. Furthermore, the mud filtrate loss of WBM samples was measured using a FANN Series 300 API Filter Press. The experimental results demonstrated that the WBM with an equivalent density of 10-ppg, which is composed of 20-lb/bbl (ppb) Bentonite, 40-ppb Barite, 0.25-ppb Xanthan gum, 0.50-ppb CMC, and 6-ppb starch, exhibited minimum mud filtrate loss of 7.6 mL after 30 minutes. Additionally, the plastic viscosity of this mud formula was 20-cP, and the yield point was 15.7-lb per 100 ft^2, both falling within the recommended range for KCl-polymer WBM. Consequently, the study's findings are anticipated to recommend an optimized formula of mud additives for WBM application in drilling operations within normal-pressured onshore reservoirs.

Corresponding Author: Chanapol Charoentanaworakun

EFFECT OF THE OPERATION OF AN ELECTRIC MOTOR ON THE LENGTHWISE FRACTURE IN THE ELEMENTS OF AN INHOMOGENEOUS MOUNT

Victor Rizov [1]

[1] Department of Technical Mechanics, University of Architecture, Civil Engineering and Geodesy, 1 Chr. Smirnensky blvd., 1046 – Sofia, Bulgaria

ABSTRACT

Technologies applied in modern geotechnics, as well as in mining, frequently use various mechanisms. These mechanisms are often driven by electric motors, which are usually mounted on different types of mounts. Therefore, the reliability and safe operation of mechanisms is directly dependent on the performance of the mounts. The motors generate dynamic loads of the mounts, for example, they cause forced vibrations. This shows that the study of the mechanical behavior and destruction of mounts when they perform forced vibrations is a topical problem. The application of continuously inhomogeneous structural materials of the functionally graded type in mounts under dynamic loading is one of the ways to increase their safety and improve their performance. This paper presents a study of the lengthwise fracture of a continuously inhomogeneous mount with an electric motor mounted on it. The mount represents a structure with two elements. The motor is on the horizontal element of the mount. The rotor of the motor rotates uniformly, which creates a centrifugal force of constant magnitude. The projection of this force in the direction of the mount vibrations varies according to a harmonic law, which causes forced harmonic vibrations. The horizontal element of the mount is cracked along the length. The main goal of the paper is to obtain a solution of the strain energy release rate (SERR) in mount undergoing forced vibrations. The obtained solution is verified using the method of the integral *J*. Results of a detailed analysis of the relationships between the lengthwise fracture of the horizontal element of the mount and the parameters of forced harmonic vibrations are presented. The established relationships are visualized with several graphs showing the change in the SERR when varying various parameters of the dynamic behavior of the mount. This article will contribute to improving the safety of mounts for electric motors.

Corresponding Author: Victor Rizov

ENVIRONMENTAL ANALYSIS BASED ON A GREEN CALIBRATION METHOD

Paweł Kościelniak [1]

[1] Jagiellonian University, Faculty of Chemistry, Gronostajowa 2, 30-387 Krakow, Poland

ABSTRACT

Analytical chemistry plays a key role in ecology and environmental protection by providing tools for identifying, quantifying, and monitoring substances in ecosystems. Its application enables the assessment of environmental conditions and the implementation of corrective measures. Environmental analysis should meet specific requirements: be accurate, fast, and environmentally friendly in itself. Analytical equipment often needs to be adapted to field conditions and operate continuously. All these features depend to a large extent on a crucial stage of any analysis: analytical calibration.

Calibration involves the best possible representation of the quantity and properties of the substance being determined (analyte) in the analyzed sample using a chemical standard. A commonly used calibration method is the 'external standard method' (ESM), which however is time-consuming and leads to inaccurate results when analyzing environmental samples with complex matrices. Therefore, in such cases an alternative, more advanced calibration approaches should be employed, preferably in combination with a flow-through sample treatment mode.

One of the most environmentally friendly calibration methods is the so-called "chemical H-point standard addition method" (C-HPSAM). In flow mode, the procedure involves introducing a sample and a sample spiked with the analyte into the flow system, followed by the measurement of analytical signals under two specifically selected chemical conditions. This approach allows for the elimination of both specific and nonspecific interference effects without the need to isolate interfering substances from the sample matrix or use special reagents to eliminate their influence. As a result, several (rather than just one, as in the case of ESM) calibration curves can be constructed in a very short time, which makes it possible to eliminate interference effects and thus increases the accuracy of analytical results.

The C-HPSAM is very fast and economical: the total recording time was approximately 100 s, and the total sample volume used did not exceed a few milliliters. The application of this approach was verified using examples of spectrophotometric determinations of ascorbic acid in soft drinks and juices, as well as paracetamol in pharmaceuticals. All analytical results were obtained with relative errors below 6%. Research is ongoing to adapt this method for the continuous monitoring of the chemical composition of wastewater using spectrometric and electrochemical detection.

The general conclusion is that special attention should be paid to resolving analytical issues as early as the calibration stage. This applies particularly to the analysis of samples with a complex environmental matrix.

Corresponding Author: Paweł Kościelniak

EVALUATION OF ROCK DEBRIS BASED ON PARTICLE SHAPES AND SIZES

Mária Bali Hudáková [1], Víťazoslav Krúpa [1], Alexander Kiovský [1], Pavol Vavrek [1], Edita Lazarová [1], Lucia Ivaničová [1]

[1] Institute of Geotechnics of the Slovak Academy of Sciences, Watsonova 45, SK-04001 Košice, Slovakia

ABSTRACT

This study focuses on characterizing the shape of drill cuttings produced during drilling in limestone, andesite, and granodiorite. These rock debris particles were collected in containers during drilling as a result of rock disintegration. The drill cuttings were analyzed using wet- sieve analysis with six sieves of different mesh sizes. The rock debris was divided into seven classes. When evaluating particle shape, we focus on the second class, which has the largest particles, ranging from 1000 µm to 400 µm, but the lowest percentage of the total weight of drilling debris. Particle size distribution was measured using the Camsizer X2 particle size and shape analyzer (Retsch, Germany) with dual camera technology and an X-dry sample feeder. From data obtained from the particle analyzer, we evaluated particle shape using diagrams by Sneed & Folk, which categorize drill cuttings into seven descriptive classes. Through this analysis, we aimed to gather information about the interaction between rocks and surface-set diamond core drill bits. The aim was to monitor changes in the shape and size of particles from the analyzed larger rock fragments after drilling rock samples. Changes in particle size relative to their shape were assessed using a calculated coefficient. The coefficient is represented by a single number for each rock specimen. Using the coefficient, we can identify changes in the constant drilling regimes, including the drilled length and the type of drilling tool used. Such an assessment of particle shape would help provide a more detailed evaluation of the selection of drilling tools and their wear.

Corresponding Author: Mária Bali Hudáková

EXPLORING A RELATIONSHIP BETWEEN EARTHQUAKES LOCATION AND THE TEMPERATURE EVOLUTION OF A SEDIMENTARY BASIN IN THE ATLANTIC OCEAN

Maria Rosa Duque [1]

[1] Universidade de Évora, CREATE, Rua Romão Ramalho 59, Évora, Portugal

ABSTRACT

The analysis of 8 earthquakes located in the Gorringe Bank and adjacent regions, including the northern part of the Horseshoe Basin and the region to the east, from -12oW to -9o W longitude and 35.8o N to 36.8oN latitude is carried out using temperature variations obtained from geoid height values in the region. The earthquakes occurred in 2005, 2007 and 2008.

Considering different types of crust/materials in the region that have been identified in other studies carried out by different teams, it was possible to verify that the earthquakes occurred near the boundary of different types of crust/ materials or in the Gorringe Bank.

The temperature evolution (geoid height variation) is not uniform in the region. Comparing data obtained in 2008 with data from 1996 it is possible to identify cooling and warming regions separated by points with nearly constant values. The earthquakes studied occurred in the warming regions near the border with areas that are being cooled. Earthquakes located in the western part of the region are related with the cooling process of the Gorringe Bank, an elongated chain of underwater mountains with NE-SW direction presenting a negative gravity anomaly and a high value of geoid height. The external parts of this region have been losing heat while the internal part of the mountains shows an increase of geoid height values. This fact can be related with natural cooling due to natural sinks but also with possible sources of heat inside the mountains. The epicenters of the earthquakes are located near the lateral borders of the mountains in the warming regions, close to the points of nearly zero changes. Two earthquakes are located close to the points with the highest geoid height value in the latitude of the occurrence. The heat transferred from the cooled to the warmed regions can originate pressure gradients of thermal origin whose value can increase causing rupture of the materials and earthquakes. This process related with the cooling of the region may be increased by fluid movement.

Corresponding Author: Maria Rosa Duque

GALLIUM OXIDE BASED MEMORY SWITCHING DEVICE

Zurab Kushitashvili [1], Amiran Bibilashvili [1, 2], Ekaterine Chikoidze [3]

[1] LEPL Institute of Micro and Nanoelectronics, Chavchavadze ave.13, 0179 Tbilisi, Georgia
[2] Ivane Javakhishvili Tbilisi State University, Chavchavadze ave.1, 0179 Tbilisi, Georgia
[3] GEMaC, CNRS-UVSQ, Université Paris-Saclay 45, Ave Etats Unis, 78035, Versailles, France

ABSTRACT

In recent decades, semiconductors with a large band gap (SiC, GaN, AlN, ZnO) have gained great interest and wide application in technology and everyday life. For many decades, devices based on silicon (Si) dominated the field of electronic devices. Substantial progress was achieved with the commercialization of the transistor in the 1980s, the creation of the bipolar junction transistor (IGBT) in the 1990s, and the production of the p-n junction transistor in the 2000s. Every significant improvement in devices based on silicon as the base semiconductor material has been due to the clever formation of the p-n junction. However, since 2010, devices based on other systems have entered the market, and the focus has shifted from p-n junction engineering to materials engineering. In contrast to the wide bandgap materials listed above, the ultra-wide bandgap (4.7–4.9 eV) semiconductor gallium oxide (Ga_2O_3) is the only material that can be grown from the liquid phase and is therefore a potentially low-cost material. It forms five crystalline polymorphs. The β phase is the only stable polymorph above 1800°C and 1atm pressure. The use of melt-based growth techniques provides significant manufacturing advantages, cost, and scalability compared to vapor-deposition processes used for other wide bandgap semiconductors such as SiC, GaN, and AlN.

This paper discusses the production of gallium oxide (Ga_2O_3) by reactive magnetron sputtering technology and its use in a memory device - memristor, as an active layer. Various technological conditions are selected to obtain the best physical, electrical, structural and optical parameters of gallium oxide. Volt-Faradic, Volt-Siemens, Volt-Amperic, X-ray diffraction, optic transmission spectra and Kelvin methods of measurement are used. The ratio of low resistance and high resistance is shown, calculated from the volt-amperic characteristic of the memristor.

