STATE OF GEOMORPHOLOGICAL RESEARCH IN 2024

ABSTRACTS

Plenary session I. chair: Tomáš Galia

Cosmogenic 10Be exposure dating of a pre-Holocene flowslide from the Kamienne Mountains, Sudetes

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The relief of the Kamienne Mountains in central Sudetes has been significantly reshaped by mass movements. Whereas their spatial distribution, typology and geological predisposition are reasonably well known, their timing remains very poorly constrained. A study of a flowslide at Mt. Garbatka executed a decade ago, involving mainly landform mapping and soil survey, led to the proposal that the movement predated the Holocene and two separate phases of displacement occurred (Migoń et al., 2014). However, no details about the timing of the flowslide formation could have been offered. The abundance of boulders of quartz-rich rhyolite tuff within the flowslide provided an opportunity to sample for cosmogenic 10Be exposure dating. Ten boulders were sampled at two places within the flowslide, five at each site. More distant boulders, presumed to be deposited in an older phase, yielded dates from 64.8 +/- 1.9 ka to 21.0 +/- 0.7 ka, while those from the upper cluster have ages ranging from 48.3 +/- 1.4 ka to 35.9 +/- 1.0 ka. These results are consistent with an earlier reasoning and confirm two phases of displacement. The spread of dates in the lower cluster likely indicates emergence of some boulders from the colluvium due to later erosion and much younger onset of exposure to cosmic rays.

Geomorphological impacts of crop diversification in Hungary

Dénes Lóczy, József Dezső, Ervin Pirkhoffer, Szabolcs Czigány

The destructive environmental impacts of large-scale agriculture are further aggravated by drier climate in the Danube-Tisza sand region, where soil fertility is low, water retention is very limited and groundwater levels are steadily dropping. The prevention of wind erosion is a central task in raising the level of ecosystem services. Among other related services the enrichment of the blown-sand soil with organic matter (enhancing carbon sequestration), the improvement of soil structure and water retention capacity and achieving higher soil biodiversity are major objectives. The international Diverfarming project (2017–2022) within the EU Horizon 2020 Program focused on the impacts of crop diversification and low-input practices. In the experiments intercropping with different annual crops was investigated and its influences on some provisioning and regulating ecosystem services were evaluated in an asparagus field in Jakabszállás. Although the findings point out the decisive role of soil moisture conditions, the positive impacts of diversification are also remarkable. The local farm agronomist agrees that crop diversification improves soil quality, but he denies that it would directly influence farm competitiveness, which is primarily dependent on the costs of fertilization, plant protection and labour. Further analyses are needed to prove the benefits of diversification through enriching soil microbial life and the possible reduction of fertilizer use while water demand is kept at a low level while the same crop yield and quality are ensured.

Quo vadis, dendrogeomorphology?

Radek Tichavský

The dating of geomorphic processes using tree rings is a long-term thriving approach applied to various subdisciplines of geomorphic research and natural hazard assessment. This abstract will address methodological limitations and research challenges related to determining climate triggers using dendrogeomorphic reconstructions, as well as potential applications in anthropogenic geomorphology. A review of 121 papers analysing landslide, debris flow, and snow avalanche reconstructions alongside climate variables demonstrates recent progress in using probability models to identify the best explanatory triggering factors. Additionally, it highlights the significance of recently available global climate reanalysis data as a possible surrogate for gauge data when unavailable or distant from the study site. Further challenges arise in employing dendrogeomorphology in anthropogenically modified terrains, such as subsidence troughs or spoil heaps, which present relatively new landforms with dynamics that are not fully understood. Several

examples utilizing dendrogeomorphic approaches from the Ostrava-Karviná mining region will be presented, along with potential research applications.

Contemporary dynamics of glacial lakes in Spitsbergen: comparison between systems developing in northern, central and southern regions

Iwo Wieczorek

The study examines the classification, dynamics, and responses of glacial lakes in the Svalbard archipelago during the ongoing deglaciation process. The analysis focuses on four distinct catchments, each containing glacial lakes with varying classifications, from ice-dammed to moraine-dammed. The study observes notable differences in the occurrence of Glacial Lake Outburst Floods (GLOFs) and their subsequent impact on discharge zones and morphological changes. The cyclical changes of Goësvatnet, an ice-dammed lake, contrast with the stability and gradual filling observed in frontal moraine-dammed lakes at Knivsggbreen, Nepebreen and Ragnarbreen. The Crammerbreen glacier exemplifies rapid evolution, leading to irreversible drainage and the cessation of glacial lake formation. In contrast, the Ragnarbreen glacier presents a stable example of a glacial lake, showcasing the influence of deglaciation on lake formation and stability. This analysis offers important insights into the varied responses of glacial lakes to deglaciation. It highlights the significance of classification, GLOFs, and catchment characteristics in shaping their dynamics. Understanding these variations is crucial for predicting future changes in glacial lake landscapes as Svalbard continues to undergo deglaciation.

