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RATE OF RIVERBANKS EROSION USING VARIOUS RESEARCH METHODS

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Abstract

The retreat of river banks is the result of various inter-related natural and anthropogenic geomorphic processes. The research was carried out on 6 research sites located in southern Poland, in the Podhale region. The research was conducted in the period 2018 - 2023. The basic research methods were the erosion pin method and terrestrial laser scanning. Measurements on erosion pins were performed 6-8 times a year, and terrestrial laser scanning 1-2 times a year. The main goal of the research was to determine the quality of the results obtained using the erosion pin method verified by terrestrial laser scanning. Based on the obtained measurements, the following were shown at individual research stations: study site 1 - using the erosion pin method - the average erosion rate was 71.4 cm, and using the laser scanning method - 71.2 cm; study site 2 (respectively) - 81.4cm, 78.8cm; study site 3 - 39.2 cm, 42.2 cm; study site 4 - 57.2cm, 58cm; study site 5 - 60.4cm, 59cm; study site 6 - 75.6cm, 81cm. However, the discrepancies in individual years were greater (the result obtained using the erosion pin method was taken as 100%) - for study site 1 - they ranged between 90.2% and 110.9%, for study site 2 - 91.9% and 114.3%, for study site 3 - 73.2% and 125%, for study site 4 - 86.5% and 140.9%, for study site 5 - 88.2% and 117.9%, for study site 6 - 89.3% and 96.3%. Based on the results obtained, the erosion pin method can be considered very accurate, showing the same direction and rate of river bank erosion

Key words: erosion pins, terrestrial laser scanning, riverbanks erosion

THE DEVELOPMENT OF THE NORTHWESTERN PART OF THE HEDVIKA COLLIERY SPOIL HEAP, UPPER SILESIAN COAL BASIN, CZECHIA

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Abstract

The Hedvika spoil heap was created by depositing spoils from the Hedvika mine into the gully system of the Orlovská plateau. In terms of geomorphic typology, Hedvika is classified as a spoil heap platform, characterized by a large heap formation with highly rugged relief and ongoing thermal activity. Geomorphologically, the most distinctive area is the burnt-out northwestern section, which exhibits the highest degree of ruggedness and contains a variety of geomorphological forms. This poster focuses on geomorphological development of the northwestern part of the Hedvika spoil heap and the current state of geomorphological research in this area. To clarify development of the spoil heap were used archival orthophotos, aerial surveys images, archival data and mapping of geomorphological forms and processes. The development of this area began around the middle of the 1950s. During the following decade, thermal activity and the bulging of bedrock at the foot of the heap occurred, leading to the formation of tension cracks at its crest. Subsequently, coal sludge was deposited on the slopes, and by the late 1960s, the heap's shape had been stabilized. Today, the geomorphology of the heap is influenced by spoil subsidence caused by burning, tree uprooting, and animal activity, which has created a system of burrows in the slopes. During the survey, the presence of ventarols, was observed in the tension cracks, with their existence confirmed by temperature measurements. The structure, thickness of spoil heap and the presence of the bulging block were analysed using geophysical methods, specifically electrical resistivity tomography (ERT).

Acknowledgement: *This research was supported by the internal project of the University of Ostrava no. SGS06/PřF/2025. Special thanks go to Michal Březný for his assistance in fieldwork and data processing.*

Key words: Ostrava-Karviná mining region, spoils, anthropogenic landforms, thermal activity, tension cracks

GEOMORPHOLOGICAL FUNCTIONS AND HYDRAULIC CONDITIONS OF GRAVEL SPAWNING GROUNDS OF BROWN TROUTS, AN EXAMPLE FROM POLISH UPLAND RIVERS

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Abstract

The paper presents the effect of implementation work carried out in the riverbed of one of the rivers in the Polish uplands. The aim was to restore the spawning ground of brown trout. Brown trout is a species dependent on conservation measures. The population of brown trout in the catchment area of the Świętokrzyskie region (Polish uplands) occurs through stocking activities. This project was collaborative, with various stakeholders coming together to restore the spawning ground. One implementation activity that can be carried out is the restoration of spawning grounds that improve the breeding conditions of brown trout, which are also used by other fish species and aquatic invertebrates. The implementation work was preceded by field measurements (hydrodynamic measurements, bottom sediment sampling), which precisely determined the required granulation and amount of gravel needed to restore the spawning ground. After the project was completed, the same level of collaboration was maintained in the repeated hydrodynamic measurements, sediment sampling and analysis, and inventory of spawning nests.

The studies show that this collaborative approach led to a successful restoration of the spawning ground. The velocity of the spawning section increased, and sand accumulation in the gravel sediments significantly reduced. These factors improved reproductive conditions in the spawning grounds, translating into more spawning nests observed after the project was implemented.

Key words: brown trout, spawning ground, fish species, aquatic invertebrates, reconstruction

ROLE OF CAPROCK THICKNESS ON STABILITY OF MESA ESCARPMENTS

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Abstract

Steep escarpments at the margins of mesas are frequently affected by landslides, often driven by the geomechanical contrast between the caprock—typically a more competent upper layer—and the underlying, weaker subcaprock. While mesas exhibit a wide range of caprock and subcaprock thickness configurations, the influence of caprock thickness on slope stability remains poorly understood. Landslides occur across a broad spectrum of caprock ratio values (the ratio between caprock thickness and the height of mesa), and on a global scale, no clear relationship exists between caprock ratio and landslide mobility. However, at a local scale, variations in caprock ratio may influence differences in landslide mobility. To assess the role of caprock ratio in slope stability, I employed numerical modeling using limit equilibrium analysis (Slide2 software). The results indicate that when the caprock constitutes more than 25% of the mesa's total thickness, it has a stabilizing effect. Sensitivity analysis further reveals that the geomechanical properties of the subcaprock exert a greater influence on overall stability than those of the caprock. Additionally, the potential role of vertical loading appears to be limited which is suggested by some authors as a potential influencing factor seems to be limited.

Acknowledgement: *This work was supported by the Czech Science Foundation, project 23-07310S.*

Key words: mesa, landslide, slope stability, numerical modeling

GEOMORPHOLOGICAL FUNCTIONS OF THE BLOCK RAMP DESIGNED IN THE NAREW RIVERBED

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Abstract

The paper concerns the innovative application of hydrotechnical technologies for protecting nature, particularly in stabilizing water levels in the Narew National Park. The project's main objective is to modernize the existing, partially destroyed weir on the Narew River by building a new hydrotechnical structure. This structure aims to raise the water level, which is crucial for maintaining marshes and communities of sedge and reed vegetation necessary for the survival of protected species of fauna and flora in the park.

The Narew National Park is a habitat for many endangered species of birds, such as the white-tailed eagle, ruff and aquatic warbler, as well as mammals, including the European beaver, muskrat, European hedgehog and larger animals, such as the moose and red deer. The park has been recognized as an IBA (Important Bird Area) since 2010, emphasizing its importance for protecting migratory and local birds. There are also protected fish species, such as the common bitterling, the stone loach, the spined loach, and the Ukrainian brook lamprey.

The project envisages using a natural barrier made of stone riprap and a block ramps, enabling the migration of fish and other aquatic animals. The iterative modelling process and the use of modern CFD numerical calculations allowed for the precise determination of the shape of the block ramps, the size of the chambers and the distribution of stones, which will ensure appropriate water permeability and the migration of organisms. The project's innovative nature lies in using advanced computational technologies to minimize the impact of hydrotechnical structures on the ecosystem while restoring the natural water conditions necessary for adequately functioning the park's ecosystem.

The project is an example of how modern hydrotechnical solutions can be effectively used in nature conservation, combining technical aspects with the need to preserve biodiversity. Implementing this project will contribute to the long-term protection of valuable natural habitats in the Narew National Park, ensuring the stabilization of water conditions necessary for many protected species.

Key words: block ramp, destroyed weir, CFD numerical modelling, geomorphological functions, the Narew River

INTRODUCING DYNAMIC THRESHOLD WEIGHTING (DTW) METHOD FOR LANDSLIDE SUSCEPTIBILITY MAPPING

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Abstract

Landslides are among the most devastating natural disasters, causing significant loss of life and property worldwide each year. Over the past two decades, landslide susceptibility mapping has gained immense popularity as a crucial tool for hazard mitigation. Various approaches, including deterministic, geotechnical, machine learning (ML), and artificial intelligence (AI)-based methods, have been extensively used. Among these, ML-based models have emerged as the most widely adopted due to their predictive capability. However, a key limitation of ML models is their "black-box" nature, which restricts understanding of how different parameters contribute to landslide susceptibility. This lack of interpretability highlights the need for a more explainable and sophisticated modeling approach. To address this gap, we introduce the **Dynamic Threshold Weighting (DTW)** method, which enhances model transparency while maintaining high predictive performance. We applied this approach in the Eastern Himalaya (Upper Teesta Basin) using 16 conditioning factors. Our results demonstrate high accuracy, with the lower basin exhibiting the highest susceptibility. Additionally, we explored the role of land surface temperature (LST) in landslide distribution and found that most landslides occurred in areas with higher temperatures, suggesting a potential thermal influence. The findings of this study provide valuable insights for landslide hazard assessment and risk management. We encourage researchers to apply our DTW method in different regions and compare its performance with existing algorithms to further enhance explainable susceptibility modeling.

Key words: Dynamic Threshold Weighting, Landslide susceptibility, Machine learning, Temperature, Himalaya

CONTROL OF RIVER CAPTURE, LITHOLOGY AND CLIMATE IN GEOMORPHIC EVOLUTION AND MODERN EROSION RATES IN CENTRAL PENINSULAR INDIA

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Abstract

The Peninsular Indian craton has remained largely tectonically stable throughout the Late Cenozoic era. Within this post-orogenic landscape, erosional processes are influenced by a dynamic interplay of lithology, structural controls, and climatic factors. Among these landscapes, the Godavari basin—the largest drainage system in central Peninsular India—offers compelling evidence of these complex interactions, as reflected in notable geomorphic features such as knickpoints and drainage anomalies. Despite its significance in understanding tropical geomorphic processes within a cratonic environment, no comprehensive study has yet analyzed the integrated effects of lithology and climate on the basin's landscape evolution at a regional scale. This paper aims to bridge that gap by leveraging high-resolution digital topographic data combined with litho-structural elements, hydro-sedimentary responses, and rainfall distribution patterns. Various geomorphic indices, including hypsometric analysis, river longitudinal profiles, stream gradient index, steepness-concavity index, rainfall-relief relationships, and modern erosion rates, are assessed to unravel the underlying mechanisms driving landscape transformation. Results indicate a dual geomorphic character within the basin: the Deccan and central regions exhibit stability with minimal erosion, whereas the northern and eastern sectors experience episodic river capture events and ongoing landscape adjustment. Notably, variations in precipitation patterns emerge as the dominant factor influencing differential erosion rates across the basin.

Key words: Lithology control, River capture, Climate, Erosion rate, India

MODELING AVALANCHE RISK DYNAMICS: A COMPARISON OF RAMMS::EXTENDED AND GRASS GIS SIMULATIONS

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Abstract

The high mountain areas of Slovakia, like other parts of the world, serve as important year-round tourist destinations. However, during the winter season, these areas are associated with increased avalanche risk, which can endanger visitors traveling on mountain trails. This study focuses on avalanche hazard modeling in the Žiarska Valley in the Western Tatras and compares the results of two different approaches: the RAMMS::Extended numerical model and the geospatial software GRASS GIS.

The primary objective is to simulate avalanche fall based on meteorological data regarding snow cover height and documented avalanche parameters. Additionally, we aim to quantify potential changes in avalanche risk up to 2034, considering predicted snow conditions and the differences between the two modeling methods. The results highlight differences in the spatial distribution of avalanche hazards between RAMMS and GRASS GIS, providing a better understanding of the strengths and limitations of each approach. These findings could contribute to more accurate avalanche risk assessments and help optimize safety measures for mountain tourism.