Corresponding Author: Zurab Kushitashvili

GEOELECTRICAL INVESTIGATION OF AQUIFERS IN THE BODOC SITE, COVASNA COUNTY, USING THE VERTICAL ELECTRICAL SOUNDING (VES) METHOD

Bărăităreanu Marius Bogdan [1], Dragoş Andrei Gabriel [1,2], Dudu Alexandra Constanța [1], Iordache Gabriel [1], Avram Corina [1], Stelea Lia [1], Sava Constantin [1]

[1] National Research and Development Institute for Marine Geology and Geoecology, GeoEcoMar, Romania; 23-25 Dimitrie Onciul Street 024053, Bucharest, Romania;
[2] Doctoral School of Geology Faculty of Geology and Geophysics, University of Bucharest, Romania

ABSTRACT

Geoelectrical methods are reliable tools for the assessment of shallow aquifers and for understanding their structure and distribution in the subsurface. In the Bodoc site, Covasna County, geoelectrical methods were applied to investigate aquifers, aiming to determine their extent and physical characteristics. The studied perimeter is located near a carbonated mineral water capture and bottling facility, highlighting both the economic importance of local resources and the relevance of the performed geophysical investigations. The geoelectrical measurements were carried out as part of a study for investigating analogues for CO_2 geological storage and testing a new monitoring methodology for future anthropic CO_2 reservoirs. The Bodoc site was selected for this study due to its good resemblance to a safe CO_2 geological storage site, being a natural CO_2 reservoir. Within the study, six electrometry profiles were carried out, distributed across various areas within the Bodoc perimeter, each reaching a maximum depth of approximately 4.2 meters. The measurements were performed using the vertical electrical sounding (VES) technique, with the help of an AGI MiniSting™ R resistivity meter, applying the Schlumberger configuration. The acquired data were subsequently processed to generate 2D resistivity sections, which allowed for the interpretation of the electrical property distribution in the subsurface. The obtained results highlight variations in electrical resistivity, based on which it was possible to delineate distinct shallow geological units and to estimate the extent of the aquifers within the studied area. The interpretation of these results led to a better understanding of the local geological structure. Ultimately, the geoelectric method proved to be an efficient and reliable tool for investigating and characterizing aquifers, providing relevant information regarding their distribution in the subsurface. The study conducted in the Bodoc area confirms the utility of these methods in analyzing geological environments and highlights their application potential in diverse contexts, including studies on monitoring the geological storage of CO_2.

Corresponding Author: Bărăităreanu Marius Bogdan

GROUND-PENETRATING RADAR INVESTIGATIONS OF GAS EMISSIONS AT BĂILE LĂZAREȘTI, HARGHITA COUNTY, ROMANIA

Dragoş Andrei Gabriel [1,2], Dudu Alexandra Costanța [1], Iordache Gabriel [1], Bărăităreanu Bogdan Marius [1], Avram Corina [1], Stelea Lia [1]

[1] National Research and Development Institute for Marine Geology and Geoecology, GeoEcoMar, Romania; 23-25 Dimitrie Onciul Street 024053, Bucharest, Romania
[2] Doctoral School of Geology Faculty of Geology and Geophysics, University of Bucharest, Romania

ABSTRACT

This paper presents the results of ground-penetrating radar (GPR) investigations conducted in 2022 and 2024 at Băile Lăzarești, Harghita County, Romania, an area characterized by post-volcanic activity and active gas emissions. The aim of the study was to identify shallow subsurface anomalies related to the migration and accumulation of carbon dioxide (CO_2). The GPR surveys were carried out using a Sensors & Software Noggin Ground Penetrating Radar system equipped with a 250 MHz antenna and SmartCart survey cart, which facilitated systematic data acquisition. The 2022 GPR survey covered a defined perimeter of approximately 777 square meters and was carried out using continuous profile acquisition, allowing for detailed imaging of subsurface features in both lateral and depth dimensions. In 2024, the survey area was slightly larger and investigated using the same continuous GPR profile acquisition methodology, with a total surveyed area of 865 square meters. The acquisition strategy employed for both survey areas enabled the generation of radargrams, depth slices, and GPR amplitude distribution maps. Data processing was conducted by using standard GPR procedure, including signal filtering, gain correction, time-to-depth conversion, and interpolation. The interpretation highlights zones of contrasts in signal attenuation and reflection, interpreted as preferential pathways for gas migration and accumulation. Some of these anomalies exhibit spatial correspondence with surface features, notably mofette gas emission zones that have cleared their surrounding areas of vegetation. By comparing the GPR measurements with the CO_2 flux data, also presented as spatial distribution maps, it was possible to identify correlations and perform a comparative analysis between the two datasets, demonstrating the benefits of GPR for non-invasive investigations of gas emissions.

Corresponding Author: Dragoș Andrei-Gabriel

HEAVY METAL CONTAMINATION OF COAL MINING TAILING DUMPS: A CASE STUDY OF THE PETRILA MINING SITE, JIU VALLEY, ROMANIA

Andrei Szollosi-Mota [1], Maria Prodan [1], Vlad Mihai Pasculescu [1], Nicolae Ioan Vlasin [1], Gheorghe Daniel Florea [1], Vasilica Irina Nalboc [1], Niculina Sonia Suvar [1]

[1] National Institute for Research And Development for Mine Safety and Protection to Explosion - INSEMEX, Department of Safety Mineral Resources, 32-34 G-ral Vasile Milea, Petrosani, Romania

ABSTRACT

The increasing demand for metals and the depletion of primary mineral resources have led to a growing interest in alternative sources of raw materials. In this context, mining waste deposits are increasingly considered as potential secondary resources within the concept of urban mining and the circular economy. Historical mining activities have generated large quantities of waste rock that can contain significant concentrations of valuable metals. The Petrila mine tailings dump, located in the Jiu Valley coal basin (Hunedoara County, Romania), includes such a deposit, where millions of tons of mining waste have accumulated over decades of mining. The tailings dump occupies an area of approximately 225,201 m² and constitutes an important anthropogenic deposit with potential resource value.

The objective of this study was to characterize the chemical composition of residual materials from the tailings dumps of the Petrila mine and to evaluate their potential as secondary resources for metal recovery potential, in urban mining zone.

Sampling was carried out at several locations in the tailings heap, at depths of approximately 30 cm, 50 cm and 70 cm, to investigate the distribution of metals within the deposit of tailing dumps. Elemental concentrations were determined using inductively coupled plasma optical emission spectrometry (ICP-OES). In addition, X-ray fluorescence (XRF) analysis was performed to determine the majority oxide composition of the samples and to support the geochemical characterization of the tailings material.

XRF analyses show that the tailings material is dominated by silicate phases, with SiO_2 concentrations ranging from approximately 42 to 65 wt % and Al_2O_3 concentrations ranging from approximately 15 to 24 wt %. Iron oxides are also significant, with Fe_2O_3 values reaching up to about 17% by weight, while TiO_2 concentrations range between about 1.2 and 2.4% by weight.

Trace metal concentrations determined by ICP-OES indicate the presence of several elements of economic interest, including chromium (up to ~137 mg/kg), nickel (up to ~90 mg/kg), copper (up to ~50 mg/kg), and zinc (up to ~105 mg/kg).

The obtained results indicate that the Petrila mine tailings dump represents a potential secondary source of metals. Although the material is mainly composed of silicates and iron-bearing minerals, the presence of several base metals suggests possible opportunities for resource recovery through modern processing technologies. The study highlights the importance of geochemical investigations of historical mine waste deposits in the context of urban mining and sustainable resource management.

Corresponding Author: Andrei Szollosi-Mota

IMMERSIVE DECISION SUPPORT FOR INLAND PORT ACCESSIBILITY UNDER VARIABLE WATER LEVELS USING DIGITAL TWIN-ORIENTED FRAMEWORK AND VIRTUAL REALITY

Tomasz Templin [1], Julia Leszczyńska [1]

[1] Department of Geodesy, Faculty of Geoengineering, University of Warmia and Mazury in Olsztyn, Oczapowskiego 2, 10-719 Olsztyn, Poland

ABSTRACT

Water-level variability significantly influences the operational availability of inland ports by altering the depth, spatial continuity and accessibility of navigation areas. Traditional bathymetric charts and hydrological observations provide essential information for navigation planning; however, they rarely support rapid evaluation of multiple operational scenarios involving different vessel types and changing environmental conditions. This study presents a Digital Twin-Oriented Framework based decision support framework that combines bathymetric data, hydrological observations and immersive visualisation to assess navigability under dynamically changing water levels.

The proposed system integrates a high-resolution three-dimensional model of an inland port with variable water-surface elevations, vessel draught and user-defined under-keel clearance requirements. The Digital Twin is implemented in the Unity environment and visualised using a Meta Quest 3 headset, allowing users to interactively modify hydrological and operational parameters while immediately observing their influence on navigable areas. For each simulation scenario, local water depth is calculated from the current water level and bathymetric model, after which spatial analysis automatically classifies the port into safe, conditionally accessible and non-navigable zones.

Beyond immersive visualisation, the framework performs quantitative spatial analyses, including the calculation of navigable area statistics, identification of critical shallow sections, assessment of route continuity and evaluation of accessibility for vessels with different operational characteristics. The proposed workflow enables rapid comparison of multiple hydrological scenarios without rebuilding the underlying Digital Twin, providing a practical tool for infrastructure management, maintenance planning, operational decision support and training.

The presented approach demonstrates how Digital Twins combined with interactive spatial analysis can improve understanding of the relationship between hydrological variability and port accessibility, supporting more resilient management of inland water transport infrastructure under changing environmental conditions.

Corresponding Author: Tomasz Templin

INTEGRATED STRUCTURAL ANALYSIS AND 3D SEISMIC DATA: IMPLICATIONS ON THE ENDOGENIC ORIGIN OF THE CIRCULAR MAÂDNA STRUCTURE (TALEMZANE, ALGERIA)

Atmane Lamali [1], Pierre Rochette [2], Mohamed Arab [3], Hallal Nassim [1], Nacer Eddine Merabet [1], Said Maouche [1], Lamine Hamai [1], Abdeslam Abtout [1]

[1] CRAAG, B.P. 63, Bouzaréah 16340 Alger, Algeria
[2] Aix-Marseille Université, CNRS, IRD, CEREGE UM34, 13545 Aix en Provence, France
[3] Sonatrach/Exploration Division, Avenue du 1er novembre Bat 'C' BP 68, Boumerdes, Algeria

ABSTRACT

The Maâdna circular structure in the Sahara Atlas (Algeria) has long been interpreted as a meteorite impact crater (Lambert et al. 1980). However, recent studies (Lamali et al., 2016, 2019, and 2022) have challenged this interpretation, while proposing instead that it has a tectono-sedimentary origin involving the diapiric intrusion of Triassic evaporites. This new analysis is supported by a combination of geophysical, structural, and field evidence, including the presence of tilted Cretaceous strata and radial fault patterns, and basement-rooted lineaments. Unlike previous studies, this one relies on 2D regional seismic profiles and structural reconstructions (e.g., Bracene and Frizon de Lamotte, 2002), this work integrates high-resolution 3D seismic data acquired for hydrocarbon exploration to provide new insights into the deep structure of the Maâdna circular crater. Though earlier interpretations emphasized basement uplift and thickening of the Mesozoic sequences, our data reveal a more localized diapiric mechanism originating from the Triassic evaporites. This mechanism may have played a key role in the formation of the present-day relief and structural depression. We also interpret the uplift of the Maâdna structure as a manifestation of a mid-Cretaceous tectonic phase that affected the Sahara Platform, contrary to the traditional view of its passive tabular subsidence. Integrating 3D seismic imaging with field observations around Maâdna sheds new light on the polyphased evolution of the Sahara platform and questions the basic tectonic models previously applied to this region. This reinterpretation, based on structural configuration related to salt tectonics, highlights the presence of long-wavelength folding that had previously been overlooked in surface geology due to their subtle curvature. Our results offer a "non-impactist" resolution to a decades-old debate. More importantly, they reveal a faulted and folded hydrocarbon-prone domain within an area that has long been considered tectonically stable. Thus, beyond resolving a scientific controversy, this study emphasizes the importance of re-evaluating suspected impact structures in light of advanced geophysical data, and highlights the need for a revised tectonic framework for the central Sahara Platform. Furthermore, it provides a valuable structural model with implications for future resource exploration in the region.