Plenary session II. chair: Zdeněk Máčka

Assessing Large Wood Dynamics Using Time-Lapse Photography

Zuzana Poledniková, Adriana Holušová, Tomáš Galia

Large wood (LW) is usually defined as wood pieces exceeding 1 m in length and 0,1 m in diameter that interact with river channels, plays a pivotal role due to its biophysical benefits and the potential flood risks associated with mobilized LW. The continuous quantification of LW is essential for providing insights into its volume and spatial distribution over time. Contemporary research methodologies incorporate advanced monitoring technologies for data acquisition. In our study, we employed time-lapse photography to capture a significant high-flow event in the Odra River, Czechia, resulting in a dataset of 75,000 images taken from May 16 to 19, 2023. This event, marked

by a peak discharge of 112 m³/s, which is less than the Q1 discharge, was meticulously recorded. Cameras were strategically placed at three meander bends, roughly 1 km apart, to thoroughly document the dynamics of the LW movement. Our contribution also discusses the manual processing of the extensive image dataset, evaluates the pros and cons of this approach, and explores the potential for integrating artificial intelligence to improve future analysis efforts.

Riparian Vegetation Change Detection Using Random Forest Along the Danube Side Arms

Miloš Rusnák, Hamid Afzali

Riparian zones provide many principal functions and benefits for biodiversity, stabilizing channel banks, and preserving aquatic ecosystem integrity. This research focuses on satellite imagery analysis for assessing vegetation change in riverine landscapes, crucial for effective environmental management and conservation. Multi-temporal Landsat and Sentinel-2 images from 2004 to 2022 were acquired from Google Earth Engine (GEE) and processed using Sklearn and SciPy Python libraries, involving normalization, dimensionality reduction, and feature extraction. Various band compositions, textural, spectral, and morphological features were used for classification model. The Random Forest (RF) algorithm was optimized through Grid Search and assessed via fivefold cross-validation to ensure robust classification model. RF feature importance was measured for all band compositions to assign the more informative features all over the datasets. Results demonstrate effective feature combinations for classifying satellite datasets, with Shortwave Infrared and vegetation indices-related features deemed significant by Random Forest feature importance analysis. Overall accuracies consistently exceeded 85%, affirming the robustness and high performance of the methodology for vegetation analysis, mapping, and monitoring in riparian zones.

This research was supported by the Science Grant Agency (VEGA) of the Ministry of Education of the Slovak Republic and the Slovak Academy of Sciences (02/0016/24).

Impacts of Climate Change and Human Activity on Sediment Load Variability in Western Ghats Rivers

Sumit Das, Gianvito Scaringi, Yunus Ali, A.C. Narayana

In the past few decades, rivers worldwide have been undergoing notable shifts in sediment discharge due to the collective influences of climate change and human intervention. In India, many

rivers have experienced significant changes in sediment transport, largely due to dam construction. This study focuses on small rivers originating from the Western Ghats, flowing over 50 km and draining into the Arabian Sea. It aims to (i) identify factors influencing temporal changes in sediment load in recent decades and (ii) explore potential geomorphic and ecological consequences. Hydro-meteorological data from the Central Water Commission (CWC) and the Indian Meteorological Department (IMD) covering the mid-1970s to 2018 were analyzed using statistical methods such as the Mann-Kendall test, Pettitt test, and double mass plot. Key findings are as follows: (a) the Netravati, Chaliyar, Bharathapuzha, and Periyar rivers contribute 59% of sediment to the Arabian Sea among the 18 major rivers studied; (b) a decline in sediment load is observed in southern Kerala rivers; and (c) temporal variations in sediment load follow four significant episodes, reflecting pre-dam construction, a phase of deforestation and dam construction, reduced deforestation with increased dam construction, and a stable period post-dam construction (dam and land use data based on government reports). These findings have implications for sediment control and the ecological understanding of the Western Ghats, affecting both human communities and biodiversity in the region. In the future, this work will be extended to project sediment load patterns in Western Ghats rivers, considering climate change and its impacts on precipitation patterns, land use, and erosion rates.