Acknowledgement: *The research was carried out within the project VEGA 1/0780/24: „Combining lidar and hyperspectral data with machine learning methods to improve land cover classification“*

Key words: avalanche, avalanche risk, spatial modeling, DMR, RAMMS::Extended, GRASS GIS

EXPLORING THE SPATIAL DISTRIBUTION AND MORPHOMETRIC PARAMETERS OF PERIGLACIAL CROP MARKS UTILISING ORTHOPHOTOS AND SATELLITE IMAGERY IN NORTHWESTERN HUNGARY

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Abstract

Polygonal vegetation and soil patterns (crop marks) can be found in numerous locations throughout the lowlands of northwest Hungary. High-resolution satellite imagery and orthophotos from the Lechner Centre (Hungary), along with profiles of active and abandoned gravel pits, offer valuable insights into the presence of buried landforms. In addition to analysing existing images, we captured drone images (orthophotos) and conducted field excavations in the gravel pits to study these sediments in laboratory conditions.

The polygonal crack networks are generally covered by 0.3 to 0.5 m of Holocene sediments and recent soil, filled with poorly sorted, aeolian fine sand. These polygons typically have a diameter of 15 to 25 meters and exhibit five to seven edges, with depths ranging from 1.5 to 3 metres and an average width of about 1 metre. According to optically stimulated luminescence measurements, these formations were created at the end of the Last Glacial Maximum or during the colder phases of the Greenland Stadial 2.1a-b, approximately 15,000 to 22,000 years ago.

These structures likely represent thermal contraction cracks, also known as relict sand-wedge polygons, and they are among the southernmost occurrences of the late Pleistocene "permafrost" zone in Europe. A detailed study of these features provides valuable insights into the surface evolution processes during this rapidly changing period.

Acknowledgement: *The University of Pécs supported this research (project numbers: 020_2024_PTE_RK/32 and EKÖP-24-3-II-PTE-15).*

Keywords: Sand-wedge polygons, remote sensing, Late Pleistocene, NW-Hungary

MICRO-SCALE FROST WEATHERING AS AN INDICATOR OF PAST PERMAFROST? A COMPARATIVE STUDY

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Abstract

During the Late Pleistocene, permafrost conditions were present in the foreland of the Laurentide Ice Sheet in North America, and supposedly in the Pannonian Basin in Central Europe, 600 km south of the Fennoscandian Ice Sheet. In both areas, sand wedges developed in cold, arid climatic conditions. The aim of this study is to compare the micromorphological properties of the sand wedge (SW) infilling materials and to determine the influence of micro-scale frost weathering on the studied sediments. Fossil sand wedges and their host materials from two study sites in Wisconsin, USA (Olson Pit, Wildenberg Pit) and one study site in Transdanubia, Hungary (Szemenye Gravel Pit) were sampled. The grain size distribution (GSD) of the sediments was determined using a laser diffraction device following standard chemical pretreatment (Konert and Vandenberge, 1997). The morphoscopy of sand-sized (250–500 µm) quartz grains was analysed under a binocular following the methodology of Cailleux (1942) as modified by Gozdzik (1980) and Mycielska-Dowgiałło and Woronko (1998). The surface microtextural characteristics of 15 Wisconsin and 15 Hungarian samples were studied under a scanning electron microscope. Fresh conchoidal fractures and breakage blocks were counted on the grains to estimate the degree of frost weathering on the quartz grains. Both the HU and WI sand wedges are filled with fine sand, although the HU samples are poorly sorted as opposed to the well-sorted WI samples. Grains in the WI sand wedges and the outwash host deposit are generally well rounded, partly originating from aeolian, and partly from a subaqueous environment. In the HU samples, there is a clear difference between the host and the SW infill materials, as the former exhibits more subaqueous grains, while the latter is mainly composed of aeolian grains. Only a few, frost-related microtextures were identified on the mature WI grains, mainly on the convex parts of the grains. The immature HU grains bear more frost-related microtextures, but their type and relative position indicate an initial stage of frost weathering. This comparison shows how the different factors (e.g. number of freeze-thaw cycles, GSD of the sediments, primary microtextural characteristics of quartz grains) may influence the development of frost-originated microtextures and therefore it might be misleading to solely rely on these observations when interpreting sediments affected by permafrost conditions.

Acknowledgement: *The University of Pécs (under project number EKÖP-24-3-II-PTE-15) and Fulbright Hungary are gratefully acknowledged.*

Keywords: periglacial environment, sand wedges, Wisconsin, Pannonian Basin, scanning electron microscopy

TOWARDS A COMPREHENSIVE UNDERSTANDING OF FLASH FLOODS: HYDROLOGICAL INSIGHTS COMPLEMENTING BRÁZDIL ET AL. (2024)

Dominika Faturová[1], Rudolf Brázdil [1,2], Monika Šulc Michalková[1], Jan Řehoř[1,2], Martin Caletka[3], Pavel Zahradníček[2,4]

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Abstract

Flash floods are one of the extreme events that can be enhanced in frequency, intensity, and impact during recent climate change. By Brázdil et al. (2024), the unique database of flash floods in the Czech Republic in the 2001–2023 period was compiled from documentary sources (newspapers, internet sources, CHMI reports, and professional papers) enabled a detailed study focused on the spatiotemporal variability of flash floods, their meteorological, hydrological, and geographical triggers, and their human impacts. For events documented by Brázdil et al. (2024), where flood waves were recorded by water gauging stations at an hourly interval, unit peak discharge was calculated, and the corresponding catchments were subjected to further analysis.

Brázdil, R., Faturová, D., Šulc Michalková, M., Řehoř, J., Zahradníček, P., Caletka, M. (2024): Spatiotemporal variability of flash floods and their human impacts in the Czech Republic during the 2001–2023 period. Natural Hazards and Earth System Sciences, 24, 3663–3682. https://doi.org/10.5194/nhess-24-3663-2024

Acknowledgement: *Support from Masaryk University (grant no. MUNI/A/1469/2023) is gratefully acknowledged.*

Key words: flash flood database, flash flood triggers, physiographic parameters, susceptibility

FAST-TRACKING CHANNEL CHANGE: HUMAN-INDUCED DEGRADATION AND FLOW-DRIVEN MORPHODYNAMICS IN AN INTERMITTENT RIVER

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Abstract

The links between channel morphodynamics, flow variations, and the associated recruitment and storage of large wood (LW) are still not fully understood, particularly in aquatic systems experiencing strong human and natural pressures, such as intermittent rivers in the Mediterranean region. In this study, we examine the rapid upstream propagation of channel degradation — specifically incision and subsequent channel widening — in an intermittent Mediterranean river (Evrotas River, southern Greece) following short-term intensive gravel extraction and riparian vegetation removal during the 2013–2016 period. Using a multidisciplinary approach (GoogleEarth image time series analysis, detailed field inventory, and hydrological modeling), we assess how these disturbances triggered channel adjustments in response to subsequent flow variations. Our findings indicate that the combination of human interventions and high flows facilitated a rapid upstream progression of erosion processes (ca. 2 km), leading to approximately a twofold widening of the active channel within just two years (2017–2019). This morphological transformation increased bank erosion and, consequently, the recruitment of LW into the channel. However, in the 2019–2021 period, the prevalence of relatively low, geomorphologically ineffective flows resulted in the stabilization of incision and widening processes, while LW storage continued to increase due to enhanced trapping efficiency in the widened channel. These results highlight the sensitivity of intermittent Mediterranean rivers to even short-term human interventions and underscore the dominant role of flow variability in driving channel evolution. Additionally, the interaction between morphological adjustments and LW recruitment suggests that LW may influence the post-disturbance evolution of the channel, contributing to sediment retention and potential stabilization processes. Understanding these dynamics is essential for developing effective river management strategies in highly dynamic, human-impacted river systems.

Acknowledgement: *The study was supported by Czech Science Foundation 25-15609S: Hydrogeomorphological Dynamics in the Face of Climate Change: Impacts of consecutive floods on Mediterranean River Channels.*

Key words: channel morphodynamics, flood, large wood, Mediterranean river

PHYSICAL GEOMORPHOMETRY IN CAVE SYSTEMS: A CASE STUDY OF DOMICA CAVE, SLOVAKIA

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Abstract

We introduce a novel application of physical geomorphometry to the Domica Cave system in Slovakia, leveraging high-resolution terrestrial laser scanning to construct a detailed 3D mesh model. This model is the foundation for applying physical geomorphometry principles to subsurface environments. This study defines the calculation of unit total cave work, a subsurface analogue of exogenous work, which establishes a direct link between 3D cave geomorphometry and 2D surface geomorphometry. The workflow involved a novel application of cave profiling comprising an automated extraction of the cave central line and systematically generating transverse profiles. The analyzed section of the Domica Cave follows a largely horizontal trajectory with a slight gradient. The total volume of the section was over 68,000 m^3, with a horizontally projected area of the cave section of around 14,000 m^2. Based on these measurements and assumed uniform rock density, the calculated unit cave work amounts to 122.7 kJ per unit volume of denuded material. The interpretation of the calculated physical geomorphometric parameters requires careful consideration, but the findings highlight the potential of physical geomorphometry in cave research, offering new insights into cave formation processes and their connections to broader landscape evolution.

Acknowledgement: *The presented research was funded by the Slovak Research and Development Agency under contract No. APVV-22-0024.*

Key words: 3D mesh, terrestrial laser scanning, unit total cave work, cave profiles

DENUDATION OF KARST RELIEF BASED ON LIMESTONE TABLETS EXPERIMENT IN THE SLOVAK KARST AREA

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Abstract

Karst surface dissolution is a fundamental process shaping karst landscapes, driven by chemical denudation. This study investigates the dissolution rates of limestone tablets placed at different depths (surface, 20 cm, and 50 cm) in two sites of the Slovak Karst: the Silická Plateau and the Jasovská Plateau. The experiment, conducted from December 2016 to the end of 2021, used two sets of limestone tablets—one made from high-purity limestone and the other from locally sourced limestone, which exhibited lower dissolution rates. Weight loss measurements were taken at three-month intervals. The results show that dissolution was lowest on surface-exposed tablets and highest at 20 cm depth, likely due to increased biological activity in the soil. The dissolution rates ranged from 2.65 to 2.82 mg/cm²/year at 20 cm depth, while overall rates were influenced by seasonal climatic conditions and soil processes. The findings highlight the role of biological and climatic factors in karst surface dissolution and contribute to a better understanding of chemical denudation processes in temperate karst environments.

Acknowledgement: *This research was supported by National Naturel Science Foundation of China (W2412149)*

Key words: karst surface, dissolution, limestone tablets, denudation rate

GEOMORPHOLOGIST IN THE SERVICE OF MINISTER OF TRANSPORT

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Abstract

A significant portion of studies presented at conferences focuses on basic research, aiming to broaden the fundamental knowledge of each scientific discipline — in our case, geomorphology. We often share contributions on new discoveries, descriptions of previously undocumented sites, and fresh data on landscape evolution. However, it is equally important to highlight that geomorphological research can also provide tangible benefits to society through applied, problem-oriented studies.

One of the most prominent examples of such practical relevance emerged in June 2013, when the threat of landslide to linear infrastructure became dramatically evident. A major slope failure occurred above the newly constructed D8 highway near Dobkovičky, causing severe damage to the road under construction, destroying a section of railway, and triggering complex legal disputes over the causes and responsibilities of the event. This incident not only underscored the potential hazards posed by unstable slopes but also prompted the Directorate of Roads and Highways of the Czech Republic (ŘSD) to take proactive steps toward landslide risk mitigation.

Since then, the Institute of Rock Structure and Mechanics (IRSM) has been regularly commissioned — approximately every three to four years — to assess planned routes of major highways, bypasses, and state roads for potential landslide hazards. These preventive evaluations combine detailed LiDAR analyses, comprehensive field mapping, and geophysical surveys to identify and assess slope instabilities that could threaten future infrastructure projects.

This contribution aims to present our general methodological approach to such assessments, share insights from some of the most compelling case studies we have encountered, and outline the types of recommendations we provide to the ŘSD. Our goal is to ensure that future transport infrastructure projects are — as much as reasonably possible — safeguarded from repeating the unfortunate fate of the D8 highway. Through this, we hope to demonstrate how applied geomorphology can play a crucial role in enhancing public safety and supporting sustainable infrastructure development.