Corresponding Author: Atmane Lamali

INTEGRATING BATHYMETRY, GEOSPATIAL DATA AND AUGMENTED REALITY FOR SAFER INLAND NAVIGATION: THE ŻEGLUJ! MOBILE APP – A CASE STUDY IN THE GREAT MASURIAN LAKE

Dariusz Popielarczyk [1], Tomasz Templin [1], Marcin Gryszko [2]

[1] Department of Geodesy, University of Warmia and Mazury in Olsztyn; Oczapowskiego 2, 10-719 Olsztyn, Poland
[2] INFEO Marcin Marek Gryszko; Królewny Śnieżki 18, 10-696 Olsztyn, Poland

ABSTRACT

The safety of navigation on inland water bodies is an important factor supporting the sustainable development of nautical tourism. This issue is particularly relevant in the Great Masurian Lakes region of north-eastern Poland, where intensive recreational traffic coincides with complex post-glacial lake morphology. Numerous shallow areas, submerged rocks, abrupt changes in depth and narrow waterways pose significant risks to small sailing and motor vessels. These risks are intensified by rapidly changing weather conditions, limited navigational marking, outdated bathymetric information and the large number of inexperienced users who may operate smaller recreational vessels without a licence.

This paper presents Żegluj!, a mobile navigation system developed to improve situational awareness and support safer navigation on inland lakes. The system integrates updated bathymetric and high-definition maps, GNSS and sensor-based positioning, navigable routes, hazardous-area databases, weather information and an intuitive mobile interface. Bathymetric surveys, laser scanning and UAV photogrammetry were used to acquire detailed spatial data for representative environments, including large lakes with varied underwater topography, narrow waterways, canals and inland port approaches.

A key functionality is the automatic warning mechanism that alerts users when their current or predicted trajectory approaches a shallow area, underwater obstacle or other navigational hazard. The system also provides route calculation, cardinal-mark visualisation and an augmented reality interface displaying navigational information directly over the camera view. Additional components include object detection, day and night display modes, multilingual support, an emergency SOS function and dedicated tools facilitating cooperation with water rescue services. The application's safety functionalities were developed and assessed in cooperation with the Masurian Voluntary Water Rescue Service (MOPR), enabling their evaluation against practical rescue and navigation requirements.

The presented solution demonstrates how bathymetric data, Earth observation technologies, geoinformatics, mobile positioning and augmented reality can be combined into an accessible decision-support tool. Żegluj! may contribute to reducing navigational risk, improving emergency communication and supporting the sustainable growth of recreational activities on inland water bodies.

Corresponding Author: Dariusz Popielarczyk

LASER-PLASMA TECHNOLOGY FOR CREATING SILICON-GRAPHENE SOLAR CELLS

Amiran Bibilashvili [1, 2], Zurab Kushitashvili [2], Larisa Jangidze [2], Sergo Sikharulidze [2], Afshin Bakhtiari [3], Paata Kervalishvili [3].

[1] Ivane Javakhishvili Tbilisi State University, Chavchavadze ave.1, 0179 Tbilisi, Georgia
[2] LEPL Institute of Micro and Nanoelectronics, Chavchavadze ave.13, 0179 Tbilisi, Georgia
[3] Georgian Technical University, Kostava Str. 77, 0160 Tbilisi, Georgia

ABSTRACT

In response to the growing concerns of global warming and the urgent need for sustainable energy solutions, the exploration of alternative energy sources has become increasingly important. Among these, solar energy stands out as a clean, abundant, and renewable option. The efficiency of solar cells depends significantly on the base semiconductor material, with silicon currently dominating global production. However, modern research focuses on enhancing solar cell performance through innovative approaches, such as the deposition of graphene layers using advanced laser-plasma technology. Laser-plasma technology integrates laser ablation and plasma deposition techniques to fabricate high-efficiency thin-film solar cells, including those based on silicon-graphene nanosystems. This approach enables precise structuring, local doping, and film growth at the nanoscale, which enhances optical absorption, electrical conductivity, and carrier collection efficiency. By optimizing the deposition process and exploring various technological conditions, graphene-enhanced solar cells can achieve improved electrical conductivity, better light absorption, and reduced energy losses, paving the way for highly efficient and environmentally friendly solar energy solutions.

The presented work discusses the deposition of graphene on a solar cell using laser-plasma deposition technology and the analysis of the results obtained. Experiments were conducted under various technological conditions in order to investigate the optimal conditions for obtaining high-efficiency solar cells. In the experiments used 2-inch diameter, (100) crystallographic orientation and 400 μm thick p-type silicon wafers. Different phosphorus diffusion depths were considered to achieve n-type conductivity. In one case, silicon nitride and graphene were used as the antireflective layer, and in the other case, only graphene was used. The volt-ampere characteristic was measured and the margin action coefficient of the solar cell was estimated in each experiment. The parameters of the solar cell obtained with and without graphene were compared.

Corresponding Author: Amiran Bibilashvili

MODELLING MONTHLY CONCENTRATION OF AMMONIUM AND NITRATE NITROGEN IN THE HRON RIVER BASIN: INTEGRATION OF TIME SERIES OF ENVIRONMENT FACTORS

Veronika Bačová Mitková [1], Pavla Pekárová [1], Dana Halmová [1]

[1] Institute of Hydrology, SAS, Dúbravská cesta 9, 841 04 Bratislava, Slovakia

ABSTRACT

As a vital hydrological unit in Slovakia, the Hron River basin is fundamental to regional water governance, agricultural activities, and biodiversity conservation. While our previous research was concentrated mainly on oxygen regime, water temperature (Tw) and pH, this study shift the focus toward ammonia nitrogen ($N\text{-}NH_4^+$) and nitrate nitrogen ($N\text{-}NO_3^-$) on the Hron River. With this new focus, the study aims to assess long-term trends in nitrogen compounds in the Hron River at two key sampling sites: Valaská (upper basin) and Kamenica nad Hronom (lower basin). The analyzed period from 1992 to 2021 captures the impact of socioeconomic transitions, industrial activities, and the progressive implementation of environmental mitigation measures. Using statistical methods, long-term trends were assessed, indicators such as pH, BOD, Do, and Tw exhibit distinct seasonal fluctuations, which serve as key drivers for biochemical processes affecting nitrogen compounds. The second part of the work focuses on mathematical modelling of the nitrogen compounds such as $N\text{-}NH_4^+$ and $N\text{-}NO_3^-$. Based on simple regression analysis, the relationships between nitrogen concentrations and quality indicators such as DO, BOD, Tw, pH, and discharge Qd were derived. Derived regressions were than used as exogenous values for constructing a Seasonal Autoregressive Integrated Moving Average (SARIMA) model. An innovative aspect of this study is the integration of these derived regression parameters as external regressors within the ARIMA framework to enhance the predictive accuracy of $N\text{-}NH_4^+$ and $N\text{-}NO_3^-$ concentrations. While the chemical purity (less waste, more oxygen) has improved significantly since 1992, the Hron River is now facing new challenges associated with environmental changes (water warming and pH changes). Water quality in the upper reaches (Valaská) responds more sensitively to cleaning measures, while the lower reaches (Kamenica) show a more stable but still warming environment. The resulting predictive model enables the simulation of future pollution trends, providing a valuable tool for water management and river basin planning in the context of climate change.

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Corresponding Author: Veronika Bačová Mitková

MULTISECTORAL TASKS IN THE FIELD OF WASTE MANAGEMENT WITH THE AIM OF IMPROVING ENVIRONMENTAL PROTECTION

Dragan Milošević [1], Željko Praštalo [1], Josip Išek [1], Teodora Đurđević [1]

[1] Mining Institute, Belgrade, Batajnički put 2, Serbia

ABSTRACT

The rate of discovery of new environmental hazards to human health is increasing every year. Identifying these hazards, assessing the damage to human health that they may cause in the population, and evaluating these risks in a comparative manner is the task of health risk assessment. Today, the aim is to achieve a complex and comprehensive view of the interrelationships that can arise within ecosystems. Therefore, a multidisciplinary approach is needed by experts who assess the health status of the population and other specialized monitoring of parameters present in the environment.

Surface mining in the zone of excavation, loading, transport and ancillary works results in numerous forms of environmental degradation. Exploitation activities should fully comply with the principles of adapting the technological process to the characteristics of the mineral raw material and environmental protection measures, i.e. the rational use of natural resources. All potential waste materials that pollute the environment in the mining complex must be analyzed through the categories defined by the pollutant register.

Most of the hazards present in the environment to which the population is exposed are at a low level compared to the normative "low-level exposure", but the exposure relates to the entire lifespan. Although we know or assume from some data that even low-level exposure is harmful to health, it is not so easy to prove the clinical or physiological effects of such exposure at the population level. Often, there is a long incubation period between the first exposure and clinical effects and therefore we find a low incidence rate in those exposed. Especially if a small proportion of the population was exposed to a particular agent in early life, health damage may go undetected for many years. The impact assessment, or risk assessment, of the identified risk factors (direct and indirect) on human health was conducted using methodologies provided in the recommendations of recognized global (WHO, EU) and national (EPA) institutions that have dealt with this area.

Achieving long-term terrain stability and establishing self-sustaining ecosystems will be ensured by permanent cessation of exploitation and includes a series of related activities that begin with conceptual closure planning. Supervision and maintenance of devastated areas and landfills includes all measures that the operator must take during exploitation and after closure, in order to prevent harmful impacts on the environment and human health, ensure the technical stability of the terrain and fulfill obligations towards the competent authorities.

Corresponding Author: Dragan Milošević

NARRATING DEEP TIME IN THE DIGITAL ERA THROUGH A MULTI-PLATFORM 3D ENVIRONMENT FOR GEOTOURISM AND GEOLOGICAL OUTREACH

Annachiara Rosati [1], Luisa Sabato [1], Marcello Tropeano [1]

[1] Department of Earth and Geoenvironmental Sciences, University of Bari Aldo Moro, Bari, Italy

ABSTRACT

The effective communication of the concept of Deep Time and the history of the Earth to non-expert audiences remains a paramount challenge in geological outreach. As angular unconformities serve as exceptional manifestations of geological time gaps, this research aims to demonstrate their potential as assets for public education and the creation of concrete geotourism products.

This study presents the ongoing development of an interactive web-based platform designed for the visual translation of angular unconformities through lightweight three-dimensional (3D) Virtual Outcrops.

As initial implementation cases, two strategic geosites within the MurGEopark (recently recognised as the first UNESCO Global Geopark in Puglia, Italy) were integrated into the project. The first is the historic urban centre of Gravina in Puglia, showcasing the sub-horizontal Plio-Pleistocene calcarenites resting upon tilted Cretaceous limestones. The second consists of the former open-cast bauxite mines of Murgetta Rossa near Spinazzola, now integrated into the region's industrial geoheritage, where karst-filling deposits evidence the significant stratigraphic hiatus between two Cretaceous limestones Formations.