Influence of vegetation on meander morphodynamics over two decades: A case study from the Odra River, Czechia

Tomáš Galia, Zuzana Poledniková, Václav Škarpich

Historically, the significance of vegetation in shaping fluvial geomorphic processes was quite overlooked by classical geomorphological studies until the 1980s. In recent years, however, the impact of both living and dead vegetation on channel morphodynamics has become a prominent area of research. Our contribution provides insights derived from two decades of field observations and aerial photographic analyses of a freely meandering, approximately 4-km long reach of the Odra River in Czechia. Our findings reveal a consistent increase in the amplitude of most meander bends in the analyzed segment. The data indicate that floodplain hardwood forests exert a stabilizing influence, effectively reducing erosion rates for two meanders in proximity to these forests. The study also identifies the role of large wood (LW) in modulating sediment dynamics, notably through sediment accumulation near stable LW structures and the provision of some bank protection at the outer bend by LW. In contrast, we observed that erosion accelerated by LW-induced flow deflection against banks was transient and limited to specific sites. Importantly, while broader catchment-scale factors such as hydrology, valley slope, and sediment

supply are crucial in shaping meander geometry, the interaction with vegetation introduces a layer of complexity to these fundamental relationships.

Geomorphic Assessment of Discharge potential to identify areas more vulnerable to erosion after River Training, A case study of the Belá River

Akhtar Zeb Khan, Anna Kidova

In the context of river restoration, 'river training' refers to the loss of geomorphic diversity and hydro-morphological lateral continuity, and vice versa. Human-induced disruption, combined with the current climate change scenario, has had a substantial impact on the river's natural equilibrium. As a result, these disruptions emphasize the urgent need for river restoration initiatives to maintain the natural equilibrium of European rivers. Geomorphic recovery is a crucial objective in river restoration, encompassing the revitalization of the river's morphology and processes. This study focuses on the 1D discharge potential of the multi-thread, braided-wandering Bela River, belonging to the highly protected areas of Natura 2000. The research is prompted by ongoing fluvial processes following river training in 2018. The chosen methodology aims to highlight the current geomorphic processes in the disturbed reaches of the braid-plain and floodplain area and their influences on ecological succession. Additionally, it will also evaluate the hydro-morphological response of the studied river system to the assorted disturbances via Remote Sensing (RS), Geographic Information System (GIS), and field investigations framework. The methodology employed in research offers valuable insights into the dynamic river system, thereby facilitating the foundation for well-informed decision-making in future river restoration projects.

Plenary session III. chair: Lucie Kubalíková

Geotouristic and educational potencial of the geosites in the Podtatrze Area

Ján Novotný, Anna Chrobak-Žuffová, Anna Delekta, Joanna Fidelus-Orzechowska, Vladimír Székely, Daniel Michniak

The region of the Podtatrze is a bordering area surrounding the Tatra Mts., which includes four historical and cultural regions: Podhale, Orava, Liptov and Spiš. This area is also characterized by a long tradition associated with tourism, which is largely based on visiting the most famous and most promoted places, therefore the phenomenon of the overtourism is observed here. This contribution summarizes the recently completed IVF project, the main objective of which was to

evaluate the tourist potential of the geosites in the surroundings of the Tatra Mts., with the vision of diverting at least some of the tourist flows away from the most visited places. The research within the project was conducted on three levels: 1) Inventory and evaluation of the geosites; 2) In-depth interviews with representatives of local stakeholders (municipalities, national parks, entrepreneurs, NGOs); 3) Questionnaire survey among geography teachers. Results confirmed the high educational and natural value of the analyzed geosites and in most cases a positive attitude of local authorities towards the development of new forms of tourism in their region.

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200 years of coupled relief disturbance in the heart of a former industrial city

Jan Lenart, Martin Kašing, Kristýna Schuchová, Radek Tichavský

Landscapes in industrialized areas undergo distinct stress due to numerous and rapid changes, including geomorphic disturbances. We investigated a distinct abandoned sloped area above the river channel in the heart of an industrial city with a population of 300,000 inhabitants. Traces of numerous past changes enabled us to reconstruct a narrative of coupled and chained disturbances spanning over 200 years. Ten different landscape-forming processes of natural, mining, urban, and war origins were identified and dated through field mapping, dendrogeomorphic and geophysical surveys, speleological exploration, and analysis of historical maps and reports. The most impactful processes included slope retreat, structural landslides, stone quarrying, and ground subsidence induced by coal mining, while rockfalls, urbanization, and war disruptions had lesser effects. The collapse of an air-raid shelter, combined with other processes, created a remarkable cave exposing coal seams. These identified processes interact within a complex environment, either immediately or with time gaps of tens or even hundreds of years. The responses of relief and landscape to these events were captured in discernible landscape layers. The derelict landscape, composed of numerous spatial layers resulting from many temporal events, is unique—a landscape devastated and yet valuable. We discuss two potential scenarios for the site's future development: gradual erasure of past layers leading to landscape homogenization, or the occurrence of further disturbances increasing the number of individual past layers.