Acknowledgement: *We acknowledge the support of TAČR project RENS SS02030023 Horninové prostředí (Program prostředí pro život) and the support from the ŘSD.*

Key words: Landslides, road construction, ERT, field mapping, D8 highway

THE HIGH-MAGNITUDE 2024 FLOOD AS A DRIVER OF GRAVEL BAR REWORKING: SEDIMENT AND VEGETATION CHANGES IN TWO CONTRASTING RIVER ENVIRONMENTS

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Abstract

Gravel bars are dynamic geomorphic features that are negatively affected by insufficient flows and reduced sediment supply, often associated with river regulation. Periods of low flow can lead to vegetation encroachment and sediment stabilization, altering the natural dynamics of these features. This research examines the condition of selected gravel bars in the Lučina and Olše Rivers (Czech Carpathian foothills), focusing on sediment grain size and vegetation cover to assess their overall dynamics or stagnation over the period 2020–2024.

The 2024 flood event significantly reworked the gravel bars after a prolonged period of low flows (2022–2023). Sediment grain-size analysis revealed a general coarsening of bar surfaces across most sites (frontal, central, and distal sections) in both rivers. Vegetation was partially removed, yet in many cases, not to the initial unvegetated state observed in 2020. Morphological changes varied between freely meandering and regulated sections. In the Lučina River, bars in freely meandering reaches became shorter and narrower, while those in regulated channels became wider and longer. In the Olše River, initially large bars became shorter, and vice versa, whereas bar width generally increased. In meandering sections, the current force accumulated sediment at the bar edge which contributed to the observed narrowing. The flood also demonstrated sufficient energy to mobilize large, vegetated bar areas in the Olše River, indicating substantial sediment transport.

Sieve analysis confirmed significant sediment redistribution, with surface coarsening being the dominant trend, whereas in some cases, finer flood deposits covered underlying coarser sediments. The findings underscore the considerable impact of the 2024 flood on bar morphology and sediment, with some bars experiencing complete reworking. However, in the dam-regulated Lučina River, the prolonged period of low flows before the flood facilitated extensive vegetation expansion, preventing a full reset of some bars. This suggests that vegetation succession will likely continue in the coming years, reinforcing the long-term stabilization of these features.

Keywords: gravel bar, vegetation cover, grain-size, river regulations

WHAT WE KNOW ABOUT THE HYDROMORPHOLOGICAL EFFECTS OF WATER TRANSPORT? A CASE STUDY OF THE LOWER ELBE

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Abstract

This paper examines the long-term impact of water management and navigation modifications on the hydromorphology of the lower Elbe River in Czechia. The research focuses on gravel-sand bars, which are remnants of the river's natural morphology. The analysis revealed a significant shift in the hydromorphological quality of the river, evaluated using a morphological quality index and historical data. The study analysed morphological and grain-size parameters of selected gravel-sand bars, as well as daily flow data. The results show a significant reduction in channel width and maximum average daily flows, leading to lower disturbance frequencies of the bars. The analysis suggests that close-to-natural processes affect the development of the bars but are influenced by artificial modifications. The findings indicate the need for restoration measures, which are discussed too.

Acknowledgement: *Lorem ipsum odor amet, consectetuer adipiscing elit. Sed convallis integer posuere posuere litora donec hac potenti. Curae magnis interdum malesuada class tincidunt interdum. Platea nascetur platea penatibus suspendisse feugiat arcu ad.*

Key words: hydromorphology, channel changes, river bars, ecological effects, lower Elbe, Czechia

VIRTUAL FIELD TRIPS: HOW TO ENGAGE STUDENTS WHO CAN'T JOIN THE EXCURSION?

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Abstract

Fieldwork and excursions constitute an indispensable component of geomorphology education. However, there are circumstances in which students are unable to participate in fieldwork. Health-related limitations, financial constraints, global pandemics, armed conflicts, and various other external factors may hinder participation. Additionally, some field sites may be inaccessible due to safety concerns or excessive distance from the institution, rendering them impractical for in-person visits. Moreover, traditional field trips often have a considerable environmental footprint, as they frequently require extensive travel by car or even air transport.

This conference poster explores the potential of virtual field trips as an effective tool for either replacing or supplementing traditional fieldwork or excursions. Using the example of a field trip focusing on volcanic landforms of Czechia, we will demonstrate how virtual environment can be utilized and how content can be effectively adapted for digital integration. Furthermore, we will provide practical recommendations for high-quality data collection to facilitate the development of such virtual excursions.

Acknowledgement: *This speech is supported by the SGS-2015-016 NaturTech 5 project of the University of West Bohemia in Pilsen.*

Key words: Virtual excursion, volcanic landforms, Czechia

EXPERT ASSESSMENT OF GEOSITES IN SUBTATRA REGION (N SLOVAKIA)

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Abstract

The SubTatra region includes four ethnographic regions located around the Tatra Mts: Orava, Liptov and Spiš in Slovakia as well as Podhale in Poland. This area is characterized by a very high geodiversity and biodiversity index. Geodiversity is manifested, among others, by the occurrence of abiotic nature objects - geosites of special cognitive, educational and tourist values. The aim of this contribution was to inventory such objects and their expert assessment using point valuation methods and triangulation methods. The authors assessed a total of 44 geosites, which were rock outcrops, including travertine outcrops, fragments of river valleys, lakes, caves, waterfalls, mineral springs, peat bogs, landslides, viewpoints and others. Of all the assessed objects, the best values of the final valuation coefficient were obtained by: the Oravské hradné bralo outcrop, the Dreveník outcrop, the Strednica lookout point and the Spišský hradný vrch outcrop. These are objects located in the Pieniny Klippen Belt area, as well as objects associated with travertine outcrops unique on a European scale. The authors believe that the promotion of geotourism and geosites in the SubTatra region can contribute to greater dispersion of tourists and minimize the phenomenon of overtourism in the High Tatra Mts.

Acknowledgement: *The contribubion was created as part of the University of the National Education Commission Krakow Grant no. WPBU/2024/03/00098 and the scientific project no. VEGA 2/0072/24 financed by the Slovak VEGA Grant Agency.*

Key words: Geotourism, geodiversity, geosites, assessment method, SubTatra Region

SLOPE DEFORMATIONS ON THE HOŘICE RIDGE (CZECHIA)

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Abstract

The aim of the paper is to describe specific slope deformations of rock sliding, or rotational landslides respectively. These landforms have been observed in two former quarry areas on the Hořice Ridge in the vicinity of the town Hořice (E Bohemia). The Hořice Ridge (53.18 km^2) is an asymmetrical ridge with a flat top, steeper NNE slopes (sometimes with boulder debris) and gentler SSW slopes. The highest point of the Hořický Ridge is the Maxinec Hill (449.6 m). The Hořice Ridge is transversely crossed by antecedent valley of the Bystřice River and the Javorka River. At least a triple subsidence of the erosional base in the Pleistocene combined with uplift tendency were the causes of complicated changes in the drainage of the Javorka River, the Bystřice River and the Trotina River.

The Hořice Ridge is built by the Paleozoic phyllites of the Nově Město Unit of the Lugicum, Carboniferous–Permian sandstones, siltstones and aleuropelites, Permian rhyolites and rhyolite ignimbrites. The Upper Cretaceous sediments consist mainly of quartz, clay and glauconitic sandstones of the Korycany Member. In the upper part of the Hořice Ridge, there are relics of fluvial or fluvio-lacustrine tertiary gravels, sands and clays. The Quaternary cover is fluvial gravels, sands and alluvial sediments, deluvial fluvial sediments, deluvial stony to stony-loam sediments, loess and loess loams, freshwater carbonates in the vicinity of some springs and anthropogenic deposits. The Hořice Ridge is bounded by two fault structures – the Mlázovice Fault in N and the Jílovice Fault zone in S. During the fieldwork at four sites in the vicinity of Chlum at Hořice and Skála at Boháňka, the dip azimuth and the dip of joints were measured by the Freiberg geological compass (40 measurements), including 16 measurements of microfault planes and striations. The documentation of the cores of the drills located closest to the investigated sites No. 1–4 was studied. The programme MARK was used to evaluate the palaeostress analysis. Due to the near-surface position of the rotational landslides, the lithostatic pressure was used to estimate the fluid pressure required to soften the clays and claystones according to Eq: $P = h*\rho*g$, where P – fluid pressure [MPa], h – 10 m (estimation of the average depth of the sandstone/claystone interface based on available drill documentation, ρ – average volume mass of overburden material (sandstone) 2050 kg/m^3,g – gravitational acceleretion 9.81 m/s^2. According to the drill cores in the vicinity of the investigated sites, Permian or Cenomanian clays and claystones underlying Cretaceous sandstones. Maximum normal stress σ_1 has trend 249°/41.4°, intermediate normal stress σ_2 of 349.3°/11.5° and minimum normal stress σ_3 was 91.7°/46.3°. Fluid pressure was ~0.2 MPa. Precipitation water flowing down the tension joints in the sandstones was the cause of an increase in fluid pressure in the pores of the underlying Permian and Cenomanian clays and claystones, which led to their softening and reduction in strength, after which the blocks of the Korycany member sandstones, separated from each other by weakly smoothed and striated planes of shear joints, rotated elliptically by up to 60°. The slope deformations in abandoned sandstone quarries on the Hořice Ridge is an example of Holocene non-tectonic gravitational rock sliding.

Acknowledgement: *The research was sponsored from internal project at Museum of Eastern Bohemia in Hradec Králové No. 160018, 190017, 202116 and 202313. Thanks Markéta Kernstocková and Rostislav Melichar for permission to use the programme MARK for non-commercial purpose.*

Key words: Hořice Ridge, slope deformations, rotational landslide, rock sliding, sandstone

HYDRO-GEOMORPHIC ADJUSTMENT OF BRAIDED-WANDERING RIVER TO TRAINED CONDITIONS: INSIGHT FROM THE BELÁ RIVER, SLOVAKIA

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Abstract

The study aims to identify the natural recovery phases within the disturbed river reaches of the Belá River, which is a part of the highly protected area of the Natura 2000 network, following river training interventions in 2018. A comprehensive methodology that combines remote sensing data, field survey and an advanced GIS environment along with the HEC RAS hydrological modeling was employed to evaluate the hydrogeomorphic response of the disturbed river section accurately. The natural geomorphic pattern of the river reach was significantly modified three key points; 1st after the flood event in 2018, which had a recurrence Interval (RI) of 5-10 years and is designated as a reference state; 2nd after the river training for flood protection in 2018, marking a degraded stage; and finally following several consecutive flood events with 2-5 year recurrence interval from 2019 to 2023. Hydrological modeling revealed a notable variation in channel hydraulic parameters including the mean maximum depth, which decreased from 2.27 meters to 1.87 meters, and velocity, which dropped from 4.56 m/sec to 4.29 m/sec from 2019 to 2021. This observed reduction indicated a decline in channel capacity and hydraulic efficiency, which was potentially attributed to sediment retention and deposition. Additionally, the consecutive lower-magnitude flood events facilitated lateral migration of the channel associated with erosion and the creation of avulsion in 2021. Furthermore, the recorded increase in lower magnitude flood events, coupled with an increase in vegetation patches and the stabilization of large wood debris with bars area, is a critical indicator of the river reach transitions from the state of dynamic equilibrium to one of disequilibrium. These findings may offer valuable insight for nature conservations and future management strategies while also addressing a research gap in understanding the complex processes of natural recovery in braided-wandering river systems.