Digital datasets were acquired via Unmanned Aerial Vehicle (UAV) and processed using Structure-from-Motion (SfM) and Multi-View Stereo (MVS) workflows, generating high-fidelity dense point clouds and high-resolution textured meshes. These models were semantically segmented and labelled to highlight different deposits separated by a discontinuity surface recording a significant gap of time, and sometimes showing an angular unconformity. The platform employs an interactive multi-device digital ecosystem to implement user-centred edutainment dynamics. The architecture incorporates colour-coded visualisations aligned with the International Commission on Stratigraphy (ICS) standards alongside multi-layered virtual rendering modes. The system is structured for future on-site deployment as outdoor interactive digital panels placed facing the outcrops. This configuration caters to a broad and diverse, non-specialised target audience, ranging from casual tourists to dedicated geotourists and residents, allowing them to visually deconstruct the present-day landscape and re-enact the local Deep Time narratives on the spot.

Corresponding Author: Annachiara Rosati

NEW RELIABLE, EFFICIENT, AND COST-EFFECTIVE CATHODIC PROTECTION SYSTEM

Nikoloz Chikhradze [1,2], Giorgi Leluashvili [1,2], Levan Leluashvili [2]

[1] Georgian Technical University, 77, Kostava street, 0160, Tbilisi, Georgia
[2] Grigol Tsulukidze Mining Institute, 7 Mindeli Street, Tbilisi 0186, Georgia

ABSTRACT

Electrochemical corrosion represents one of the most significant challenges facing modern industrial and civil infrastructure, causing the gradual degradation of underground and underwater metal and reinforced concrete structures. As a result of electrochemical reactions, structural elements lose their mechanical strength, reliability, and long-term serviceability, leading to substantial economic losses and increased maintenance costs worldwide. The corrosion process develops when metal atoms transfer electrons to depolarizing agents present in the surrounding environment, while the presence of moisture and electrolytes enables ion transport and accelerates corrosion. Therefore, the development of reliable and efficient corrosion protection technologies remains one of the key objectives of modern engineering. Among existing anti-corrosion methods, cathodic protection is considered one of the most effective techniques for protecting metal structures. Traditional cathodic protection systems are primarily based on sacrificial anodes or impressed current systems powered by an external direct current source. Despite their widespread application in underground and underwater metal and reinforced concrete structures, these systems are often associated with high energy consumption, limited-service life of anodic elements, complex maintenance requirements, and the gradual degradation of anodic grounding electrodes caused by electrolysis. The aim of the research was to develop a new, reliable, energy-efficient, and economically sustainable cathodic protection system capable of extending the operational lifetime of both protected structures and anodic grounding electrodes. The proposed system operates on the principle of alternating current and provides intensive cathodic polarization of the protected structure, while the main anodic grounding electrode functions not under continuous oxidation, but in an oxidation–reduction regime. The system includes a transformer, capacitor, oppositely connected parallel diodes, anodic grounding electrodes, and conductive filler materials, enabling automatic stabilization of the protective current without the need for an additional automatic regulator. The proposed protection principle ensures equality between the incoming and outgoing currents of the electrode, thereby eliminating electrolytic degradation of the anodic grounding electrode. This represents one of the major advantages of the system and significantly increases its operational reliability. The developed protection system can be applied to underground and underwater linear metal structures, reinforced concrete constructions, marine infrastructure, reservoirs, foundations, anchors, and other engineering facilities operating in aggressive corrosive environments.

Corresponding Author: Giorgi Leluashvili

NUMERICAL ANALYSIS OF THE MAGNETIC FLUX LEAKAGE FIELD INDUCED BY INTERNAL DEFECTS IN LONGITUDINAL FERROMAGNETIC STRUCTURES

Giorgi Nozadze [1], Nikoloz Chikhradze [1,2], Giorgi Leluashvili [1,2], Giorgi Chiqovani [3]

[1] Grigol Tsulukidze Mining Institute, 7 Mindeli Street, Tbilisi 0186, Georgia
[2] Georgian Technical University, 77, Kostava street, 0160, Tbilisi, Georgia
[3] Tbilisi State University/EMCoS LLC , 27 Pekini Str.160 Tbilisi, Georgia

ABSTRACT

This paper discusses approaches to improving the magnetic non-destructive testing (NDT) method for longitudinal ferromagnetic bodies, leveraging the advanced simulation capabilities of modern Multiphysics engineering software.

The subject of the research is steel wire ropes composed of individual wires of various shapes and cross-sections. Since steel wire ropes do not constitute a homogeneous, continuous body, the application of magnetic NDT methods encounters significant challenges. This is primarily manifested in the difficulty of reliably detecting the magnetic flux leakage (MFL) field generated by wire breakages, as the discrete, multi-wire structure of the rope increases background electromagnetic noise and complicates the extraction of the useful signal. Although modern flaw detectors partially address this issue, the reliable registration of internal wire breaks remains a critical challenge to this day.

In this work, the numerical calculation of the MFL field intensity resulting from an internal breakage within a simplified, two-layer steel wire structure is modeled in an engineering software environment. The spatial distribution of the leakage field induced by defects of varying widths and depths is investigated both within the ferromagnetic medium itself and in the surrounding atmospheric environment. The latter is of particular importance for practical NDT applications, given that magnetic sensing devices are typically positioned outside the ferromagnetic component.

Based on the obtained results, it can be concluded that the utilization of modern engineering software tools enables a detailed and highly reliable study of the detection and registration processes for internal defects in ferromagnetic wire structures. In the future, developing an accurate geometric model of real steel wire ropes and conducting simulation studies will allow for the precise numerical computation of the MFL field spatial distribution, thereby establishing a foundation for the optimization and refinement of magnetic sensor mechanisms.

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Corresponding Author: Giorgi Nozadze

NUMERICAL MODELLING OF MICROPLASTIC TRANSPORT IN THE CONFLUENCE AREA OF THE EAST JIU RIVER AND THE MALEIA STREAM USING A CFD–DPM APPROACH

Angelica-Nicoleta Gaman [1], Alexandru Simion [1], Daniel Pupazan [1]

[1] National Institute for Research and Development in Mine Safety and Protection to Explosion – INSEMEX Petroșani, Romania

ABSTRACT

Microplastic pollution in aquatic ecosystems represents a major environmental concern, and understanding the mechanisms governing transport, dispersion, and accumulation requires methodologies capable of describing particle–turbulence interactions. This study proposes an integrated methodology for investigating microplastic transport in the confluence area of the East Jiu River and the Maleia Stream, combining experimental data on polymer typology (reported in a previous study) with Computational Fluid Dynamics (CFD) numerical simulations. The numerical modelling was performed in ANSYS Fluent over a representative river reach, employing the Reynolds-Averaged Navier–Stokes (RANS) equations to describe the continuous phase and the Discrete Phase Model (DPM) within a Euler–Lagrange framework to track microplastic particles. Turbulence effects on particle trajectories were incorporated using stochastic tracking methods, enabling a realistic representation of particle dispersion within the flow field. The numerical model consistency was verified through hydrostatic pressure distribution analysis, velocity field evaluation, mass balance closure, and residual convergence assessment. Simulations were conducted for commonly encountered polymers in aquatic environments (PET, HDPE, LDPE, and PVC) with particle diameters ranging from 25 to 250 μm. The results reveal distinct transport behaviors governed by material density and particle size. Polymers with densities lower than water (HDPE, LDPE) are predominantly transported within the upper flow layers, polyethylene terephthalate (PET) exhibits turbulence-controlled dispersion, while polyvinyl chloride (PVC) demonstrates rapid and stable sedimentation. The proposed CFD–DPM approach proves effective in identifying potential accumulation zones and supporting monitoring and mitigation strategies for microplastic pollution in riverine systems, providing a transferable methodological framework for similar studies in other hydrological contexts.

Corresponding Author: Angelica-Nicoleta Gaman

NUMERICAL MODELING USING THE FINITE ELEMENT METHOD OF THE DRILL-WORKING TOOL-ROCK WALL SYSTEM, TAKING INTO ACCOUNT THE PROPAGATION OF LONGITUDINAL VIBRATIONS IN THE SLIDING CROSSBEAM AND THE MOVEMENT MECHANISM OF DRILLS

Daniel Radu [1], Ioan Doșa [1], Florin Vîlceanu [1]

[1] Department of Mechanical, Industrial and Transport Engineering, University of Petrosani; 20 University Street, 332006, Petrosani, Romania

ABSTRACT

In this paper, we present a simplified model of the vibro-mechanical behavior of the drill- working tool-rock wall system, a rather complex task for any proposed model, being very difficult to reproduce accurately the real world phenomena. The difficulties in modeling this phoenomena come from the interactions of the many different variables that define the drilling process. For this reason, a series of simplifying assumptions were made, and the study was conducted using a hypothetical (but realistic) calculation examples, comparing the results obtained analytically with those obtained numerically, refining the model in the processes. Nevertheless, this model provides insight into the mechanical phenomena occurring within the system and may serve as a basis for further studies of the drilling process and the mechanical phenomena involved.

Corresponding Author: Daniel Radu

ON THE ERROR DISTRIBUTION IN PRECISE LEVELLING SECTIONS

Vasil Cvetkov [1]

[1] University of Architecture, Civil Engineering and Geodesy, Sofia 1046, Bulgaria

ABSTRACT

The assumption that measurement errors follow a Gaussian (normal) distribution is widely accepted in geodesy and related sciences. However, numerous studies over the past decades have reported observational evidence that challenges this assumption, particularly with the use of modern measurement techniques such as Global Navigation Satellite Systems, Satellite Laser Ranging, gravimetry, and astronomical observations. Earlier investigations from the mid-20th century also indicated deviations from normality in precise and hydrostatic levelling data.

This study examines the statistical properties of levelling discrepancies from several national levelling campaigns: the Second Levelling of Bulgaria (1953–1957), the Third Levelling of Bulgaria (1975–1984), the Second Levelling of Finland (1935–1955), and the Third Levelling of Finland (1978–2006). The analysis focuses on testing the normality of the discrepancies using statistical measures of skewness and excess kurtosis, as well as chi-squared goodness-of-fit tests.

The results reveal significant deviations from normality in all examined datasets. The Bulgarian levelling data show platykurtic distributions with excess kurtosis values of 2.386 and 2.516 for the Second and Third Levelling, respectively, both exceeding the three-sigma confidence limits, while their skewness values (0.134 and −0.087) remain within the threefold standard deviation range. In contrast, the Finnish datasets exhibit leptokurtic distributions with excess kurtosis values of 3.467 and 4.557. Chi-squared tests confirm the rejection of the normality hypothesis for all datasets at a significance level greater than 99%.

Further analysis of standardized discrepancies, obtained by scaling discrepancies by squared levelling distances, reveals even stronger deviations from normality, with excess kurtosis values increasing to 2.225, 2.439, 4.407, and 7.147 for the four levelling campaigns. These findings highlight that the distribution of levelling discrepancies can substantially differ from the assumed Gaussian model, emphasizing the importance of considering real data distributions when evaluating measurement accuracy and planning geodetic observations.