Remnants of extreme morphodynamic processes at the site of a World War II military conflict (Koźle Basin, southern Poland)

Jan M. Waga, Bartłomiej Szypuła, Kazimierz Sendobry, Krzysztof Jochymczyk, Mariusz Grabiec

In 1944, American military aviation carried out bombing of synthetic fuel plants for the Nazi army, located in the Koźle Basin, where bomb explosion craters are still visible today. In total, many thousands of craters were created; their density in the study area reaches 80/ha in places. The study area has different environmental conditions - dry, wet and swampy zones and different types of land cover (forest, agricultural). The basic morphometric parameters of the craters were measured under intimate conditions on the basis of a DEM, and selected forms were measured in the field. Geological and soil surveys were also carried out by performing exposures and soundings with a hand auger. Laser rangefinders were used, as well as a scaled soil stick and a broken measuring pole for bathymetric measurements. Structures left by filled funnels were surveyed using electrical resistivity, GPR, a conductivity meter and a proton magnetometer. Large part of the craters surveyed in the Koźle Basin are flooded with water (usually several tens of centimeters deep, sometimes up to 1.5 meters and with diameters exceeding 10 meters). In addition to craters from the war, new ones are being created after the explosion of unexploded ordnance in the ground.

Cave Pearls: The Hidden Treasures of Mines

Kristýna Schuchová

Cave pearls are a fascinating geological formation in caves and mines worldwide. These small, smooth, rounded pearls are formed through calcification, where mineral-rich water slowly drips onto a small object and gradually forms a hardened layer around it. As more layers form, the pearl grows, ranging from a few millimetres to several centimetres. Cave pearls can be found in various environments, including limestone caves, lava tubes, and abandoned mines. They are often found in underground bodies of water, where the slow dripping of water over time forms these unique geological features. Several examples of cave pearls are found in caves and mines in Czechia. One such example is the Litultovice mine located in the Nízký Jeseník and the štola Mír in the Vysočina region, where cave pearls have been discovered and are currently being researched. The study of cave pearls is essential in understanding the geological history and mineral content of the caves or mines where they are found. The formation of cave pearls is a complex process. It provides insight into the mineral composition of the surrounding rocks and soils, the quality of water in the cave or mine, and the precipitation rate. In addition, cave pearls can indicate environmental changes, particularly in water quality. In conclusion, cave pearls are a fascinating geological formation providing valuable insight into caves and mines' geological and environmental history. The

examples of Litultovice mine and Štola Mír in the Czechia show the diverse range of environments where cave pearls can be found and their potential for further research.

Plenary session IV. chair: Piotr Migoń

Generalization of LiDAR data for computing morphometric characteristics in land cover change modelling

Adam Rusinko, Richard Feciskanin, Michal Druga, Jozef Minár

Studies focusing on land cover change modelling often emphasize the statistical aspect of the model, overlooking the selection of spatial predictors. In our research, we address the geomorphometric characteristics and their derivation and improvement. LiDAR data provide very detailed information of land surface that surpass those of previously used DEMs. The question is whether the hierarchical forms of georelief captured by LiDAR correspond to the land cover. We assume that DEM generalization is required to preserve important features of georelief while eliminating negligible microforms. We utilize a method of generalization based on irregular triangular networks. The tool has optional parameters of triangle reduction and the resulting raster resolution. Our work was conducted at four levels: non-generalized DEM, and triangles divided by 2000, 10 000, and 30 000. At each level, morphometric characteristics were derived and compared using logistic regression. The response variable was the land cover changes in model areas of Slovakia from 1990 to 2010. Preliminary results suggest that detailed information from LiDAR is redundant, although certain responses were unaffected by different levels of generalization. On the other hand, generalized DEM offers the advantages of reduced computation time and elimination of artifacts from elevation data.

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Circular structures in central Europe indicated by composite landform features

Pavel Roštínský

Using remote sensing topographic data, circular structures appear to occur in the surveyed region of central Europe. Analogous composite geometric patterns combining together discontinuous concentric rings and sets of dispersed excentric radial landforms were searched for there. Curved

valleys, slopes and ridges have been variously combined in their architecture; spatial arrangement of fluvial system was taken as a starting phenomenon. The largest elements allowed to approximately locate central points of the circular structures, which again helped in adding smaller landforms into these complexes. While in the Bohemian Massif mainly meso-scale structures (>50 cases of common tens-km diameter) have been yet indicated, in the surrounding areas large-scale circular phenomena (>10 cases of hundreds-km diameter) have been proposed. Related to other possibly associated geoscience phenomena (doming core complexes, sedimentary belts, subsidence domains or crater-like structures), more plausible factors for an origin of the focused features can be assumed: deep magmatic, near-surface volcanic or even meteoric. The comprehensive study of circular structures is highly supported by their presumable strong influence on a dense crust segmentation; yet (straight-)linear fault ruptures or topolineaments as the phenomena characterised by (possibly only apparent) antagonistic geometry have been considered as primary ones related to such process.