Acknowledgement: *This research was supported by the Slovak Research and Development Agency under the project Marginalized Roma concentrations in the context of natural hazards and social inequality (APVV-22-0428) and by the Science Grant Agency (VEGA) of the Ministry of Education of the Slovak Republic and the Slovak Academy of Sciences (02/0086/21).*

Key words: River training, geomorphic recovery, HEC RAS, Belá River

EFFECTS OF SOIL TEMPERATURE CHANGES ON SLOPE STABILITY

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Abstract

Soil temperature changes significantly influence slope stability by affecting soil moisture content, pore water pressure, and material properties. Seasonal variations in temperature alter the thermal expansion and contraction of soil particles, leading to stress accumulation and potential crack formation. Temperature changes also affect shearing behaviour of clay soils possibly resulting in landslide occurrence. Cyclic surface and near-surface deformations were observed suggesting possible temperature effects on hydromechanical fatigue of the material. Climate change-induced temperature variations could further exacerbate these effects. Understanding the thermal influences on clay-rich soils is crucial for developing predictive slope stability models and implementing mitigation measures to prevent infrastructure damage.

Acknowledgement: *The work was supported by the Czech Grand Agency project no. 24-12316S "Landslides in a changing climate: temperature controls over landslide susceptibility and hazard in temperate climate".*

Key words: Landslides, slope stability, temperatures, cyclic changes

RECENT ACTIVITY OF PATAGONIAN LANDSLIDES

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Abstract

The tableland landscapes of Patagonia, characterized by volcanic mesas overlying sedimentary rocks, host the largest landslides area on Earth. The semi-arid climate, minimal fluvial erosion, and low tectonic activity of the area create conditions where recent landslides are generally unexpected due to the absence of typical triggers. However, a variety of slope failure mechanisms, including rotational slides, rock spreads, earth flows, and rockfalls, have been documented. While many landslides appear to be relics of past environmental conditions, some may still be active, requiring further analysis to determine their recency and ongoing evolution.

To analyze recent landslide activity, this study employs Differential Interferometric Synthetic Aperture Radar (DInSAR) with the Small Baseline Subset (SBAS) technique, utilizing Sentinel-1 imagery from 2016 to 2021. The analysis focuses on three areas in Argentine Patagonia: the Sarmiento area, the Lago Cardiel area, and the coastal area.

The results indicate notable recent landslide activity primarily in the coastal area in the Pampa de Salamanca Mountains, particularly on its eastern slopes. In the Sarmiento area, limited landslide activity was detected in a small section, while no recent landslides were observed in the Lago Cardiel area. These findings highlight the slow but persistent nature of recent landslides in the coastal and Sarmiento areas, demonstrating the effectiveness of DInSAR in detecting millimeter-scale ground displacements in remote areas. For further research, we recommend extending the observation period and refining input parameters to enhance the detection and characterization of ongoing landslide activity.

Acknowledgement: *The study was supported by Czech Science Foundation 23-07310S: Deciphering the largest rock spread on Earth: why in arid Patagonia?*

Key words: Patagonian tableland, landslides, DInSAR, SBAS, Sentinel-1

SEDIMENT CONNECTIVITY ASSESSMENT AND SOIL EROSION MODELLING: HOW TO IDENTIFY HOT-SPOTS AND IMPROVE SOIL PROTECTION MEASURES

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Abstract

Extreme rainfall events have become more frequent in recent decades. They especially threaten small watersheds with limited drainage capacity. Knowledge about sediment connectivity is crucial for the mitigation of the negative impacts of these events on local communities. Unfortunately, information on connectivity, extent of soil erosion, and causal precipitation events is insufficient or missing. In our research, we used various methods for sediment connectivity assessment (ECA, IC, field mapping) and tested the WEPP (GeoWEPP) model in five small catchments in the Czech Republic, where the precipitation caused soil erosion on arable land. The WEPP model was validated by results obtained from UAV measurement. GeoWEPP soil erosion maps were compared with the results of the connectivity assessment for Hot-spot delineation. The main output is maps for each catchment containing hot spots regarding soil erosion and sediment connectivity. For one catchment, a series of maps were created showing the impact of crop type change on soil erosion and sediment connectivity. This study i) offers a new perspective on the link between sediment connectivity and the topic of soil erosion, ii) Tests the widely used WEPP model and its GIS interface on available data for the Czech Republic, iii) Suggests results that can serve as a basis for land use management, soil erosion, and flood protection improvement.

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Key words: Connectivity, Soil erosion, Extreme rainfalls, Critical points, Hot-spots, WEPP model

GEOMORPHOLOGICAL MAPPING OF A SANDSTONE ROCK CITY AT OSTAŠ, BROUMOVSKÁ VRCHOVINA, CZECHIA

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Abstract

Rock cities are distinctive and complex assemblages of erosional landforms that consist of closely spaced residual rock massifs separated by narrow intersecting slots and corridors. An abundance of meso- and microforms is often combined with the existence of hardly accessible zones and deficiency of precise high-resolution digital elevation datasets. Such a state of affairs makes rock cities a challenge in terms of detailed geomorphological mapping and most of them still lack cartographic presentation despite its potential to shed light on the origin and evolution of rock cities. Here, we focus on a small compact rock city present at Ostaš mesa located in north-east Czechia. It is developed within nearly horizontal sandstone caprock layers that overly finer-grained rocks. It has the area of around 200 x 80 metres and is partly accessible via a tourist path. The geomorphological map of this rock city is based on field measurements, orthophotomap analysis and geomorphometric analysis of airborne-LiDAR-based digital terrain model (DMR5G). The map shows a diversity of forms such as short corridors, isolated towers, loose boulders and sandy cones. Consequently, it facilitates the recognition and interpretation of factors controlling the appearance of a rock city and processes shaping its relief, including the evaluation of the current dynamics. However, in order to complement the content of the map with e.g. a microrelief of upper parts of rock massifs and the height of the rock walls, using a LiDAR drone would be recommended.

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Key words: rock city, mesa, Sudetes, sandstone, field mapping

GEOHERITAGE VALUES AND THREATS RELATED TO SANDSTONE CRAGS OF THE CHŘIBY RIDGE (MORAVIAN CARPATHIANS, CZECH REPUBLIC)

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Abstract

Rock landforms provide non-invasive, easy insights into the distant geological past, and they reflect landform evolution and processes shaping the earth surface in the past and present. Moreover, rock landforms, especially crags and tors, have a high geoheritage relevance. The territory of the Czech Republic shows many diverse examples of crags and tors, especially in sandstone areas. However, while the Bohemian Cretaceous areas have been examined in detail, the sandstone crags in Moravian Flysch Carpathians have been given only limited attention. The paper is focused on the sandstone crags in the Chřiby Mountains being explored from two main perspectives: identification of the crags as geoheritage elements and their assessment in terms of threats and degradation risk. The application of semi-quantitative assessment methods (degradation risk evaluation and Risk Assessment Matrix) enabled the ranking of the sites according to the degree of possible deterioration and helped to identify particular threats, which can be considered important when planning and managing the area's natural resources. The recognition of geoheritage values of sandstone crags, along with identifying and evaluating risks and threats, may serve as a basis for effective management and further research.

Key words: Sandstone crags, geoheritage, Chřiby, degradation risk, threats to geodiversity

LATERAL AND VERTICAL EVOLUTION OF THE BELÁ RIVER FLOODPLAIN BASED ON THE RELATIVE ELEVATION MODEL

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Abstract

The Belá River is a characteristic braided-wandering river running through the Liptovská basin in the Western Carpathians. Its transformation from an originally braided to a braided-wandering watercourse has been accompanied by degradation of the river system, retrospectively monitored since the mid-20th century. The observed transformation is a consequence of erosional-accumulative changes in the river. These are mainly the result of changes in the land cover, anthropogenic interventions into the channel, but also of climate change. These factors have created a specific system of development of the Belá river floodplain. To identify the evolutionary phases, the methods based on remote sensing data combined with field work were used. The primary input data were LiDAR point cloud data collected in 2018 and 2019, and aerial survey imagery and orthophotos from 1949, 1963, 1971, 1986, 1992, 2002, 2006, 2009, 2012, 2015, and 2018. The LiDAR point cloud was processed into a raster format digital elevation model and then into a relative elevation model. The model normalizes the absolute elevation of the river floodplain in relation to the watercourse. Three models have been created, the first considering the water surface elevation from the digital elevation model, the second the water surface elevation as measured by the GPS, and the third model was based on the bed elevation of the channel as measured by the GPS. The models have been used to identify the inaccessible floodplain, the perched floodplain with its levels, and the active floodplain. Subsequently we have used spatial statistics to identify locations of river floodplain modeling by incision of the channel into the bedrock or by simplifying the watercourse. Floodplain development phases, levels, and complex floodplain evolution since 1949 have been complemented and validated by being identified in the field and in the context of identifying of ledges. The result leads to a process-oriented hypothesis of the lateral and vertical evolution of the river floodplain along the Belá River based on the identification of evolutionary phases of the river floodplain in relation to erosion-accumulation processes.

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Key words: river floodplain, floodplain development, relative elevation model, braided river, Belá River

RELIEF OF THE ORAVA-NOWY TARG BASIN, WESTERN CARPATHIANS – NEW DATA

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Abstract

To date, the intramontane Orava-Nowy Targ Basin (Western Carpathians) has been the subject of numerous geomorphological studies in which attention was paid to the origin of the prevailing types of landforms, their transformations in the Quaternary, their distribution in relation to the stratigraphy and tectonics of the bedrock and to anthropogenic changes. In this context, the available professional literature is clearly short of studies in text and, even more significantly, cartographic form covering the distribution of all types of landforms, even minor or secondary. Particular emphasis needs to be placed on determining their morphometric features and the role of all types of landform, regardless of their dimensions, in the formation in different spatial scales of the relative falls, slope angles, and aspect within the Orava-Nowy Targ Basin. Such an approach to the geomorphological analysis would afford possibilities for detecting interdependences between the qualitative and quantitative features of the relief of the Orava-Nowy Targ Basin, i.e. something that is still missing in relation to this area in the professional literature. This presentation relies on the literature and our investigations to outline the main properties of the relief of the intramontane Orava-Nowy Targ Basin which is dominated by three fluvioglacial fans. The focus, however, was on the genetically-varied landforms, mostly found within the limits of the fluvioglacial fans, which contribute to the diversity of the basin's geomorphological landscape. Based on the results of geomorphological mapping of the area and the area's digital elevation model, an explanation was provided for the distribution of particular landform types, with specification of their parameters. Building on this exercise, the three chief morphometric properties of the Orava-Nowy Targ Basin, i.e. local relative height, slope, and aspect, were analysed. In the area occupied by the fluvioglacial fans, these morphometric parameters were found to display the greatest variety along the S-N and W-E axes. The results presented combine qualitative and quantitative approaches to geomorphological studies in the first such attempt regarding the Orava-Nowy Targ Basin and as such fill a significant gap in the existing geomorphological studies of the area. The Orava-Nowy Targ Basin continues to present a promising area for comprehensive studies on the relief of the area with respect to its geomorphology, including, inter alia, its morphography and morphometry, with special consideration of the various types of landforms found in the geomorphological landscape.

Key words: relief, landform, geomorphometry, Orava-Nowy Targ Basin

THE INFLUENCE OF BRIDGE STRUCTURES ON THE HYDRAULIC CONDITIONS OF FLOOD IN THE SELECTED CARPATHIAN RIVERS

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Abstract

The study analyzed erosion processes occurring on three Carpathian tributaries of the Vistula River: the Skawa, Raba, and Dunajec. The research determined the extent and rate of channel processes (erosion, accumulation) at gauging cross-sections. The study has a historical character, as hydrological observations at the gauging stations date back to the late 19th and early 20th centuries. Thanks to such long-term observations and analyses, it was possible to identify the type of process occurring and its tendency to alter the vertical bed structure over an extended period. An attempt was also made to predict future changes in riverbed elevation.

The analysis mainly considered the impact of bridges on riverbed erosion processes, as erosion can intensify in their vicinity. The findings indicate that, over the entire observation period, the riverbeds of all analyzed rivers have incised, lowering by the following amounts (from source to mouth):

- Skawa River: 1.0 m in Sucha Beskidzka, 3.0 m in Wadowice, and 1.5 m in Zator.
- Raba River: 2.5 m in Mszana Dolna, 2.5 m in Kasinka Mała, and 2.5 m in Proszówki.
- Dunajec River: 1.0 m in Krościenko and 1.0 m in Gołkowice.

These results highlight the long-term changes in riverbed morphology and the significant influence of natural processes and infrastructure on erosion dynamics.