Corresponding Author: Vasil Cvetkov

ON THE PERFORMANCE OF SOME LOCATION ESTIMATORS REGARDING THE SKEWNESS OF THE DATA

Vasil Cvetkov [1], Gergana Antova [1], Christina Mickrenska [1], Danail Nedyalkov [1]

[1] University of Architecture, Civil Engineering and Geodesy, Sofia 1046, Bulgaria

ABSTRACT

This study investigates the performance of various location estimators across increasing skewness levels (0.00–1.70), evaluating their relative efficiency relative to the sample mean. The analysis is based on simulations of standard normal data contaminated with 10% extreme values to mimic real-world deviations. The findings reveal substantial variation in robustness and bias among estimators as skewness increases. Using the sample mean as a benchmark, the median exhibits a sharp increase in relative efficiency, rising from 66 to 781 as skewness intensifies. Robust estimators such as Hodges–Lehmann and Hampel show moderate increases in efficiency, indicating partial sensitivity to skewness. In contrast, the Danish, Andrews, Tukey, S-25, and MM estimators demonstrate strong robustness to contamination, with rapidly increasing efficiency values, making them well-suited for highly skewed distributions. The Huber family of estimators exhibits performance that depends on the tuning parameter: smaller constants (e.g., Huber (1.345)) provide greater robustness to contamination, whereas larger constants (e.g., Huber (4)) behave more like the mean, indicating reduced resistance to outliers. The L1-norm estimator displays only limited robustness across skewness levels. Overall, estimator performance is strongly influenced by skewness. The MM-estimator and the S-estimator (with a 25% breakdown point) emerge as the most robust and efficient choices, even under moderate skewness (greater than 0.10). The Danish estimator also demonstrates notable robustness. Conversely, the L1-norm and high-parameter Huber estimators appear less suitable for heavily skewed data.

Corresponding Author: Vasil Cvetkov

OPTICAL PROPERTIES OF GALLIUM NITRIDE RECEIVED BY REACTIVE MAGNETRON SPUTTERING

Zurab Kushitashvili [1], Amiran Bibilashvili [1, 2]

[1] LEPL Institute of Micro and Nanoelectronics, Chavchavadze ave.13, 0179 Tbilisi, Georgia
[2] Ivane Javakhishvili Tbilisi State University, Chavchavadze ave.1, 0179 Tbilisi, Georgia

ABSTRACT

In this paper optic transmission spectra of Gallium Nitride (GaN) polycrystalline samples received by reactive magnetron sputtering technology are presented. Due to its wide band gap, gallium nitride remains a leading semiconductor material in the research and production of optoelectronic devices. Optical properties are one of the important subjects of research, including the analysis of transmission spectra. Due to the direct band gap, GaN has a sharp minimum of the transmission spectrum near the edge of the band gap. Accordingly, it is possible to make conclusions about the optical properties of GaN from the optical spectra. The paper discusses about GaN samples obtained under various technological conditions (mainly temperature). Measurements were carried out on a UV/VIS/NIR Spectrophotometer Analyzer.The analysis of transmission spectra reveals correlation with growth temperature of GaN samples and band gap of the GaN material. By increasing temperature of samples for the formation of GaN, the edge of minimum of transmitted wavelength is shifted towards 361nm, which corresponds to the band gap 3.4 eV of the GaN material. The band gap of GaN material can be calculated from the edge of transmission spectra minimum. This work also shows that, with the increase of growth temperature of the samples for growing GaN, the optic properties of the GaN improve, which corresponds to increasing angle of the slope of the graph transmission spectra.

Corresponding Author: Zurab Kushitashvili

ORGANIC–MINERAL FORMULATION FOR IN SITU RECOVERY OF PETROLEUM-CONTAMINATED SOIL

Beata Matuszek [1]

[1] Department of Bioprocess Engineering, Energy, and Automation, Faculty of Production and Energy Engineering, University of Agriculture in Krakow, Poland

ABSTRACT

Petroleum hydrocarbon contamination may impair soil quality, plant development and the ecological functions of land resources. Conventional management frequently relies on excavation and off-site treatment, which can generate additional transport and disposal burdens. This study investigated an organic–mineral formulation designed to support the in situ recovery of petroleum-contaminated soil. The formulation combines a mineral amendment with a selected microbial consortium. Dolomite and bentonite were assessed as candidate mineral components on the basis of physicochemical characteristics, porosity-related properties and multicriteria decision analysis. Dolomite obtained the more favourable overall ranking and was selected for further research. The biological component comprised *Pseudomonas putida, Yarrowia lipolytica, Bacillus subtilis* and *Arthrobacter globiformis*, chosen for their complementary functions associated with hydrocarbon transformation, biosurfactant production and adaptation to variable soil conditions. The formulation was evaluated in phytotoxicity tests and pot experiments using petroleum-contaminated soil. Variants containing the combined mineral and microbial components improved plant emergence and growth indicators relative to untreated contaminated soil. The results indicate that the proposed system has potential to support biological recovery alongside contaminant management. By focusing on restoration of soil functions, the approach contributes to more resource-efficient remediation practices and may reduce the need for excavation, transport and disposal. Further studies will address hydrocarbon reduction, long-term stability and field-scale performance.

Corresponding Author: Beata Matuszek

PROBABILISTIC ASSESSMENT OF LOW FLOWS IN THE UPPER IPEĽ RIVER BASIN (SLOVAKIA)

Pavla Pekárová [1], Veronika Bačová Mitková [1], Ján Pekár [2]

[1] Institute of Hydrology SAS, Dúbravská cesta 9, 841 04 Bratislava, Slovakia
[2] Faculty of Mathematics, Physics, and Informatics, Comenius University in Bratislava, Mlynská dolina, 842 48 Bratislava, Slovakia

ABSTRACT

Over the past decade, a significant decrease in river discharges and a more frequent occurrence of hydrological drought have been recorded in Slovakia, including the Ipeľ River basin. This trend, likely driven by higher air temperature and increased evaporation, poses a severe challenge to sustainable water resource management and the preservation of local ecosystems. The main objectives of this study are: a comprehensive analysis of the occurrence of low flows and hydrological drought in the Upper Ipeľ River basin at four gauging stations – Holiša, Kalinovo, and upstream and downstream of the Málinec Reservoir – and the probabilistic estimation of *T*-year 7-day minimum specific runoff. The research processed long-term series of mean daily discharges covering the observation period from 1931 to 2022 at Holiša, 1971–2022 at Kalinovo, and 1995–2022 at Málinec stations. The three-parameter Log-Pearson Type III (LP3) theoretical distribution was applied for the probabilistic assessment of low flows and the calculation of design values. Non-exceedance curves were constructed with a special focus on the part of historical minima, taking into account the impact of extreme outliers and appropriately adjusting the skewness coefficient. While the most water-rich period occurred between 1936 and 1940, the most significant drought episodes in the Ipeľ River at the Holiša gauge were recorded from 1981 to 1990, and extreme minima occurred in 1947 and 1993. The long-term analysis confirmed a declining trend in both average and maximum discharges at the Holiša station. The estimated values of the *100*-year seven-day minimum specific runoff for the Holiša station reached extremely low levels of 0.06 $l.s^{-1}.km^{-2}$. The derived *T*-year design values provide an essential methodological and data foundation for water management planning and adaptation to ongoing climate change in the region.

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Corresponding Author: Veronika Bačová Mitková

RECYCLED PVC GRANULATE IN MACRO-LEVELING MIXTURES AS A SECONDARY CONSTRUCTION MATERIAL

Maciej Gliniak [1]

[1] Department of Bioprocess Engineering, Energy, and Automation, Faculty of Production and Energy Engineering, University of Agriculture in Krakow, Poland

ABSTRACT

The construction sector consumes substantial volumes of natural aggregates while polymer waste streams remain a persistent material-management challenge. The use of recycled materials in earthworks should therefore be assessed not only in terms of resource recovery, but also with respect to technical performance and environmental safety. This study examines the potential application of recycled PVC granulate in macro-leveling mixtures used for terrain shaping and earthwork operations. The objective was to identify the role of PVC granulate within the mixture and to define the conditions necessary for its responsible use as a secondary construction material. The assessment addressed the preparation and traceability of the recycled input, its material characteristics, expected behaviour during placement and compaction, and potential interactions with water and soil. Particular attention was given to issues relevant to long-term application, including material stability and the potential migration of substances from the mixture. The findings indicate that recycled PVC should not be considered a direct, universally interchangeable substitute for natural aggregate. Its use requires a controlled input stream, defined mixture composition and verification of geotechnical and environmental performance for the intended site conditions. When these requirements are met, PVC granulate may partially replace conventional aggregate fractions in selected macro-leveling applications. The proposed approach supports the development of secondary material loops while reducing demand for primary mineral resources. Further research will focus on full-scale testing, leaching behaviour and the establishment of acceptance criteria for recycled polymer components in earthwork materials.

Corresponding Author: Maciej Gliniak

RE-EVALUATION OF THE INTERNAL STRUCTURE OF THE OULED H'DAÏM TRIASSIC DIAPIR (WESTERN BIBAN, ALGERIA) USING ELECTRICAL RESISTIVITY TOMOGRAPHY (ERT)

Hallal Nassim [1], Atmane Lamali [1], Lamine Hamai [1], Anis Mazari [1]

[1] CRAAG, B.P. 63, Bouzaréah 16340 Alger, Algeria

ABSTRACT

The Ouled H'Daïm Triassic outcrop, located south of the autochthonous chain of the Western Biban, southeast of Berrouaghia (Algerian Alpine domain), was historically described as a Triassic thrust sheet beneath the Tellian tectonic units. This interpretation has been revisited following new geological observations and targeted geophysical investigations. A combined geological and structural survey, complemented by two Electrical Resistivity Tomography (ERT) profiles, was conducted to better characterize the internal geometry of the structure. Field campaigns provided complementary geological and structural data, helping to identify the lithologies and the characteristics of the Triassic outcrop. Resistivity contrasts observed in the models highlight the distinction between the diapiric body and the surrounding geological formations, confirming the presence of an ascending intrusive structure. The integration of geological and geophysical information leads to a re-evaluation of the local tectonic configuration, establishing that the Ouled H'Daïm Triassic outcrop corresponds to a diapiric intrusion rather than a thrust sheet. This new understanding refines the local tectonic framework and provides insights into the diapiric processes affecting the Western Biban region.

Corresponding Author: Nassim Hallal

RESILIENT RIVER DEFENSES IN THE VICINITY OF THE TITICACA DELTAS: SLOPE STABILITY ANALYSIS OF DIKES

Roberto Alfaro-Alejo [1,2], Ecler Mamani-Chambi [3], José A. Mamani-Gomez [1,5], Jorge Luis Aroste-Villa [4], Wilber Laqui [1,5]

[1] School of Agricultural Engineering, Universidad Nacional del Altiplano, Puno, Peru
[2] Doctorate Program in Water Resources, Universidad Nacional Agraria La Molina, Lima, Peru
[3] School of Civil Engineering, Universidad Peruana Union, Juliaca, Peru
[4] School of Topographic Engineering and Surveying, Universidad Nacional del Altiplano, Puno, Peru
[5] Research Institute of Water Science and Technology, Universidad Nacional del Altiplano, Puno, Peru

ABSTRACT

Flooding in the Lake Titicaca basin poses a critical risk to communities and infrastructure, and endangers human lives. Dikes are commonly used to protect against flooding, but their stability is essential to their effectiveness. This study examines the stability of embankment slopes on the Ilave River dams through hydraulic and geotechnical modelling, using the limit equilibrium method with specialized software. This analysis was applied to sections between 2 and 5 m in height, with variable slopes, and considering scenarios of constant seepage and seismic loading (0.12 g). The hydraulic analysis of the design flow rate Q_{100} of 1360 m³/s determined a maximum water level of 3819.56 m a.s.l. and was used to establish the crest elevation of the embankments. The slope of 1.5:1 upstream and 1.75:1 downstream on a dam of ≤ 2 m yielded safety factors of between 1.45 and 1.54 under critical conditions. Embankments ranging from over 3 m to 5 m in height, reinforced with a drainage system and a cut-off trench rather than 2.0-metre piping, showed an increase in the safety factor from 2.5 to 11.6. They therefore possess high stability and resilience, making them safe in the face of extreme events. Adaptive design, redundancy and seepage control are essential to reduce the risk of extreme flooding and protect riverside communities that were vulnerable along certain stretches of the river. It is hoped that the recommendations from this research will contribute to improving the safety of riverside communities based on hydraulic and geotechnical modelling, thereby ensuring the long-term viability of these river defenses.