Combining multi-BACI approach, LiDAR data, historical aerial photographs and UAV survey for inferring multi-decadal and ongoing channel degradation

Miloš Rusnák, Ján Kaňuk, Anna Kidová, Milan Lehotský, Hervé Piégay, Ján Sládek, Lukáš Michaleje

This paper presents the degradation evolution of this multi-channel river system since 1949 based on analyses of floodplain surface heights above the river channel, dated from historical aerial images. The study applied the BACI (Before-After-Control-Impact) approach that compared pre-state (Before), post-state (After) and reach (Control) that is not affected by potential external effects with degraded (impacted) reach. This paper presents an innovative approach to assess the degradation evolution of a multi-channel river system since 1949 by LiDAR-based analyses of floodplain surfaces above the river channel dated from historical aerial images. Analyses of floodplain heights and cross-section changes indicate that the maximum incision rate (5.7 cm/year) occurred in the most degraded reach. Moreover, our analyses point to accelerated incision (24.5 cm/year) in the last ten years (2011-2021). Overall, the 573,303 m3 of gravel sediments constituted outwash from the channel system. River system degradation here is connected with channel regulation of the downstream part, comprising embankment and gravel mining activities that activated a naturally conditioned knickpoint into a backward erosion system with knickpoint migration upstream.

This research was supported by the Science Grant Agency (VEGA) of the Ministry of Education of the Slovak Republic and the Slovak Academy of Sciences (02/0016/24).

Images of flysch bedrock structures on ERT cross-sections: order from chaos?

Filip Hartvich, Ivo Baroň and Rostislav Melichar

Outer Western Carpathians, formed as part of the Alpine-Himalayan orogenic belt, are built by Mesozoic and Cenozoic flysch formations, formed by alternating sandstone and conglomerate layers interbedded with claystones and marls. The sedimentary bedrock was heavily deformed, tilted and folded during the orogenetic formation. As a consequence, numerous currently observed processes, such as slope movements, erosion, and tectonic deformations, are pre-conditioned by the local geometry of the sedimentary layers. To understand the structural building of the mountains, it is often useful to complement the structural measurements, surface observations and LiDAR-based information with the underground tracing of the structures. This is often done using geophysical surveying, most commonly ERT profiling. In theory, the flysch composition should be rather easy to observe on resistivity maps, as the two main rock types have very different resistivity values. However, the complicated geometry of the layers and its relation to the surface make it often difficult for the inversion modelling, generally designed to subhorizontal strata.

Here we present several case studies from our extensive research using ERT to reveal structural conditions in relation to the possibly seismically triggered landslides within the GACR project GC22-24206J: "Coseismic Landslides in Mountain Ranges of Active and Stabilized Accretionary Wedges“

Discovery of deeply eroded diatremes with negligible geomorphic manifestation in the Bruntál Volcanic Field, Czechia

Martin Kašing, Jakub Jirásek, Dalibor Matýsek, Jan Valenta, Petr Tábořík, Vladislav Rapprich, Tomáš Pek

Maar-diatreme volcanoes represent specific volcanic forms, generally accepted to be formed by the explosive phreatomagmatic eruptions in a short time. In the Bruntál Volcanic Field (BVF) within the Nízký Jeseník Upland, Czechia, only two possible indications of maar-diatreme volcanoes have been previously documented (Šešulka et al. 2014; Rapprich and Skácelová 2022), both belonging to the Pleistocene period. Here, we identified two additional diatremes within the BVF, situated at the Biskupice site near Albrechtice Town. One was newly discovered during a comprehensive ground magnetic survey of nearby volcanic dikes. The second structure has been recognized since the 1960s as an unspecified volcanic feature; however, interpretation of our newly acquired data led us to interpret it as a diatreme. Since these volcanoes have no geomorphic expression, a

combined geophysical survey was conducted to image their subsurface structure. Magnetic, gravity, and geoelectrical surveys (dipole electromagnetic profiling and electrical resistivity tomography), together with petrographic analysis of excavated material from auger wells and test pits, provided compelling evidence supporting the phreatomagmatic origin of the studied structures. Both circular-shaped bodies exhibit highly magnetic and conductive responses, accompanied by negative anomalies in gravity. The small diameter of the circular structures, coupled with minor negative gravity anomalies and the presence of excavated diatreme breccias, suggest a lower diatreme facies and imply exposure of a deep part of the diatremes at the current erosional surface. Presently, awaiting results of Ar-Ar dating from excavated material, we anticipate assigning a Miocene age to the studied volcanoes.