Key words: geomorphological processes, bridges, numerical modelling, MIKE 11, Carpathians rivers

GRAIN SIZE FRAGMENTATION ANALYSIS VIA PHOTOSIEVING APPROACH USING UAV (LIDAR AND ORTHOPHOTOS)

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Abstract

The grain size distribution (GSD) of sediment is a fundamental parameter that governs various environmental dynamics, influencing processes such as sediment transport rates, the stability of slopes and the design of effective flood protection measures within a river system. This study focuses on the efficiency of the recent technological advancement to enable the integration of small sensors and unmanned aerial vehicle (UAV) to perform non-invasive, continuous, and repeated monitoring of GSD of gravel-bed within the fluvial environment. A significant step for photosieving is involved using imagery captured during a field survey of Ondava River in the Western Carpathians. Acquired images are then processed using photogrammetric software to perform bundle of image alignment, features overlapping, edge detection, colour detection of grains, camera position and orientation. Photosieving operates on the principles of measuring the size of particles within an image in terms of pixel units and subsequently converting this measurement into real-world linear units by utilizing the algorithms of image scale. The core of this sediment detection process-specialized software packages like BASEGRAIN and PebbleCounts are used for this purpose. Statistical correlation methods used to estimate the GSD based on the image's textural characteristics of roughness. Alternatively, use the field data processed in the laboratory for the validation of the GSD from UAV-based data with correlation statistics. We aim to demonstrate the potential of UAV photosieving for accurate grain size distribution of gravel-bed rivers.

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Key words: Photosieving, unmanned aerial vehicle, grain size distribution, river dynamics, gravel bar

PHYSICAL GEOMORPHOMETRY IN DIGITAL GEOMORPHOLOGICAL MAPPING

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Abstract

Digital geomorphological mapping includes the use of various subfields of geomorphometry: general geomorphometry characterizing the land surface as a continuous field of elevation, slope, aspect, curvature, etc.; specific geomorphometry characterizing individual discrete forms (volume, area, asymmetry, ...); and discrete geomorphometry delimiting objects (forms) from different geomorphometric fields. Physical geomorphometry combines the geometric properties of the land surface with various aspects of influence of the gravity field on the land surface within the framework of general, specific, and especially discrete geomorphometry. It defines various types of geomorphic energies responsible, for example, for gravitational flow, their acceleration or diffuse geomorphic processes as so-called physical-geomorphometric variables. With the help of them, it performs the segmentation of the landscape surface into elementary forms that have not only geomorphometric, but also morphogenetic and morphodynamic peculiarities. Elementary forms can then be characterized by a physical-geomorphometric signature, which is a specific type of traditional geomorphological signature used to identify genetic forms e.g., landslides, planation surfaces or moraines.

In recent years, we have made significant progress in the development of the theory of physical geomorphometry and its application in the automatic delineation of elementary forms, their description with a physical-geomorphometric signature and the subsequent creation of digital geomorphological maps. We verified the methodology in the case studies of structural and fluvial, glacial and karst topography of a part of the Western Carpathians. Comparison of our results with traditional geomorphological maps confirms that our methodology is not only able to replicate the essential features of traditional maps, but also to refine them, supplement them and quantitatively characterize them. This is essential for the objectification of the process of geomorphological mapping, its replicability and scientific nature. The combination of physical geomorphometry and digital geomorphological mapping makes it possible to formulate and falsify hypotheses of geomorphological development, thus contributing to the strengthening of the hypothetical-deductive approach in geomorphology and making geomorphological mapping more scientific.

Acknowledgement: *This work was supported by the Slovak Research and Development Agency under the contract No. APVV-22-0024.*

Key words: elementary forms, land surface segmentation, geomorphological signature, gravity field

THE USE OF DEM AND DERIVED MODELS TO DETECT LANDSLIDES MODIFYING DRAINAGE DIVIDE IN THE POLISH OUTER CARPATHIANS

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Abstract

The dissemination of high-resolution digital elevation model (DEM) obtained from airborne laser scanning (ALS) has opened up new possibilities in geomorphological studies of mountain landslides. LiDAR data (light detection and ranging) make it possible to present the topography of the land surface under the vegetation cover, enabling detection of landslides on forested slopes, as well as monitoring their activity based on digital differential models (DDM). This is often the only method that allows the analysis of the morphological features of the landslide surface. LiDAR data for the Polish Outer Carpathians were made available by the Head Office of Geodesy and Cartography (Republic of Poland). They were obtained during two projects: the Information System of National Protection Against Extraordinary Risks Project (ISOK Project) – data from 2011-2014, and the Centre for Spatial Analysis of Public Administration Project (CAPAP Project) – data from 2019-2023. Analysis of the DEM generated on their basis and derived models such as hillshade, hillshading from multiple directions, slope gradient, positive and negative openness, sky-view factor or digital differential models enabled detailed identification of the influence of landslides on drainage divides migration. This phenomenon leads to changes in the length, height and spatial location of drainage divides, and thus the shape and area of the entire catchment also changes. This affects, among others, the intensity of runoff on slopes and the severity of slope erosion, because the surface from which rainwater is drained changes.

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Key words: LiDAR data, digital elevation model, drainage divide migration, geohazards

EVALUATING THE IMMEDIATE EFFECTS OF FLOODS ON LAND USE CHANGES IN IRAN'S CENTRAL ZAGROS: A FOCUS ON SEFID KUH PROTECTED AREA

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Abstract

Flooding is one of the most devastating hydrological events and can dramatically change land cover and land use particularly in mountainous regions. The biodiversity, ecosystem services and well-being of people have been put at greater risk from flooding, but at present, there is inadequate work done in terms of comprehensive research on immediate and long-term consequences of flooding on land cover changes in the Central Zagros region, one of the most climatically vulnerable hotspots and a high-biodiversity area. This study was mainly aimed at understanding the effects of flooding on land cover changes in Sefid Kuh Protected Area, Lorestan Province, Iran. We utilized multi-temporal Landsat 8 images, together with land use/land cover change detection, fragmentation analysis, and various landscape metrics. These methods gave us new insights into the impacts and changes brought by floods. Field surveys and local interviews provided an insight of the ground effects of floods. Results showed that floods brought considerable changes to land cover types such as thin woodlands, thick woodlands, agricultural lands, rock, and snow areas. The metrics analysis included: Shannon's Diversity Index (SHDI), Interspersion and Juxtaposition Index (IJI), Patch Density (PD), Edge Density (ED), Largest Patch Index (LPI), Aggregation Index (AI), Percentage of Land Area (PLAND), Number of Patches (NP), Total Edge (TE), Landscape Shape Index (LSI), and Splitting Index (SPLIT). Results indicate that flooding decreased landscape diversity and heterogeneity, increased fragmentation and isolation of forest patches, and promotes the aggregation of bare soil patches. This may affect the resilience and adaptability of the study area under future flooding and climate change scenarios.

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Key words: land use/land cover change detection, fragmentation analysis, flood impact, landscape pattern indices

FACTORS INFLUENCING THE INTENSIFICATION OF GULLY EROSION DURING THE LITTLE ICE AGE IN THE SERTEJKA RIVER VALLEY, EASTERN EUROPE

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Abstract

Erosion cuts are located on the western slopes of the modern Serteyka River valley (Vitebsk Lakeland, western Russia). They form a branched system of gullies and ravines that cut into the surface of the glaciofluvial plain for a distance of up to 210 m, to a depth of up to 7 m.

The age of the largest fan, and therefore the entire system of cuts, was determined using a series of ^{14}C datings of organic (organic lake sediments) remains and sediments underlying the mineral deposits of the fan and occurring within them. The obtained datings indicate that the slope processes were initiated in the 2nd half of the 17th century. Based on palynological studies, strong deforestation of the area and an increase in the share of synanthropic plant pollen in the upper part of the organic sediments were noted. Deforestation and climatic changes during the Little Ice Age led to the intensification of slope processes within the slopes of the valley. The largest accumulation fan is formed by slope sediments, in which the following have been distinguished: lower deluvia, middle deluvia and upper deluvia with proluvial insertions and tillage diamicton. Detailed grain size analyses were performed for these sediments using the laser diffraction method, geochemical analyses (XRF, pH, electrolytic conductivity and percentage of calcium carbonate), as well as analyses of plant macrofossils. It was proven that the individual layers of slope sediments have characteristic textural, sedimentological and geochemical features. This indicates different environmental conditions during sedimentation.

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Key words: slope sediments, gully erosion, Little Ice Age, Eastern Europe

DENDROGEOMORPHOC EVIDENCE OF SUBSIDENCE IN MINING AFFECTED LANDSCAPE

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Abstract

Subsidence is a well-known issue associated with subsurface mining operations and often causes irreversible environmental changes, including surface deformations and alterations to the local gradient. If settlements exist within the affected area, they may not withstand the resulting damage, potentially leading to their abandonment or disappearance. The severity of the damage depends on various factors, including prior overburden disturbances and the mining techniques used. This study examines two sites subjected to different degrees of undermining, assessing long-term surface damage using dendrogeomorphic methods. The results align well with known mining activities. Trees at the heavily exploited site have been continuously affected by mining and recorded ongoing subsidence events corresponding to periods of intense mining activity. In contrast, the site at the mining district's edge, which experienced undermining for a limited period, exhibited sudden subsidence events. Notably, trees at this site also recorded subsidence linked to distant mining operations, demonstrating the sensitivity of the applied methods. These findings reinforce the potential of dendrogeomorphology for high-resolution subsidence reconstruction, offering valuable insights into mining-induced landscape changes and their broader environmental impact.

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Key words: mining, subsidence, dendrogeomorphology, dating, reaction wood

TREE-RING RECONSTRUCTION OF SNOW AVALANCHES IN PARANG MOUNTAINS (SOUTHERN CARPATHIANS, ROMANIA)

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Abstract

Snow avalanches (SAs) are a widespread natural hazard in the Carpathians, often damaging transportation infrastructure, forests, and threatening recreational activities. To understand their past behaviour and predict future trends of this hazard in the context of ongoing climate change, information on the long-term history of SAs is essential. However, in the Carpathian Range, as in most mountain regions worldwide, the lack of historical records regarding the temporal frequency and spatial extent of past SAs limits the ability to gain a comprehensive understanding of their history. Indirect reconstruction methods, such as tree-ring analysis, can be used to infer past SA history in forested mountain areas. When SAs pass through forests, they disturb trees, leaving distinct signs of past disturbances in their growth rings. Dendrogeomorphic approaches analyse growth anomalies caused by the mechanical impact of SAs on trees, which are recorded in their rings, allowing for the reconstruction of past SA activity with annual resolution. In the past decade, dendrogeomorphic methods have been extensively applied to reconstruct SA activity in both Southern and Eastern Carpathians. In this study, we present new tree-ring data from an investigation of past SA activity in the Parâng Mountains (Southern Carpathians). Trees disturbed by SAs in the studied paths were sampled, and growth anomalies identified in their annual rings were used to reconstruct the event chronology. Further dendrogeomorphic investigations extended to multiple SA paths will provide valuable insights into SA patterns across the entire Carpathian Range.

Key words: snow avalanches, tree rings, Parang Mountains, Southern Carpathians

DRAINAGE PATTERN OF THE NW INTRA-SUDETIC TROUGH – A GEOMORPHOMETRIC STUDY

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Abstract

The NW part of the Intra-Sudetic Trough, encompassing the Zawory Mts, Adršpach-Teplice Rocks, Broumovské Steny and Stołowe Mts, presents a diverse and complex landscape shaped by intricate geological processes. This study aims to explore the diverse morphology of the relief within the region, emphasizing the influence of both lithological and structural factors on landform development. Topographic and geomorphological characteristics were analysed to investigate the spatial variability in the valley morphology.