Corresponding Author: Roberto Alfaro-Alejo

RGB IMAGE-BASED CHARACTERIZATION OF DOLOMITE WEATHERING FOR MINING APPLICATIONS

Candan Alptekin [1]

[1] Zonguldak Bülent Ecevit University, Engineering Faculty, Department of Mining Engineering, Zonguldak, Türkiye

ABSTRACT

This study explores the potential of RGB image-based analysis as a predictive approach for characterizing weathering in dolomites and for guiding excavation tool optimization in mining engineering. The investigation was conducted at the Dolomite Quarry (Gebze, NW Türkiye), where two stratigraphic levels (A–B) of a representative dolomitic profile were systematically analyzed.

Key indicators, such as the progression from gray tones in fresh dolomite to reddish-brown hues in weathered stages, the development of dissolution voids and microcavities, and the enrichment of clay and iron oxides, were systematically identified and evaluated.

The results reveal strong and consistent correlations between RGB parameters and mechanical indices across all two stages. Fresh dolomite samples are characterized by higher UCS and SHR values, reflecting stronger resistance to mechanical excavation, while progressively weathered samples exhibit measurable decreases in strength that coincide with distinct spectral and textural transformations. These correlations confirm the capacity of RGB image analysis to differentiate intra-quarry weathering grades, and anticipate excavation challenges. The study further demonstrates that integrating RGB cameras with excavation systems can provide real-time detection of lithological and weathering transitions at the tunnel face. Such integration enables adaptive tool selection and operational adjustments that reduce cutter wear, optimize excavation efficiency, and enhance overall tunnel stability.

By combining petrographic, mineralogical, and geomechanical insights with digital image analysis, this research provides an innovative, low-cost, and field-applicable methodological framework. It advances the development of intelligent excavation systems capable of responding dynamically to spatially variable rock properties, offering significant contributions to mining engineering practices in carbonate rock environments.

Corresponding Author: Candan Alptekin

SEASONAL CONDITIONS OF WATER TEMPERATURE IN THE HRIŇOVÁ RESERVOIR

Yvetta Velísková [1], Márta Koczka Bara [1], Marek Sokáč [1]

[1] Institute of Hydrology SAS, Dúbravská cesta 9, 841 04 Bratislava, Slovakia

ABSTRACT

Water is an integral part of the Earth's environment. Its availability, and therefore its usability in space and time from a social and economic point of view, is connected not only with its quantity, but also with its quality. Supplying the population with drinking water is an important, even key, task, the weight and importance of which are growing even more in the face of ongoing climate change.

To ensure this task, underground water sources are primarily used; in the event of a shortage, water reservoirs are often used. In Slovakia, 7 reservoirs are currently used for these purposes. One of them is the Hriňová water reservoir in central Slovakia on the Slatina stream (the Hron river basin) at r. km 47.850 in the immediate vicinity above the town of Hriňová. The reservoir's total volume is approximately 7.4 million m^3 of water. The dam creating this reservoir is rocky with an internal inclined and upper vertical seal (the choice was given by the complicated geology - granodiorites, mylonites) and with a height of 41.5 m. Construction took place in the first half of the 1960s, with the main purpose of ensuring drinking water supply to the population for the Hriňová–Lučenec–Fiľakovo group water supply system. In addition, the reservoir ensures minimum flow rates in the Slatina stream below it, supports fish farming, and uses the existing hydropower potential through built-in small hydropower plants.

Given the reservoir's primary purpose, it is necessary to monitor water quality indicators in it. One of the objectives of the national project APVV-22-0610 is also to monitor basic water quality indicators in this reservoir to track seasonal changes in their values and determine the processes occurring in the reservoir. The measurement was carried out three times a year - in spring, summer and autumn (winter is omitted due to freezing of the water surface) - in several verticals at depths of 2 m increments, from 20 m increments of 5 m to the bottom. The measurement was carried out from a boat using a portable multiparametric probe WTW Digital Multi 3630. Water temperature, electrical conductivity, pH and dissolved oxygen content were measured, but only water temperature measurements are evaluated in this article. Electrical conductivity and dissolved oxygen content, in connection with pH values and, of course, water temperature, will be the subject of further investigation. Their values indicated the possible occurrence of cyanobacteria, which needs to be confirmed by further measurements.

The results of the 2025 campaign show that the measurement in the spring (April 2025) took place at the beginning of the spring water circulation in the reservoir. The water temperature ranged from 4.9 °C at the bottom to 13.4 °C at the surface, with the temperature profile along the depth being similar in deeper verticals. The vertical from the shallower part of the reservoir – with a depth of up to 10 m – showed greater water overheating. The maximum temperature gradients were in the depth range of 2-6 m, in the shallower area 4-8 m.

In the summer (July 2025), the measurement results indicated the formation of a temperature stratification to a depth of approximately 20 m in the deeper areas of the reservoir, and, in the shallower areas, throughout the entire depth. The water temperature ranged from 6.2 °C at the bottom to 22.3 °C at the surface, with the temperature profile along depth similar across all verticals. The maximum temperature gradients occurred at depths of 5-10 m.

In the autumn period (November 2025), measurements were taken when the autumn circulation was almost complete - the water temperature along the depth was balanced with a value of (8.8-9) °C up to the 20 m horizon. The water temperature from this depth to the bottom changed not very significantly (by 1 °C in total).

These interim results, despite everything, provide basic information about the temperature stratification of water in this water reservoir and indicate other processes related to the development of water quality in this water body, which will be the subject of further research, which should contribute to more efficient handling of water resources intended for supplying the population with drinking water.

Corresponding Author: Yvetta Velísková

SOME REMARKS ON THE MOST GLACIOTECTONICALLY DEFORMED LIGNITE DEPOSITS IN THE WORLD – SIENIAWA, WESTERN POLAND

Marek Widera [1]

[1] Institute of Geology, Adam Mickiewicz University, Krygowskiego 12, 61-680 Poznań, Poland

ABSTRACT

In the area around the village of Sieniawa in western Poland, lignite has been exploited on an industrial scale for over 150 years. The deposits where mining is carried out, initially underground and now opencast, were strongly deformed glaciotectonically during the Pleistocene. The lignite seam in the exploited deposits creates numerous folds and thrusts/nappes, giving them complex geology. As a result, the lignite deposits in the vicinity of Sieniawa are considered the most disturbed of all the world's deposits still being mined.

Corresponding Author: Marek Widera

SPATIAL VARIABILITY OF NUTRIENT CONCENTRATIONS ALONG A HUMID TEMPERATE CATCHMENT: THE ROLE OF LAND USE AND SEASONAL HYDROLOGY

M. Luz Rodríguez-Blanco [1], M. Teresa Taboada-Castro [2], M. Mercedes Taboada-Castro [3]

[1] Physical Geography Area, History, Art and Geography Department, GEAAT Group, University of Vigo, Campus As Lagoas, 36310 Ourense, Spain
[2] Faculty of Sciences, University of A Coruna, 15071 A Coruna, Spain
[3] ETSIIAA, Area of Soil Science and Soil Chemistry, University of Valladolid, 34004 Palencia, Spain

ABSTRACT

Nutrient pollution, particularly nitrogen (N) and phosphorus (P), represents one of the most pressing water quality challenges in European fluvial systems. Excessive nutrient loads drive eutrophication processes, compromising aquatic ecosystem functioning and threatening the ecological status of water bodies. In this context, the Water Framework Directive (WFD) establishes a comprehensive framework for the protection and restoration of water bodies, requiring member states to achieve good ecological and chemical status. Understanding the spatial and temporal dynamics of nutrient concentrations in fluvial systems is therefore essential for the design of effective management measures and the fulfilment of WFD objectives.

This study analyses the spatial and temporal evolution of N and P concentrations along a humid temperate catchment located in Galicia (NW Spain), where land use is predominantly forest (65%) and agricultural (30%). Water quality was monitored at four sampling points: a headwater reference site, two intermediate points, and a closing gauge station at the catchment outlet.

Results reveal a marked increase in nutrient concentrations from the headwater reference site towards the downstream stations. Median nitrate (NO_3) concentrations at the headwater were 2.0 mg L^{-1}, increasing to values between 4.7 and 5.2 mg L^{-1} at the intermediate and outlet stations. A similar spatial trend was observed for phosphorus. The variability of concentrations, assessed through the 10th and 90th percentiles, was generally higher at the downstream stations, reflecting the heterogeneous influence of agricultural land use on nutrient dynamics. Significant seasonal variability was also observed, with the highest concentrations recorded during the wet season, suggesting that rainfall-driven surface runoff from agricultural areas constitutes the main nutrient transport pathway to the stream network

Corresponding Author: M. Teresa Taboada-Castro

STUDY OF MECHANICAL STRESSES IN AN AREA NEAR THE CUTTING EDGE OF STANDARD TEETH USED TO DETERMINE THE DISPLACEMENT FORCES DURING THE MACHINING OF COAL AND ROCK

Daniel Radu [1], Ioan Doşa [1]

[1] Department of Mechanical, Industrial and Transport Engineering, University of Petrosani; 20 University Street, 332006, Petrosani, Romania

ABSTRACT

In this paper, we attempt to establish the stress distribution in an area near the cutting edge of a standard tooth using elasticity theory and numerical methods, when the stress forces are known from experiments.

To improve the design and quality of the cutting teeth on the bucket wheels of excavators used for coal extraction in mines, it is necessary to know the forces acting on them during the excavation process. These forces can be determined under laboratory conditions using standard teeth, or directly on the excavator using actual teeth (when the machine is operating under real-world conditions). In both cases, the mechanical stresses in the cutting teeth are determined and then converted into forces.

Although the second option is more accurate, due to its complexity and the high financial cost required to procure the necessary imported equipment, the first option was chosen. Knowledge of the maximum stresses occurring near the cutting edge of the standard cutting teeth is necessary to determine, by analogy, the geometric characteristics, material, and treatments (thermal, chemical, mechanical) required for the actual teeth.

The stress state in a detached element near the cutting edge of the tooth under study was also determined using the finite element method, when the tooth is loaded with the the experimentally determined tangential and normal forces (F_{x_0} and F_{y_0}) and a comparation was made between the results obtained using the equations of elasticity theory and those with F.E.M.