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Plenary session V. chair: Jan Klimeš

Failed Patagonian tableland: landslides distribution and controls

Jakub Kilnar, Tomáš Pánek, Michal Březný, Diego Winocur, Karel Šilhán, Veronika Kapustová

Argentinian Patagonia is formed mostly by tableland relief created by Cenozoic basaltic efusions, general uplift and relief inversion. The tableland is vastly effected by landslides. Using TanDEM-X we manually maped 30 000 km2 of landslides in the Patagonian tableland and conducted spatial analysis of their distribution and controls. Based on relative dating to lava efusions, glaciation and paleoshorlines we propose, that the landslide activity in the region spans across several millions of years. In contrary to general knowledge of landslide distribution, most of the landslides in the Patagonian tableland are located in low-seismicity, tectonicaly stable, semiarid to arid conditions. We propose, that the leading landslide distribution control is the tableland stratigraphy: basaltic caprock overlaying weak sedimentary and volcanoclastic rocks. The caprock protects the underlying weak rocks and thus it becomes elevated above the surroundings over time, forming

plateaus and mesas. As long as the topography of the formed tableland becomes high enough to laterally expose underlaying weak rocks, the tableland margins becomes unstable and collapse. It starts as lateral spreading a rotational landslides and later often evolve to flow-like mass movements. Many of the plateaus and mesas in the Patagonian tableland are fringed by almost continuous landslides. Some mesas are already completly consumed by landslides. This study helps to understand distribution and evolvement of landslides in volcanic tablelands.

Landslides on the growing folds of the Kura fold-and-thrust belt (Azerbaijan, Georgia)

Michal Břežný, Tomáš Pánek, Hans-Balder Havenith, Alessandro Tibaldi

Rising hillslopes in the active fold-and-thrust regions present new landslide-prone slopes. However, studies investigating landslides in newly formed fold-and-thrust belts are limited. In this research, we analyse landslide occurrences in the Kura fold-and-thrust belt, a geologically active region at the southern edge of the Greater Caucasus. This area has experienced significant tectonic shaping over the last 2-3 million years, affecting Miocene to Quaternary sediments. Using satellite imagery, we identified about 1600 landslides, a quarter of which are active. These landslides, although occupying less than 1% of the land, are predominantly found at higher elevations and areas with greater relief. They mainly occur in regions elevated by tectonic forces, especially on steep anticlines and valley slopes cut by active faults. Our findings lead to a conceptual model for the temporal evolution of landslide patterns in weak sediment-based fold-and-thrust belts: 1) Initially, slow deformations at thrust fronts lead to landslides in deep valleys intersecting the uplifting hanging walls. 2) As anticlines rise and steepen, they become more prone to planar sliding when dip slopes exceed friction angle, and valley development creates additional dip slopes resulting in widespread landslides. 3) Finally, erosion lowers relief, forming badlands and reducing landslide occurence.

Geomorphometric studies of valley network in the Stołowe Mountains

Wioleta Porębna, Piotr Migoń, Milena Różycka, Krzysztof Parzóch

The tableland of the Stołowe Mountains, due to its distinctiveness, complexity resulting from the occurrence of sedimentary and crystalline rocks, and long research history, constitutes an excellent field for analysing relief development in tableland settings and serves as a research laboratory for testing various methods of relief parametrization. The valley network was the subject of analysis. The aim of the study was to detect and quantify similarities and differences in the fluvio-

denudational morphology of the massif. Following the concepts of connectivity and hierarchy in geomorphic systems, components of various scales were considered: catchments, basins, valleys and valley segments. Characterization of morphogenetic domains in the context of the valley network was performed. Investigation of drainage spatial pattern revealed seven classes of erosional dissection, within which various valley styles (i.e. gorges, canyons, V-shaped valleys, broad troughs and flat-bottomed valleys) in different morphological position (plateau top surface, escarpment, slope) occurred. Three main zones of enhanced erosional signal have been distinguished. Multiple track analysis shows that morphological diversity of valley systems expresses the complexity of geological setting, relief and geomorphic processes. Detailed parametrization of valley morphology of Stołowe Mountains offers a new, more quantitative look at this complex area, hidden beneath forest cover.

Anthropogenic impact on the water course in the Labe (Elbe) and Jizera confluence area

Tereza Steklá

The impact of human activities on the landscape has significantly changed throughout history. Especially, the natural evolution of rivers was extensively disrupted by course modifications and water management. Presented research evaluates the anthropogenic impact on the evolution of the middle Labe (river-km 854 –882) and the lower Jizera (river-km 0 – 17) and its influence on the dynamics of the fluvial processes. The historical change analysis of the water courses was based on the historical maps of the Second and the Third military survey, various artworks and field reconnaissance. The most significant changes of the studied sections of the Labe and Jizera course occurred during the 19th century mostly for flood protection and transport purposes. During the last 200 years, the Labe was shortened by 20.6% and the Jizera by 7.4 % of its original length. The longitudinal profiles of the Labe and Jizera were disrupted by water management structures. Recently, the lower reaches of the Jizera show a lengthening and curving tendency caused by fluvial erosion and accumulation. The reinforcements of the Labe banks limit the natural evolution of its channel. As a result of irreversible landform changes, a valuable record of their past evolution has been lost.