The Zawory Mts, characterized by more subdued relief, provided insights into the interplay of lithological resistance and structural factors in forming rolling hills, V-shaped valleys and intermontane depressions. The Adršpach-Teplice Rocks, exhibiting a high degree of morphological diversity with towering rock pillars and deeply eroded canyons, were shaped by complex jointing and localized weathering. The Broumovské Steny are particularly notable for their characteristic vertical rock cliffs of cuesta front scarp, and canyon network in cuesta backslope – a result of the regional tectonic framework and differential erosion processes. The Stołowe Mts are known for their tablelands and fault-controlled valleys, shaped by similar regional tectonic influences and erosion processes.

This research integrates field observations, geospatial analysis, and geomorphometric techniques to comprehensively understand the morphological diversity across the region. It contributes to a broader understanding of landscape evolution in structurally complex areas. The findings offer important contributions to the studies of relief development in sandstone areas, as well as to regional geotourism and nature conservation.

Acknowledgement: This research is a contribution to the research project no. 2021/41/N/ST10/00598 of the National Science Centre, Poland.

Key words: valley network, sandstone areas, geomorphometry

FROM TOPOGRAPHIC INDICES TO UPLIFT RATES: TOPOGRAPHIC METRICS FOR MORPHOMETRIC DATING APPLIED IN THE WESTERN CARPATHIANS TERRAINS

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Abstract

Rivers sensitively respond to vertical crustal movements by adjusting their channel profile geometries to local or regional base-level changes. Rivers also transmit these signals to hillslopes and the rest of the landscape. In this way, river networks and drainage basins act as tape recorders, preserving information about past uplift events. At the same time, they also offer the opportunity to extract such information and reveal the history of landscape evolution through appropriately designed methods. In this contribution, we present results obtained by applying two different approaches focused on morphometric dating and extraction of uplift/incision rates. While the first linear inversion method is based on data derived from rivers' long profiles, the second hypsometric method relies on data extracted from complex hypsometric parameters of drainage basins.

The linear inversion of river profiles was applied in a selected area in the Slovenské Stredohorie Mts. The method circumvents the necessity of knowing the detailed spatiotemporal distribution of erodibility values using a *K*-independent analytic solution that allows the obtaining of dimensionless proxy values (of time and erosion rates). These can be calibrated using a model K_{est} parameter determined from independent geochronological data. Data extracted from the left-side Hron River tributaries in the chosen study area indicate cumulative uplift up to 550 m during the Pliocene-Pleistocene period and peak uplift/incision rates up to 0.2 mm/yr for K_{est} value of $2.55.10^{-6}m^{0.1}$/yr.

The youngest uplift events were estimated using *R* and S_R indices in two model areas, the Orava River drainage basin and the upper part of the Hron River drainage basin. While the *R* indexes are calculated from complex hypsometric characteristics of catchments (i.e., three different hypsometric integrals), the S_R index, which is relevant for age estimate, represents the slope of linear regression line on a semi-logarithmic plot of *R* against catchment area Ln(*A*). In some cases, the *R* indexes should be corrected for catchment shape factor to obtain adjusted *R** indices. Age estimates based on *R* and *R** indices are significantly different in the Orava River basin. The S_R index derived from more vigorous *R**-Ln(*A*) relationships reveals a considerably younger age of 0.1 Ma compared to 4.6 Ma based on the uncorrected *R* index. In the area situated in the Hron River catchment, the *R*-Ln(A) covariance is more vigorous and provides more consistent results than the corrected (*R**) ones, and suggests the Middle Pleistocene age (0.35 Ma) of the youngest uplift event.

Acknowledgement: *The contribution was prepared in the framework of the project no. 2/0014/25 "From digital topography and morphometric indices to uplift/erosion rates" supported by the VEGA grant agency.*

Keywords: topographic metrics, morphometric dating, tectonic uplift history, Western Carpathians

ASSESSING THE IMPACT OF WILDFIRES AND HIGH TEMPERATURE ON ROCK PROPERTIES ON DIVERSE LITHOLOGIES IN THE CZECH REPUBLIC

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Abstract

Wildfires are a worldwide concern because they cause destruction and disturbances to natural ecosystems and human society. They can occur in different parts of the world, in deserts and abundant forests, and in the most dangerous ecosystems where the climate is warm and dry. A massive wildfire in the Bohemian Switzerland National Park in the Czech Republic, which is famous for the unique characteristic sandstone cliff lines on the Czech-German border, in 2022 was a clear indication that it is necessary to investigate the impact of extreme heat on the properties of rocks. Wildfires are common in the region; however, the unprecedented scale of this event implies that the term was probably intensified by the intense wind and consistently high temperatures resulting from the ongoing climate change.

In this study, we subjected the thermal effect on rock strength and elasticity to testing using samples of primary lithologies in Czechia, including sandstone and crystalline rocks. Our research design included a controlled heating protocol aimed at simulating wildfire conditions. A process of drying the sample at 105°C followed by gradual heating to 200°C, 400°C, 600°C, and finally 800°C. After each heating cycle, ultrasonic P- and S-wave data were measured to evaluate changes in the dynamic elastic properties of the rocks. The heating cycle was planned carefully to mimic natural wildfire behavior, with slow increases in temperature, targeted temperature suspension, and sequential cooling.

Our results indicate that the thermal behavior of rocks varies notably with lithology. In our tests, sandstone and crystalline samples began to show signs of weakening as early as 105°C, a change likely linked to alterations in their cementation and structure. Interestingly, these materials achieved a peak in strength at 200°C; beyond this point, progressive weakening occurred and ultimately reached their lowest mechanical integrity at 800°C. This trend, consistent with prior research, deepens our understanding of how wildfire-level temperatures influence rock properties and emphasizes the broader environmental impacts of high-temperature events.

Acknowledgment: *This research is supported by the Technology Agency of the Czech Republic (TA ČR), Grant No. SS07010216. The authors are thankful to all the field researchers and technical staff who assisted in sample collection and preparation.*

Keywords: Wildfires, Rock Properties, Sandstones, Crystalline

REFLECTION OF TECTONICS IN THE CHARACTERISTICS OF WATERSHED AND WATERCOURSES OF THE HRUBÝ JESENÍK MOUNTAINS

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Abstract

The Hrubý Jeseník Mountains, part of the Sudetes Mountains, originated during the Variscan orogeny and were later rejuvenated by neotectonic processes in the Cenozoic. Their geological structure is complex, with longitudinal and transverse faults playing a key role in shaping the present-day relief by dividing the landscape into individual fault blocks. The river network holds valuable informational potential for reconstructing landscape evolution, as it is the most dynamic component of the geomorphological system and responds rapidly to environmental changes. This study analyses the Czech Republic's digital elevation model (DMR 4G) using the TopoToolbox functions in MATLAB. The study area was divided into 20 subbasins and assessed using morphometric parameters: the hypsometric integral (HI), asymmetry factor (Af), and normalized steepness index (Ksn). Additionally, Chi (χ) analysis was applied to evaluate watershed migration. To better understand the relationship between drainage patterns and structural controls, the results were analyzed in the context of geological maps and tectonic lineaments. Results suggest that neotectonic activity has a limited influence on river network development. Chi analysis indicates a migration of the watershed between the Merta and Desná river basins toward the Moravice and Podolský river basins, aligning with a lithological boundary where more resistant metagranites and gneisses transition to less resistant phyllites and mica schists. This implies that lithology, rather than active tectonics, controls drainage evolution. Higher HI and Ksn values in basins underlain by resistant rock types further support this interpretation. While faulting has influenced the overall landscape structure, its direct role in active river adjustment appears subdued.

Key words: morphometric analysis, drainage evolution, tectonics, lithology, Hrubý Jeseník Mts

A RECORD OF ENVIRONMENTAL CHANGES AT THE TURN OF THE PLEISTOCENE AND HOLOCENE IN THE REMAINS OF THE CLADOCERA FAUNA DEPOSITED IN THE SEDIMENTS OF THE ŁUGI AND ŻABIENIEC PEATLANDS

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Abstract

Biogenic sediments are deposited in lake basins and peatlands. Particularly interesting are those formed during periods of high climatic variability. One such period was the transition from the Late Vistulian to the early Holocene, characterized by rapid cooling and warming events. Sediments deposited during this time can provide answers regarding the origins of past environmental changes and help determine whether current climate modifications are analogous to those of previous epochs.

Aquatic organisms are highly sensitive to changes in environmental parameters, and their preserved remains in sediments enable paleoecological studies. One key group of organisms used for reconstructing past conditions in water bodies is Cladocera (water fleas). Their remains preserved in sediments allow for the reconstruction of environmental conditions at the time of their existence. They can provide information on various aspects, including water temperature, trophic state, pH, water level fluctuations, and even the impact of human activity on the surrounding environment. The analysis of Cladocera offers detailed insights into the environmental and climatic changes that occurred in Central Poland.

The results present a high-resolution analysis of subfossil Cladocera remains from two sites in central Poland—the Żabieniec and Ługi peatlands—which document key climatic phases associated with the Late Glacial-Holocene transition.

The Żabieniec site is located on the moraine plateau of the Łódź Hills in Central Poland. This site provides a continuous record of environmental changes spanning the Late Glacial-Holocene transition. The sediment core was analysed at a 1 cm resolution, allowing for precise differentiation between climatic phases. At the end of Older Dryas the water level in the reservoir was quite low with quite cold water temperature, creating unfavorable conditions for the development of Cladocera, leading to the dominance of cold-tolerant species. The beginning of the Allerød is marked by increasing vegetation density and rising water temperature with favorable conditions for development of rare species. At its end, there was a large diversity of species associated with a relatively deep and mesotrophic water body. The beginning of the Younger Dryas is a shift back to conditions similar to noticed during Older Dryas. The transition to the Holocene is manifested by a rapid increase in the number of species and planktonic forms, which appeared before the beginning of the Holocene

The Ługi peatland, located in the Warta River valley in Central Poland, formed as a result of fluvial processes and subsequent biogenic sedimentation following deglaciation. The profile features a sediment about 335 cm thick and its lithology predominantly consists of various types of gyttja, with sands confined to the basal section. The sampling resolution primarily ranged from 0.5 to 1 cm.

However, in layers where the material for analysis was insufficient, it was necessary to reduce the resolution to 2-4 cm. A detailed analysis of Cladocera revealed that during the Oldest Dryas, the lake was shallow, with unfavorable conditions for Cladocera development. A notable increase in species diversity and abundance occurred during the Bølling interstadial, coinciding with warming and rising water levels. The Allerød period was characterized by a peak in Cladocera diversity, followed by a sharp decline in the Younger Dryas, reflecting colder conditions and a drop in water levels. The sediment record from the Holocene indicates improved habitat conditions, with an increase in planktonic taxa associated with warmer and more stable aquatic environments.

The results from both sites underscore the utility of Cladocera as bioindicators of past climate change and highlight the importance of high-resolution sampling in reconstructing paleoenvironmental dynamics. By comparing records from two distinct yet complementary sites, this study enhances our understanding of how freshwater ecosystems in central Poland responded to abrupt climate transitions at the end of the Pleistocene and the beginning of the Holocene.

Acknowledgment: *This research is supported by the IDUB Doctoral Research Grants 2022 ,,Reconstruction of rapid climate changes at the Pleistocene–Holocene transition based on Cladoceran subfossil remains (at selected sites in central Poland)" decision no. 5/DGB/2022.*

Key words: central Poland, paleoecological reconstructions, Late Glacial, peatlands, cladocerans

DENDROGEOMORPHOLOGICAL RECONSTRUCTION OF THE LANDSLIDE ACTIVITY IN THE AREA OF VINOHRADY NAD VÁHOM

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Abstract

Slope deformations and landslides are the most frequent geodynamic phenomena occurring in Slovakia. The study area is located on significantly disturbed slopes with extensive slope failures with varying activity on the left bank of the Váh River in the section between Hlohovec and Sereď. The selected landslide is located in the cadastral territory of the municipality of Vinohrady nad Váhom (Galanta district). The territory of the selected landslide is covered with stands of trees with a dominantly spread invasive species – black locust (*Robinia pseudoacacia* L.). The dating of landslide events was carried out using a macroscopic method - analysis of the tree-ring eccentricity in tree-ring series of disturbed trees. During the field survey, 53 trees were sampled, of which 49 trees were used in the analysis. Increment cores were taken from the trees with a Pressler increment borer and the sampled trees were measured for trunk tilt in the field with a digital inclinometer. Six landslide events were identified between 1969 and 2022. The spatial distribution of the intensity of trunk lean and its direction relative to the slope was taken into account in determining the intensity of the landslide. The results of the analyses are supported by an assessment of the evolution of the vegetation cover in the vicinity of the landslide since the second half of the 20th century based on available aerial survey imagery and orthophotos.