Corresponding Author: Daniel Radu

SUSCEPTIBILITY MAPPING OF COLLAPSE SINKHOLES RELATED TO ANTHROPOGENIC CAVITIES: THE CASE OF ALTAMURA (APULIA, SOUTHERN ITALY)

Rocco Fracchiolla [1], Giovanni Bonamassa [2], Isabella Serena Liso [1], Piernicola Lollino [1], Marian Marschalko [3], Giacomina Lorusso [2], Mario Parise [1]

[1] Earth and Environmental Sciences Department, University of Bari Aldo Moro, Campus Universitario "Ernesto Quagliariello", Via E. Orabona 4, 70125 Bari, Italy
[2] Municipality of Altamura, Settore Sviluppo e Governo del Territorio, Piazza Repubblica 8, 70022 Altamura (BA), Italy
[3] Department of Geological Engineering, Faculty of Mining and Geology, VŠB – Technical University of Ostrava, 17. listopadu 2172/15, 708 00 Ostrava-Poruba, Czech Republic

ABSTRACT

Introduction. Beneath the town of Altamura lies an extensive network of anthropogenic cavities, originally excavated as underground quarries in the local calcarenite and abandoned once extraction ceased. Collapse of vaults and walls of these cavities is a well documented cause of sinkhole formation at the surface, and several such events have already occurred within the municipal area. Much of the ground now affected was farmland until a few decades ago, and the intense urban development that followed may itself have worsened the stability conditions of the cavities below. The problem is therefore one of land-use planning as much as of engineering geology.

Objectives. The study forms part of a PhD project now approaching completion. Its main purpose is to produce a GIS-based susceptibility map of the municipal territory. A second objective is methodological: empirical and machine learning approaches are applied to the same dataset in order to compare their performance under identical input conditions.

Methods. Two sources form the backbone of the analysis: an inventory of documented sinkhole events, and the surveyed extent of the cavity network held in the Catasto Cavità Sotterranee (Cadastre of Underground Cavities), the municipal register maintained by the Municipality of Altamura. These are combined with a digital terrain model and with the results of geotechnical investigations. Four predisposing factors were derived and mapped: overburden thickness, span-to-thickness ratio of the vault, depth of the void, and land use. Layer combination was then carried out twice, once by empirical weighting and once by machine learning.

Results. A geospatial database was assembled linking sinkhole occurrences to cavity geometry, and the factor layers were derived from it. The presentation sets out how each factor was parameterised and why, together with the structure of the workflow.

Conclusion. The study provides a reproducible workflow for assessing sinkhole susceptibility in urban areas affected by anthropogenic cavities, compares the outcomes of the two modelling strategies, and discusses the data requirements and the main sources of uncertainty affecting the results.

Corresponding Author: Rocco Fracchiolla

SYSTEM FOR GENERATING PURE TORSION IN DELAMINATED MULTILAYERED BARS UNDER IMPACT ACTION OF EXTERNAL LOADING

Victor Rizov [1]

[1] Department of Technical Mechanics, University of Architecture, Civil Engineering and Geodesy, 1 Chr. Smirnensky blvd., 1046 – Sofia, Bulgaria

ABSTRACT

The interest in multilayer structural materials currently shown by civil engineers is provoked by the very good properties of these materials, such as high strength and relatively low weight. Essentially, multilayer materials are combinations of different layers that are bonded together by adhesion. The layers in a multilayer material can be arranged in such a way as to achieve the fullest possible use of their strength. However, to ensure the safe functioning of structures made of multilayer materials, it is of great importance to guarantee excellent adhesion between the layers. The breakdown of adhesion between layers is known as delamination. The basic aim of this paper is to present a system for generating pure torsion in multilayered bars with delamination under impact action of external loading. This system can be used in experimental investigations of delamination in multilayered bars subjected to pure torsion under impact loading. In fact, the system transforms the impact load caused by a falling striker into a torsion moment applied to the front end of the bar. The system represents a lever mechanism consisting of a rigid horizontal lever, a rigid vertical rod and two circular discs. The rod is connected by a joint to the front end of the lower arm of the delamination in the multilayered bar. The lever is connected by a joint also to front end of the upper arm of the delamination. The two circular discs are connected by joints to the lever. In addition, the discs are also connected to each other with a thread. The impact is caused by a striker that falls downward, sliding along the right vertical branch of the thread. The striker is a cylindrical body with a hole at its centroid. The thread passes through this hole so that the striker can slide down the thread. A theoretical analysis of the bar with delamination is performed. In this regard, a solution of the strain energy release rate (SERR) in the multilayered bar under pure torsion caused by the impact is presented. The SERR is found as a function of the torsion moment applied on the front end of the bar. To verify the solution of SERR, an approach known from specialized literature is used. The behavior of SERR when changing the torsion moment and some geometrical and material parameters of the lever system and the multilayer rod is studied. This paper can serve as a theoretical basis for developing an experimental setup to study delamination in multilayered bars under pure torsion caused by impact loading.

Corresponding Author: Victor Rizov

TECHNOLOGICAL AND BIOLOGICAL STRATEGIES FOR INCREASING PROFITABILITY IN INTEGRATED AQUACULTURE FARMS IN ROMANIA

Gabriela Alina Cioromele [1], Carmelia Mariana Bălănică Dragomir [1], Floricel Maricel Dima [1, 2], Nicoleta Axinti [1], Magdalena Tenciu [2]

[1] "Dunărea de Jos" University of Galați, Domnească Street, no. 47, Galați, 800008, Romania
[2] Research and Development Institute for Aquatic Ecology, Fisheries and Aquaculture - Galati (ICDEAPA), 54 Portului Street, Galati, Romania

ABSTRACT

Optimizing the profitability of aquaculture farms by integrating valuable species and modern production technologies is a fundamental strategic approach, capable of improving economic efficiency, diversifying the productive structure and strengthening the sustainability of farming systems.

This study evaluates the evolution of the physicochemical parameters of sediments from an experimental aquaculture farm in Galați County, Romania (January 2024 –September 2025), correlating their dynamics with the local meteorological context, in order to optimize productive management and the integration of valuable species. The pH of the sediments decreased from 9.29 (May) to 8.36 (September), indicating a moderate alkaline stabilization towards the end of the warm season. The organic matter content varied strongly (63.81–118.71 mg $KMnO_4$/100 g), with a maximum in July; calcium reached 60.12 mg/100 g in June, and magnesium increased to 29.16 mg/100 g in September; the Ca/Mg ratio went from 6.60 (August) to 0.96 (September), suggesting relevant changes in mineralization. Nitrogen indicators revealed intense microbiological activity (nitrates max. 5.66 mgN/100 g in August; nitrites max. 0.331 mgN/100 g in July), while phosphates (0.063–0.373 mg/100 g) and sulfates (53.1–197 mg/100 g) showed seasonal variations in nutrient intake.

The meteorological context was synthesized on two contrasting benchmarks: January 2024, with monthly Tmed ~1.17°C, RHmed ~89.4%, Ptot ~8.6mm (12 days with precipitation; daily maximum 4mm on January 8), respectively September 2025, with Tmed ~18.9°C, RHmed ~71.9%, Ptot ~11.6mm (5 days with precipitation; peak of 9.2mm on September 17). These conditions — from cold and wet winters to warm autumns with punctual rainy episodes — can influence nutrient mobilization, organic matter decomposition and benthic habitat quality, partially explaining the variations observed in sediments.

The results support that integrated sediment–meteorology monitoring provides a solid basis for calibrating rearing, feeding and recirculation technologies, facilitating the implementation of an integrated aquaculture farm model with increased economic efficiency and sustainable resource use.

Corresponding Author: Carmelia Mariana Bălănică Dragomir

THE INFLUENCE OF ELECTROMAGNETIC FIELD EXPOSURE ON C:N RATIOS IN INDUSTRIAL SEWAGE SLUDGE

Arkadiusz Bieszczad [1]

[1] Department of Bioprocess Engineering, Energy, and Automation, Faculty of Production and Energy Engineering, University of Agriculture in Krakow, Poland

ABSTRACT

Industrial sewage sludge generated by paper mills is characterised by considerable variability in composition and physicochemical properties, which may hinder its treatment and subsequent recovery. There is therefore a need for conditioning methods that can improve the availability and transformation of organic matter without introducing additional chemical reagents. This study evaluated exposure to an electromagnetic field as a potential conditioning factor affecting carbon-to-nitrogen ratios in industrial sewage sludge. The objective was to determine the influence of field induction and exposure time on C:N ratios measured in both the solid fraction and the resulting leachate, and to identify operating conditions suitable for further investigation. The research was conducted in two stages. The first stage was performed under laboratory conditions and included magnetic-field induction values from 18 to 102 mT and exposure times from 15 to 120 min. The second stage was carried out under conditions resembling plant operation and focused on the narrower induction range of 18–70 mT, while retaining the same exposure-time interval. Carbon-to-nitrogen ratios were determined separately for the dry fraction and leachate in order to assess changes in the distribution and availability of organic matter. The results showed that field induction had a greater effect than exposure time. Induction values above 83 mT produced less favourable results than lower field strengths. In the relevant test variants, C:N ratios in the leachate and solid fraction increased substantially relative to the comparative sample, with the effect being more pronounced in the leachate. An increase in organic carbon was also observed following electromagnetic-field exposure. The findings indicate that appropriately selected electromagnetic-field conditions may influence sludge properties relevant to microbial activity and organic-matter transformation. The study identifies electromagnetic-field conditioning as a promising direction for further work on the sustainable management of industrial paper-mill sludge. Future studies should verify microbiological responses, energy demand and the reproducibility of the effect at operational scale.

Corresponding Author: Arkadiusz Bieszczad

THERMAL ACTIVITY AND VEGETATION PATTERNS ON SMOULDERING COAL-WASTE DUMPS IN THE UPPER SILESIAN COAL BASIN

Anna Abramowicz [1], Justyna Ciesielczuk [1], Ryszard Chybiorz [1], Oimahmad Rahmonov [1]

[1] University of Silesia in Katowice, Faculty of Natural Sciences, Będzińska 60, 41-200, Sosnowiec, Poland

ABSTRACT

Coal-waste dumps are a widespread element of the post-industrial landscape in coal basins and represent a significant environmental concern. One of the most serious problems associated with these sites is the spontaneous heating of waste material, which may lead to the development of subsurface smouldering fires. Such thermal processes affect the structural stability of coal-waste dumps and contribute to changes in soil chemistry, while also influencing vegetation development and plant succession. In response to these challenges, field studies were conducted to examine thermal activity and vegetation patterns on a selected coal-waste dumps located in the Upper Silesian Coal Basin. The research aimed to assess the relationship between substrate temperature and vegetation condition, and to evaluate the usefulness of ecological observations as indicators of thermal processes.

The results indicate that even relatively small dumps exhibit consistent, reproducible patterns of thermal activity. Zones of complete vegetation loss coexist with areas of scattered plant growth and sections exhibiting diverse ecosystem regeneration. Early stages of colonisation are initiated by pioneer species, which are able to tolerate unstable and thermally affected conditions. In some surfaces, the presence of biological soil crusts was also observed, mainly at the borders of thermally active zones. Their occurrence in these transition areas suggests that they develop under conditions of thermal stress and elevated contamination levels, where surface processes begin to stabilise but are still influenced by underlying heat. A clear correlation was observed between substrate temperature and vegetation condition, suggesting that plant health can serve as a reliable indicator of ongoing thermal processes and the degree of dump stabilisation. The study demonstrates that monitoring vegetation patterns alongside temperature measurements provides a practical and effective approach to assessing environmental risks and the current state of coal-waste dumps, particularly in areas where historical records are limited or absent. Furthermore, the findings emphasise the role of ecological recovery in indicating the effectiveness of natural stabilisation processes, which is essential for guiding reclamation strategies.

From a practical point of view, coal waste dumps should be treated as sites that require continuous monitoring and individual assessment. The approach applied in this study enables the identification of areas that may develop environmental or safety problems at an early stage. This is especially relevant where coal-waste dumps are located close to built-up areas and where decisions about future land use are necessary. The findings can therefore support monitoring, planning, and help evaluate options for further use of post-mining land.