POSTERS

Reach-based hydromorphological survey and morphometric analysis of a headwater catchment Várvölgy stream, Mecsek Mountain, Hungary

MD Ashraf, Balázs Víg, Akhtar Zeb Khan, Szabolcs Ákos Fábián

This study investigated the interaction between geological, geomorphological, and anthropogenic factors on fluvial processes, specifically the morphology of the channel facilitated by woody debris. To achieve this, cartographic resources, digital elevation models, and field data collected using field survey protocol for the hydromorphological survey. Out of the 103 segments measuring fifty metres each that were examined, it was seen that 72 of them had significant accumulations of woody debris, which had a noticeable impact on the morphology of the channel. The identification of step systems and transitional zones, primarily observed in the upper course of streams because of distinct geological characteristics, contributes intricacy to our comprehension. The results shed light on the complex hydrogeomorphic characteristics of tiny, low-gradient drainage basins and emphasise the strong reliability of our methodology in regions with low mountainous terrain.

Finally, we are grateful to the VEGA agency for funding this research under the grant number 2/0016/24

Numerous industrial spoil heaps in the city's industrial landscape - how can they be integrated?

Natálie Bedrunková, Jan Lenart

An integral part of the post-industrial landscape are the spoil heaps, that were created alongside the development of coal mining and metallurgy in the Ostrava-Karviná district. These spoil heaps constitute a significant landscape feature and play a functional role within the geosystem. Over the years, dozens of spoil heaps of various types and shapes have been formed, potentially posing certain hazards (e.g. contaminantion, slides) but also offering opportunities (e.g. refungium, biodiversity). Presently, many of these spoil heaps are disused, providing an opportunity for discussions regarding their future roles and integration into the landscape. For such discussions to occur, fundamental research on the spoil heaps is necessary, including their geographical distribution, geomorphic typology, material composition, and landscape function. The poster focuses on this issue in the Ostrava and Petřvald parts of the mining area. The current state of knowledge of this matter is presented trought an overview map of the area and is evaluated in the context of the existence of mines and individual industrial plants (chemical plants, coking plants, smelting plants) that have contributed to the formation of spoil heaps in the past.

Analysis of snow avalanches using the dendrogeomorphological approach, in the perspective of climate changes. Case study: Bucegi Mountains, Romanian Carpathians

Diana-Alina Bodea, Mircea Voiculescu, Patrick Chiroiu

The avalanches are movements of the snow cover being triggered by natural and anthropogenic factors producing material and human damage. Climate change influences the environment more and more, thus climate warming increases the frequency of snow avalanches. In order to develop measures to reduce their effects, it is necessary to know the chronological evolution of avalanches and their characteristics. The purpose of the study is to demonstrate that snow avalanches can be an indicator of climate change in the Southern Carpathians, Romanian Carpathians. Achieving the goal is done with the help of specific objectives, well supported by several methods of work in the field and laboratory but also by GIS techniques, satellite images. The objective of this study is the reconstruction of the avalanche activity at the upper limit of the forests and below it, by avalanche paths, in the Bucegi Mountains using the dendrogeomorphological method. In this study, dendrochronological samples were taken from two areas, Carp 2 and Târle 2, in the Bucegi Mountains. The number of samples is 43 in the Carp path and 41 in the Târle path. Affected trees record in growth rings, growth disturbances (GD) and these can be: scars, rows of traumatic resin, reaction wood, abrupt growth release or abrupt growth suppression. In total, 150 growth disturbances were registered in the Carp corridor and 139 growth disturbances in the Târle corridor. Regarding the answers obtained, it was found that in the Carp corridor were 12 events in a 40-year interval, and in the Târle path in a 36-year interval, 12 avalanches. In years such as 2006, 2011, 2013, 2015 there were a large number of tree growth disturbances sampled in both avalanche zones from the Bucegi Mountains. Thus it is very important to know the years in which the avalanches were present in these 2 colors for a better understanding of the phenomena, their cyclicity and the possible factors that determine them.