Acknowledgement: *Scientific Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic and the Slovak Academy of Sciences ("VEGA") No. 1/0217/23 supported this study.*

Key words: dendrogeomorphology, landslides, reconstruction, Vinohrady nad Váhom

EVIDENCE OF MINING ACTIVITIES IN THE KARST AREA OF THE KACZAWSKIE MTS: CHANGES IN THE TOPOGRAPHY AND KARST VOIDS DISCOVERIES

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Abstract

This study concerns changes in the terrain surface of Mt. Połom and the neighbouring hills built of carbonate rocks resulting from mining activities. Reconstruction of the original topography enabled an assessment of the scale of landscape evolution due to mining activities lasting at least since 1529. Mt. Połom (667 m a.s.l.) is an elevation located near the town of Wojcieszów, on the Kaczawa River in the Kaczawskie Mountains in southwestern Poland. The massif is composed of carbonate rocks, mainly limestones and crystalline dolomites. This contributed to developing mining plants and, consequently, significantly transforming the terrain. As a result of mining, part of the mountain was removed, and spoil tips were created at slopes. The investigation used GIS tools to reconstruct the original topography of the hill based on topographic maps (Meßtichblatt). We calculated the area and volume of post-mining landforms by comparing the obtained model and the DTM imaging current situation. An essential effect of the discussed mining activities is also the exposure and subsequent destruction of caves and karst voids. We verified the state of the massif caves over the years due to the inaccuracies of the source materials.

Key words: landscape, limestone mining, caves, Połom

OPTICAL BATHYMETRY OF WADABLE RIVER CHANNEL USING HIGH-RESOLUTION AND DETAILED UAV DATA

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Abstract

Accurate bathymetric mapping in shallow rivers is essential for understanding hydrodynamic behaviour and environmental changes over time. This study investigates the use of UAV-based RGB imagery to estimate river bathymetry in a 1 km stretch of the Bela River across two time periods i.e., 2015 and 2022 which is characterized by contrasting water depth and turbidity conditions. High-resolution UAV images (5 cm spatial resolution) were paired with ground-surveyed water surface elevations collected at 156 points in 2015 and 185 points in 2022. Using these reference points, RGB values were extracted and expanded through a set of derived features including logarithmic transformations, band ratios, and normalized difference indices. Linear, quadratic, and cross-quadratic regression models were trained and validated using a 70:30 train-test split to predict bathymetric depth. The best-performing model combinations were selected based on Root Mean Square Error (RMSE). Results show that the models yielded RMSEs of 26.16 cm, 26.31 cm, and 26.17 cm for the linear, quadratic, and cross-quadratic models respectively in 2015, while for 2022, the RMSEs improved to 15.50 cm, 14.71 cm, and 15.12 cm respectively. The higher accuracy in 2022, despite reduced water depth, is attributed to lower turbidity improving RGB signal quality. This study demonstrates the potential of cost-effective UAV imagery, enhanced with radiometric feature engineering and regression modelling, for generating bathymetric maps in shallow river systems with varying optical conditions.

Acknowledgement: *The author(s) would like to thank the Institute of Geography, Slovak Academy of Sciences, for providing the datasets essential for this study. Their support and resources greatly contributed to the successful completion of this work.*

Key words: UAV-based bathymetry, Shallow water depth estimation, Feature engineering, Surface elevation mapping, Temporal bathymetric analysis

INTEGRATION OF MAPPING TECHNIQUES: LASER SCANNING AND LEICA DISTO IN SUBTERRANEAN MAPPING – A CASE STUDY OF THE STŘÍBRNÝ DŮL IN HORNÍ MĚSTO

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Abstract

In recent years, there has been a significant increase in the accessibility of laser scanning technologies, leading to its growing adoption in various fields. However, challenges still exist in its practical application, particularly in subterranean mapping. The present study demonstrates the successful integration of laser scanning and Leica Disto technologies in the mapping of the Stříbrný Důl in Horní Město, a mine open to tourism. While laser scanning has been employed for capturing the more complex, hard-to-reach areas of the mine, the Leica Disto was used to map simpler sections. This approach enables the creation of accurate, yet user-friendly maps for both scientific purposes and public accessibility. The study emphasizes the complementary strengths of these two methods and their practical integration in subterranean mapping projects.

Key words: laser scanning, multi-method integration, old mine, public accessibility

GEOMORPHOLOGICAL ROCK VALUE DETERMINED USING THE SCHMIDT HAMMER TEST METHOD ON THE EXAMPLE OF ZÁDIELSKA DOLINA VALLEY (SLOVAK KARST MTS.)

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Abstract

The geomorphological rock value provides us with important information about the properties of rocks in a given area. We can understand it as the resistance of rocks to exogenous relief-forming processes. In the literature, we can encounter several opinions or approaches to understanding and distinguishing the degrees of geomorphological value of rocks. A relatively successful tool for the exact determination of rock resistance is the Schmidt hammer test. The paper presents preliminary results of the geomorphological value of individual lithotypes that make up the Zádielska Valley, determined using the Schmidt hammer test. The Zádielska Valley is located in the geomorphological unit of the Slovak Karst Mts., where it forms the border between the eastern-lying Zádielska Plain and the western-lying Horný vrch Plain. From a geological point of view, the area is built mainly by carbonate rocks (Wetterstein limestones, Steinalm limestones, etc.), in the northern part also by chloritic-sericite phyllites with positions of crystalline limestones and metabasic rocks. Field measurements of rock resistance were carried out in October 2024. 55 localities were selected, where measurements were taken with a Schmidt hammer perpendicular to the rock surface. The results of the measurements were subjected to statistical analysis. The results of the measurements show that most lithotypes show medium, weak to very weak resistance. Strong resistance occurs exceptionally. The cause of the different resistance must be sought in the mineral composition, structure and texture, as well as in the microtectonic failure of individual lithotypes. A more detailed analysis of the causes of the different resistance will be the subject of further research. The measurements also confirmed the use of the Schmidt hammer test as a suitable method for determining the geomorphological rock value.

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Key words: geomorphological rock value, rock resistance, Schmidt hammer, Slovenský kras Mts., Zádielska dolina valley

GLACIER RETREAT AND RECENT LANDSLIDES IN PATAGONIA: A POST-LITTLE ICE AGE INVENTORY

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Abstract

The Patagonian Andes, characterized by large scale ice fields, have undergone some of the fastest recent glacier retreats globally. Research in this region is extensive, with a number of studies analysing glacier retreat. Several reconstructions provide information on the historical extent of glaciers and their retreat from the Little Ice Age (LIA) to the present. The glacier area loss during this period exceeds 15%. However, the relationship between deglaciation and landslide activity remains understudied in this region. Previous studies have focused on individual landslides, but a regional inventory of landslides associated with deglaciation across Patagonian Andes has been lacking until now. This study presents an inventory of landslides on deglaciated slopes that resulted from glacial retreat following the Little Ice Age in the Patagonian Andes. More than 5000 landslides have been mapped and classified using high-resolution satellite imagery from Google Earth™ and ArcGIS World Imagery. Shallow landslides, such as debris slides, debris flows, and landslide-erosion complexes on moraines, predominate in the study area. Rockslides and slope deformations are less frequent. This dataset provides insights into the spatial distribution, frequency, and characteristics of landslides in previously glaciated areas. We also analyse the influence of environmental factors, including glacier retreat rates, ice thickness, geological conditions, permafrost zonation, climatic variables and recent uplift, on landslide distribution. The inventory will be used for multitemporal analyses such as determining horizontal and vertical displacement rates of selected landslides.

Key words: Landslides, Glacier retreat, Little Ice Age, Patagonia

THE IMPACT OF MINING ACTIVITIES ON CHANGES IN THE TERRAIN IN THE BYTOMKA CATCHMENT AREA (SOUTHERN POLAND)

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Abstract

The subject of the study was to determine the changes in the terrain that occurred in the Bytomka catchment area under the influence of mining activities (deep hard coal mining). The study used diverse source materials. These were historical Prussian topographic maps from the 19th century and Polish topographic maps from the end of the 20th century. On the basis of these maps, terrain models were created for two periods. The model from the end of the 19th century represented an almost natural (pre-industrial) terrain in the study area, while the model from the end of the 20th century presented the terrain after more than 100 years of mining activity. Additionally, to illustrate contemporary changes in the terrain, lidar models from 2011 and 2021 were used. Mining activities led to a number of changes in the terrain, such as: lowering the average height of the terrain, the formation of drainless depressions, changes in the course of watersheds or an increase in denivelation.

Key words: Subsidences, LIDAR models, DTM, Upper Silesian Coal Basin, hard coal mining, relief changes

EFFECTS OF THE FOREST MANAGEMENT ON DEBRIS DAMS AND LARGE WOODY DEBRIS IN A SMALL CATCHMENT: A CASE STUDY FOR THE HIDAS-VÖLGY, MECSEK HILLS (HUNGARY)

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Abstract

This study examines the occurrence and significance of large woody debris (LWD) and debris dams (DD) in a stream channel located within a small, forested catchment of the Mecsek Hills in Hungary. LWD and DD serve crucial ecological functions, including habitat formation, nutrient cycling, and the stabilisation of stream banks, which can significantly influence the geomorphological characteristics of stream channels. Utilising the large woody debris index (LWDI) developed by Rosgen, our research explores the relationship between human activities, particularly forest management practices, and the quantity and composition of woody debris in the stream. Despite the vital ecological role of woody debris, this tool has not been previously applied in Hungary, and prior geomorphological research in the Mecsek region has largely overlooked the impact of these natural features. We hypothesise that various forest management practices in the catchment area determine the abundance and diversity of DDs and woody debris. To test this hypothesis, we conducted extensive field research that assessed the stream channel's morphohydrologic structure and measured LWD and DD's morphometric characteristics. This included calculating the LWDI to quantify the relationship between forest treatment and debris variability. The geological and geomorphological settings of the headwater catchment and the soil conditions, which all affect the production and transportation of woody debris, were studied using a GIS app.

Our findings are expected to provide valuable insights into the indirect effects of human activities on the geomorphology of stream channels. By understanding how forest management influences woody debris dynamics, this study aims to contribute to more sustainable forestry practices and promote ecological integrity within aquatic ecosystems. We hope our research will spark further investigation into the interactions between human interventions and natural processes in forested catchments across Hungary and beyond.

Acknowledgement: *We want to thank Balázs Víg for sharing his experiences during the project. We also thank the Doctoral School of Earth Sciences at the University of Pécs for supporting this research. We are grateful for the assistance of Mecsek Forest Company and the Nature Conservation Authority of Baranya County. The PTE International Management supported the attendance at this conference.*

Keywords: logjam, stream channel, headwater catchment, GIS, LWDI

HOW TO IMPROVE TEACHING OF (NOT ONLY) GEOMORPHOLOGY?

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Abstract

This conference speech will discuss the possible improvement of geomorphology teaching as a tool for more engaged students and for reducing the dropout rate of your classes. The first part introduces the fundamentals of *the theory of content transformation in education*, which enables educators to design more effective lessons in geomorphology and related subjects. This approach can also be applied to the development of entire course modules or study programs. The second part of this speech will focus on *the model of the in-depth structure of education*. Even though this model was originally conceived as part of the 3A methodology (a tool for the objective evaluation of completed lessons), this model will be discussed as a framework that assists educators in preparing and implementing high-quality teaching of (not only) geomorphology.