Corresponding Author: Anna Abramowicz

THE USE OF DEEP EUTECTIC SOLVENTS IN THE RECOVERY OF METALS FROM SULFIDIC ORES

Viktória Kožárová [1], Ingrid Znamenáčková [1], Silvia Dolinská [1], Slavomír Hredzák [1]

[1] Institute of Geotechnics of the Slovak Academy of Sciences, Watsonova 45, 040 01 Košice, Slovakia

ABSTRACT

Strategic metals represent a key role in modern industry, energy systems, electronics and low carbon technologies. Among them, copper holds a particularly important position due to its high electrical and thermal conductivity, wide range of industrial applications and its essential role in electrification and the development of renewable energy infrastructure. At the same time, the growing demand for strategic metals, together with the gradual depletion of high-grade ores, increases the need for more sustainable and efficient methods for their recovery from both primary and secondary resources. In this context, increasing attention is being paid to the research of alternative solvents, which include ionic liquids. Although ionic liquids have been extensively studied for metal recovery, their practical application may be limited by high costs, complex synthesis and concerns related to toxicity and environmental impact. Their subclass is represented by eutectic solvents, which offer a promising alternative due to their relatively simple preparation, adjustable properties, low volatility and potential compatibility with the principles of green chemistry. The subject of this research is the potential use of deep eutectic solvents in the recovery of strategic metals from primary and secondary sources, with emphasis on copper-bearing materials. The contribution focuses on describing the basic characteristics of eutectic solvents, their formation and classification, as well as the main factors influencing their extraction and leaching efficiency. The presented paper describes the processing of sulfide ores, their concentrates and waste containing Cu, Fe, Zn, etc. Attention was focused on the selection of suitable components of the deep eutectic solvent, namely the hydrogen bond donor and acceptor, with the aim of enhancing the efficiency of metal dissolution.

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Corresponding Author: Ingrid Znamenáčková

ULTRA WIDE BAND GAP MATERIAL GALLIUM OXIDE, TECHNOLOGY, PROPERTIES, CHARACTERIZATION

Amiran Bibilashvili [1, 2], Zurab Kushitashvili [2], Ekaterine Chikoidze [3], Givi Skhiladze [2], Ioseb Peikrishvili [2], Beqa Melua [2]

[1] Ivane Javakhishvili Tbilisi State University, Chavchavadze ave.1, 0179 Tbilisi, Georgia
[2] LEPL Institute of Micro and Nanoelectronics, Chavchavadze ave.13, 0179 Tbilisi, Georgia
[3] GEMaC, CNRS-UVSQ, Université Paris-Saclay 45, Ave Etats Unis, 78035, Versailles, France

ABSTRACT

Gallium oxide (Ga_2O_3) is a ultra wide-bandgap semiconductor (4.7 ~ 5.3 eV) that has garnered significant attention for its exceptional structural, optical, and electrical properties, which make it suitable for high-power electronics, UV photodetectors, and catalysis. Structurally, Ga_2O_3 exhibits polymorphism, with α-, β-, γ-, δ-, ε-, and κ-phases, among which β-Ga_2O_3 is the most thermodynamically stable under ambient conditions. Synthesis methods, including hydrothermal growth, sol-gel processes, RF/DC sputtering, atomic layer deposition (ALD) and molecular beam epitaxy (MBE) enable precise control over phase formation, crystallinity, and defect density.

In the present work is demonstrated the reactive magnetron sputtering (DC) technology for formation β-Ga_2O_3. As substrate is used 2-inch, (0006) orientation and 400μ thickness sapphire wafer. Experiments are made in different condition (power, oxygen partial pressure, time, temperature etc.) for analyzing the best technological rout of growing Ga_2O_3 with good structural, optical and electrical properties.

X-ray structural analysis (XRD) was measured and a small peak was identified at the diffraction angle $2\theta=20.5^0$. In terms of optical properties, transmission spectra were measured. The calculated optical band gap was ~ 5 eV. Electrically, Ga_2O_3 behaves predominantly as an n-type semiconductor due to oxygen vacancies. Undoped β-Ga_2O_3 exhibits high resistivity (~10^6 Ω·cm). Electrical measurements also were performed on an HP 4279A C-V Meter to obtain a C-V profile, and the thicknesses of the deposited films were calculated from the graphs and compared with the values measured on the profilometer.

Corresponding Author: Amiran Bibilashvili

UNDERWATER EXPLOITATION OF COAL AND GRAVEL ON THE BANK OF THE DANUBE RIVER, AT THE KOVIN MINE, SERBIA

Branka Jovanović [1], Svetlana Polavder [1], Željko Praštalo [1], Rade Šarac [1]

[1] Mining institute, Belgrade, Batajnički put 2, Serbia

ABSTRACT

The Kovin coal deposit and the Kovin Mine are located on the left bank of the Danube, 18 km east of the town of Kovin and 70 km from the capital, Belgrade.

The Kovin deposit has been thoroughly investigated and defined based on exploratory wells that were periodically drilled from 1975 to 2025.

During more than 3 decades of underwater exploitation of coal and associated sediments at the Kovin Mine (since 1992), from the experimental phase to full development, numerous mining facilities have been built in order to improve and round off the process of exploitation, processing and commercialization of coal and gravel.

The aim of this article is to present underwater exploitation of coal and gravel applied in the conditions of the Kovin deposit and some of the positive experiences in the field of mining and environmental protection.

Corresponding Author: Branka Jovanović

USING OF ADV METHOD FOR MEASURING OF FLOW VELOCITY COMPONENTS IN THE STREAM

Radoslav Schügerl [1]

[1] Institute of Hydrology, Slovak Academy of Sciences, Dúbravská cesta 9, 841 04 Bratislava, Slovakia

ABSTRACT

In this article, the results of velocity profile measurements in a stream by using the ADV method (Acoustic Doppler Velocimetry) are presented. The measurements are carried out in the Malina stream (N 48.3469678, E 16.9651006). The velocity profile was measured with using the three-dimensional ultrasound probe of ADV device - FlowTracker (SonTek/YSI). The obstacle, represented with 120-liters barrel, was installed into the stream and by this way the velocity profile was modified. First, the undisturbed velocity profile was measured and subsequently there was measured the modification of this velocity profile caused by the obstacle installation. The FlowTracker device run in so-called „General mode operation“, in which all three velocity vectors in the measured point are recorded. Velocities were measured in the proposed grid of points, the same grid was used for both cases (without the obstacle, with the obstacle). The grid was created by verticals along the cross-section profile and by several value of depth in each vertical.

The results of the measurement is a database of v_x, v_y, v_z components in the grid points, from which it is possible to determine the velocity profiles of individual components or resultant of these three components of the point velocity. The measurement results confirmed the suitability and applicability of the ADV method represented by FlowTracker 3D to determine the distribution of point velocity components in the cross-section profile. This method, as one of the few ones, allows to obtain the values of the velocity components at any point of flow directly in the field conditions.

Corresponding Author: Radoslav Schügerl

VERTICAL ACCURACY ASSESSMENT OF POINT CLOUD AND DIGITAL TERRAIN MODEL DERIVED FROM HANDHELD LIDAR-SLAM MOBILE SCANNING IN A GEOMETRICALLY POOR URBAN ENVIRONMENT

Emiliya Ilieva [1], Petya Koleva [1]

[1] Department “Applied Geodesy”, University of Architecture, Civil Engineering and Geodesy (UACEG), 1 H. Smirnenski Blvd., Sofia 1046, Bulgaria

ABSTRACT

This study evaluates the vertical accuracy of a point cloud and a digital terrain model derived from a handheld LiDAR-SLAM mobile laser scanner. Despite the growing use of handheld SLAM systems, studies focusing on the vertical accuracy of derived terrain products in geometrically poor urban environments remain limited. The investigation was performed using the FJD Trion P1 system and FJD Trion Model software within a geometrically poor urban environment characterized by a limited number of distinctive features and challenging conditions for SLAM-based localization. The generated point cloud was transformed to the coordinate reference system and height datum of the reference geodetic survey using four independently surveyed control points. In addition to the direct assessment of point cloud elevations, a digital terrain model was generated through ground classification and subsequent terrain modelling procedures, allowing the influence of the processing workflow on the final vertical accuracy to be evaluated. The direct comparison of 111 check points extracted from the point cloud against independently acquired total station reference measurements resulted in a vertical RMSE of 4.45 cm. Similarly, the derived digital terrain model achieved a vertical RMSE of 4.74 cm based on 136 check points from the reference geodetic survey. The close agreement between the RMSE values of the raw point cloud and the derived terrain model suggests that the applied ground classification and terrain modelling procedures introduce only a minor additional uncertainty into the results. Most check points showed deviations within 5 cm. The largest deviations, reaching up to 10 cm, were spatially concentrated within a limited part of the study area, indicating localized effects rather than a uniform systematic error. The results demonstrate that the combination of the FJD Trion P1 handheld LiDAR-SLAM system and FJD Trion Model can provide reliable centimetre-level vertical information in geometrically poor urban environments and support engineering and topographic surveying applications.

Corresponding Author: Emiliya Ilieva

VIBRATION ANALYSIS AND ROCK DEBRIS IN THE ROCK DRILLING PROCESS

Mária Bali Hudáková [1], Víťazoslav Krúpa [1], Alexander Kiovský [1], Pavol Vavrek [1], Edita Lazarová [1], Lucia Ivaničová [1]

[1] Institute of Geotechnics of the Slovak Academy of Sciences, Watsonova 45, SK-04001 Košice, Slovakia

ABSTRACT

This study analyzes laboratory rock drilling of andesite and limestone using an experimental drilling rig. The description of mechanical rock disintegration was based on defining the properties of the drilled rocks, describing the measured vibrations, calculating the output parameters of the rock disintegration, and comparing them under different drilling regimes using the same drilling tool. Experiments were conducted using two three-channel surface-set diamond core drill bits with identical diamond sizes. The rock disintegration performance was assessed using the measured output variables, which were torque and penetration rate of the drill bit. From these, the specific energy and drilling strength were calculated. Vibration diagnostics were based on the measured vibration acceleration signal. The primary aim of the experimental research was to gain insight into how changes in thrust force and rotational speed (controllable input variables) affect the size of the drill debris and vibrations for the selected rock-tool system. The energy intensity of drilling andesite and limestone was evaluated using specific energy and rock debris. The rock debris was assessed using the coarseness index CI and the absolute size constant d′, employing the Rosin–Rammler method. Comparing drilling into two different types of rocks, limestone and andesite, resulted in a more precise classification of the rock debris, vibration emissions, and their relationships. The drilling of andesite and limestone was analyzed by calculating the overall vibration level in the 4000-9000 Hz frequency range using the power spectral density function. This evaluation considered variations in the constant drilling regime and was compared with the specific energy values obtained and the calculated inflection point. The inflection point indicates the start of the efficient disintegration region, where chipping occurs. It was found that evaluating only axial vibrations to describe the rock disintegration region is insufficient; it is also necessary to monitor lateral and torsional vibrations for a more comprehensive understanding of the rock-tool interaction. The results included a comparison of the power spectral density in the high-frequency range with the coarseness index (CI) and the ratio between specific energy and drilling strength. In the high-frequency range of 6500 Hz, the rock-tool interaction was characterized by higher power spectral density, increased coarseness index, and decreased drilling strength observed during limestone drilling.

Corresponding Author: Mária Bali Hudáková

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