Acknowledgement: *This speech is supported by the SGS-2015-016 NaturTech 5 project of the University of West Bohemia in Pilsen.*

Key words: Education, model of in-depth structure of education, theory of content transformation in education, lesson preparation

CHANNEL AND FAN-DELTA MODIFICATION CAUSED BY HUMAN INTERVENTIONS OF THE KERINITIS RIVER IN PELOPONNESE, GREECE

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Abstract

River fan-deltas in sea coastal zones are important geomorphic and sedimentary environments, acting as major sinks for fluvial sediments and as key features for biodiversity, where marine and freshwater environments meet. River deltas are relatively complex systems influenced by a range of fluvial, climatic, tectonic, and sea-level controls. The size and shape of a delta are controlled by the balance between watershed processes that supply sediment and coastal-marine processes (mainly wave activity, longshore currents, and tides) that redistribute it. Similar to river channels, fan-deltas are also significantly affected by human activities, which are currently altering sediment fluxes especially, disrupting natural hydrodynamics, and reshaping delta morphology.

We analyzed the fan-delta and channel of the Kerinitis River, located in northwestern Peloponnese in Greece. The Kerinitis is an ephemeral river with a drainage basin area of 82.94 km². Its catchment is relatively elongated along an S-N trending axis and with a dendritic drainage network. The upper parts of the basin are composed of limestone with conglomerates of sandstone and marl. The valleys of stremas and torrents have a V-shape with an active sediment supply from slopes.

A field study was conducted and combined with an analysis of aerial images from Google Earth software. The research revealed significant channel incision and gradual, slow changes in the river pattern in the lower parts of the basin in the fan-delta. The main factor behind these changes is the reduced sediment supply from the upper parts of the catchment, triggered by human interventions. Key anthropogenic impacts include the damming of the main channel and other river modifications (as channelization of channel), which have disrupted the natural sediment dynamics. The study highlights the significant role of human activity in the geomorphological evolution of river system and fan-delta development of the Kerinitis River.

Acknowledgement: *This study was supported by Czech Science Foundation: 25-15609S – Hydrogeomorphological Dynamics in the Face of Climate Change: Impacts of consecutive floods on Mediterranean River Channels).*

Key words: fan-delta, channel modification, damming, sediment fluxes, Kerinitis River, Greece

EARTHQUAKES AND OTHER GEOLOGICAL EVENTS IN THE BIBLE AND THEIR INTERPRETATIONS

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Abstract

Earthquakes and volcanism are an integral part of the tectonic cycle, where new crust is formed at the divergent lithospheric plate boundaries while old crust sinks during subduction, is melted, forming new – often volcanic – ranges and island arcs, or where colliding plates result in mountain building. None of these geological processes take place without earthquakes. While some researchers can study earthquakes and volcanism as fascinating natural processes through which we can also learn about the Earth´s interior analyzing seismic waves, others have to deal with them as natural disasters in areas where they cause heavy damage to lives or property. How earthquakes were perceived in antiquity can be learned also from the Bible. The books of the Bible contain many descriptions of geological events among which earthquakes and related phenomena are frequently mentioned. A complete list of references to earthquakes in the Bible has been compiled and can be categorized into several groups based on their interpretations. It was found that earthquakes in the Bible mostly precede or accompany significant events, the revelation of God to man (theophany), and apocalyptical events, and always highlight God´s glory, power and magnificence. During the Common Era, the perception of earthquakes and natural disasters has evolved. In simple terms, a paradigm shift occurred – from attributing responsibility to God, to nature, and finally to humankind in relation to the injustice of global wealth inequality, where the poorest are the most affected by natural disasters.

Key words: earthquake, theology of earthquakes, Bible, paradigm shift, global wealth inequality

STRUCTURAL, TECTONIC AND EROSIONAL CONTROL OF THE SANDSTONE MESAS EVOLUTION: CASE STUDIES FROM CENTRAL EUROPEAN SANDSTONE LANDSCAPES

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Abstract

The evolution of sandstone table mountains (mesas and buttes) can be understood through a series of geological and geomorphological processes. First, structural predispositions, including lithology, stratigraphy, and structural patterns (such as the bedding of layers), form the basis for the transformation of the original sandstone bedrock into mesas. Second, tectonic processes play a critical role in fracturing the rock mass along faults or fault zones. This is followed by weathering, which further predisposes the landscape to changes, and erosion, which transports the fractured and weathered material away from the mesa through outflow channels and fluvial erosion. Additionally, gravitational slope processes considerably impact these landscapes, causing further destabilization of the rock mass and preparing it for potential collapses (e.g., toppling, block subsidence, rockslides, or rockfalls). To investigate these phenomena, we adopted a multidisciplinary approach, employing several methods: (I) geomorphological analyses using LiDAR-based DEM data and geomorphological mapping; (II) structural measurements that prove both gravitational movements (tilting and rotation) of the studied blocks and the tectonic predispositions contributing to the disintegration of the sandstone rock mass (e.g., directed fractures); (III) electrical resistivity surveying, which confirmed (a) the thickness of the caprock sandstones, (b) the course of tectonic structures, (c) block subsidence, and (d) the outflow of sandy material (eluvia and colluvia) from study sites, such as the Zlomová rokle gorge that divides the Hejda mesa into two parts; and (IV) displacement measurements employing numerous TM-71 crack gauges installed in the area, which confirms the occurrence of gravitational movements of the rock blocks at several locations, indicating the potential for gravitational collapse of the mesas. Our results from the sandstone landscapes of Central Europe support the hypothesis that the combination of these geological and geomorphological processes plays a considerable role in the evolution of the studied sandstone mesas.

Keywords: Cretaceous sedimentary rocks, sandstone landscapes, structural predisposition, tectonic control, multidisciplinary approach, geomorphological analysis, geophysical surveying, displacement measurements

FACTORS CONTROLLING SEDIMENT YIELD IN A ANTHROPOGENICALLY ALTERED PRECAMBRIAN TERRAIN

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Abstract

Cauvery basin, located in southern Peninsular India, shows very low sediment yield throughout the catchment historically despite its moderate relief and rugged topography. In this study, we aimed to investigate the control of topography, climate and land-use in spatial variability of sediment yield in the Cauvery basin. To achieve this, we delineated sub-basins based on the locations of gauging stations and analyzed long-term average of modern-day sediment yield data for each sub-catchment. SRTM DEM was used to compute various topographic parameters, long-term average rainfall and temperature were considered as climatic parameters, Land use from ESRI and lithologic maps from the Geological Survey of India (GSI) were utilized to understand the land use and lithological variations in the basin. Additionally, dam data across the catchment was incorporated in our analysis to see the influence of sediment retention by dams and reservoirs. We employed Pearson correlation coefficient (r) and Variable Importance of Projection-Partial Least Square Regression (VIP-PLSR) approach to identify the most critical variables influencing sediment yield. Our study findings reveal that rainfall and a few topographic factors are the first-order factors in explaining variations in sediment yield. Large storage capacity and area of dams and reservoirs show a significant inverse relationship with sediment yield, indicating the influence of anthropogenic modification in the low sediment yield of the basin. This research provides a fundamental basis for erosion management, soil-water conservation, and hydrological modeling, thus contributing to better strategies for the sustainable development of the basin.

Keywords: Sediment yield, Cauvery, Rainfall, Geomorphology, Dam.

DEBRIS FLOW ACTIVITY IN THE SOUTHERN CARPATHIANS: REGIONAL CHRONOLOGY AND HYDROMETEOROLOGICAL DRIVERS

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Abstract

Knowledge of regional debris flow (DF) activity is essential for risk management but is often lacking in mountainous areas. This contribution presents the first tree-ring-based regional chronology of DF events in the Southern Carpathians (Southeast Europe), covering a 100-year history of DF activity in the Retezat, Parâng, Făgăraș, and Piatra Craiului Mountains. Sampling 476 disturbed trees and analyzing 1,038 growth disturbances, we reconstructed 72 DF events across 52 event years in eight sub-catchments, with chronology lengths from 51 to 145 years. Notable records include 1999 in Retezat, 2014 in Parâng, 1991 in Făgăraș, and 2012 in Piatra Craiului. DF activity occurred in every decade since 1910, with a slight increase in the past 20 years in Retezat and Parâng. Of the events, 65% were locally significant, while 35% coincided across at least two mountain ranges. Seasonal dating revealed 75% of DFs occurred between June and September. Climate data, including precipitation reanalysis and satellite-derived data, were analyzed in relation to DF activity. Recent DF years were marked by precipitation exceeding global thresholds for triggering DFs, with mean 1-hour intensities of 23.7 mm, 3-hour intensities of 43.7 mm, and 3-day maxima of 82–267 mm. Synoptic conditions triggering DFs included low-pressure systems originating from the Western and Eastern Mediterranean, as well as the Northern and Baltic Seas. The frequent occurrence of DFs and the diversity of synoptic triggers highlight the region's high vulnerability to future DFs under extreme rainfall conditions, a trend that is expected to persist.

Key words: debris flow, dendrogeomorphology, climate reanalysis, rainfall intensity, Southern Carpathians

FLUVIAL FLOOD HAZARD MODELING WITH THE USE OF HEIGHT ABOVE THE NEAREST DRAINAGE MODEL AND GIS

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Abstract

In this study, we aimed at fluvial flood hazard mapping using the GIS-based method – Height Above the Nearest Drainage (HAND). The studied river reach was represented by the Kysuca River having 8.1 km. The HAND model was created based on the Light Detection and Ranging (LiDAR) digital elevation model (DEM) with 1 m resolution and the river centerline. Based on these two inputs, the flow direction and flow accumulation analysis was performed when creating the HAND model. The start node for flow depth modeling was the Turzovka gauging station, for which we created a cross section profile. Using the Hydraulic Toolbox, we calculated the water stages for this cross section based on the design flood discharges for Q_{10}, Q_{20}, Q_{50}, and Q_{100}, which were obtained from the Slovak Hydrometeorological Institute, cross section geometry, and cross section roughness coefficients. Raster calculator was then used to compute flow depths from the HAND model for the studied flood water stages. The total flood extents for Q_{10}, Q_{20}, Q_{50}, and Q_{100} flood scenarios were 323,069 m^2, 414,951 m^2, 568,472 m^2, and 662,189 m^2, respectively. Using the ZBGIS spatial dataset for 2023, we calculated the number of flooded buildings for Q_{10}, Q_{20}, Q_{50}, and Q_{100} flood scenarios. There were 12 flooded buildings in case of the Q_{10} flood scenario, out of which 3 were family houses. As for the Q_{20} flood scenario, 45 buildings were flooded, out of which 10 were family houses. For the Q_{50} flood scenario, we recorded 171 flooded buildings in total, out of which 44 family houses. In case of the Q_{100} flood scenario, we recorded 227 flooded buildings, out of which 57 were family houses. The GIS-based HAND method is relatively simple and fast in producing flood extents and flow depths. However, it does not count with water movement equations, which can potentially make it less accurate compared to traditional hydraulic models. Therefore, this issue is planned to be investigated as part of the future research efforts.

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Key words: fluvial floods, GIS, Height Above the Nearest Drainage, flow depths

RECONSTRUCTION OF THE MORPHOLOGY AND HYDROGRAPHY OF THE CENTRE OF KRAKÓW (POLAND) BEFORE THE MIDDLE AGES – NEW DATA

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Abstract

This presentation concerns investigation of urban geomorphology. The subject of the presentation is the historic centre of Kraków, where the pre-human relief became masked due to rapid increase in cultural deposits during the Middle Ages, especially. The aim of our investigations is the reconstruction of the original topography, relief and hydrography of this area based on rich sources of materials in papers and non-published data on geology, geoengineering, archaeology, history and on maps and panoramic drawings of the town. A digital elevation model has been generated, which showed the topography of the study area in the period analysed. Structural analysis, cross validation test and estimation by ordinary kriging method were carried out. The final cartographic work was prepared with the use of QGIS and Surfer software. The distribution of landforms and water phenomena in the study area in period before the Middle Ages is presented as a proposed variant of the geomorphological and hydrographic maps prepared by the Authors. The opinions shown by the Authors, especially on maps and other figures, represent the first attempt to make the synthesis of the knowledge hitherto held concerning the relief and hydrography of the centre of Kraków before the Middle Ages.

Key words: pre-urban morphology and hydrography, digital cartography, geostatistics, Kraków

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