Current geomorphological processes as potential threats on hiking trails in the conditions of the Tatras (Slovakia)

Gabriel Bugár, Juraj Hreško, Veronika Piscová

As the highest mountain range of the Carpathians, the Tatras are an important area in terms of historical and current use, as well as the protection of natural resources. Since the declaration of the Tatra National Park (TANAP) in 1949 and later in 1993, after the Tatra Biosphere Reserve was registered in the world network of Biosphere Reserves, much attention has been paid to the

sustainable development of tourism and related infrastructure. Despite this, the impact of tourism in some localities is above the sensitivity threshold of ecosystems and creates frequent conflict situations that have a negative impact on the tourists and visitors of the Tatras themselves. An important category of using the alpine environment above the forest line is hiking as the most widespread form of relaxation in practically the entire territory of the Tatras. In the article, we pay attention to the impact of current geomorphological processes on the stability of hiking trails, as well as on the direct or indirect threat to tourists themselves. In the conditions of a changing climate, especially in the last 25 years, the frequency of occurrence of such threats has been increasing.

Several slope deformations activated in recent years in Czech Republic

Martin Dostalík, Jan Jelének, Milan Aue, Petr Kycl, Jan Novotný, Lucie Koucká, Martin Kýhos, Vít Baldík

CGS continuously documents slope deformations in the Czech Republic. Currently also with the support of the RENS project (TAČR SS02030023), one of whose goals is the research of geological risks in the entire Czech Republic. This post shows several hazardous slope deformations activated in recent years. These localities can be seen at the photo exhibition "Sesuvy s nadhledem". On the northern shore of the Nechranice reservoir, the shore line is continuously shifting mainly due to abrasion. We recorded a landslides along a rotational-planar shear plane at the location of the fault line, which are gradually regressively expanding. The removal of material in the critical area of the Řečica landslide (part of the stabilization measures) initiated a translational landslide, potentially leading to a rock avalanche. We are documenting the landslide of the dump between the Družba and Jiří coal mines in the Sokolovská coal basin. And a risky polyphase flow-type landslide on the southern slope of the Družba quarry, which regressively expands towards the village of Horní Pískovec. A small landslide in the village of Janová in the Vsetín region damaged a recreational facility and is still active. In the village of Žiželice in Žatecko, a landslide was activated just below the baroque chapel and family houses.

Preparation of landslide mapping of the Khevsureti region in Georgia

Martin Dostalík, Jan Novotný, Petr Kycl, Vít Baldík, Jan Jelének, Lucie Koucká, Martin Kýhos

The goal of the Georgia 2024 development project, which was supported by the Czech Challenge 2023 fund, is to map the relevant geological risk in the Pirikita Khevsureti region, as this area is not addressed by the national geohazard project of the Green Climate Fund (GCF). This mountain area

is landslide active and dynamic, but very difficult to access. The area is deforested and therefore suitable for the deployment of a new system for detecting changes in the landscape using automated comparison of satellite images. The results are then verified by a classic field survey using drones. The main milestones of the project are the study stay of NEA experts in the Czech Republic and 3 expeditions of the CGS team to Georgia for workshops and training as well as lectures at the university. Field work will also take place in the Khevsureti region. The main outputs of the project will be engineering-geological risk maps of the Khevsureti area and the described analytical tool.

This project is a continuation of the cooperation started by the "Mccheta-Mtianeti 2014-2016" project implemented under the auspices of CzechAid. Cooperation continued with the "Kazbegi 2021" project after the Czech Challenge fund 2020.

Gravel bar sediment and vegetation dynamics: Specifics of the Lučina and Olše Rivers

Adriana Holušová

Gravel bars are negatively affected by insufficient flows, inundation, and sediment supply, often associated with regulated rivers. This research aims to examine the condition of selected gravel bars in terms of sediment grain-size, transport, vegetation cover and diversity of plant species (late summer-autumn) to determine the rate of their overall dynamics or stagnation over the period of 2020-2023. The selected rivers were the Lučina (dammed / free meanders section) and the Olše rivers (no dam / embankments) that represented different anthropogenic impacts on gravel bars in various environmental settings. The Olše represented site with large gravel bars in advanced stage of succession, where areas rich in biodiversity were associated with upstream gravel bars. All traced sediment was transported, and sediment size varied throughout the years suggesting sufficient flow regime. The Lučina represented mostly point bars in freely meandering section in early stage of succession. Following the high flows in 2019-2020, the flow rates remained minimal, which allowed rapid expansion of vegetation generally poor in biodiversity. Sediment transport was limited by height of a bar and grain size generally declined towards finer sediment. This research suggests the importance of unregulated flow regime to preserve essential dynamic processes for gravel bars.

Genesis of sandstone ruiniform relief and its environmental controls, on the example of the Stołowe Mountains, Poland

Andrzej Kacprzak, Filip Duszyński, Wojciech Bartz, Kacper Jancewicz, Anna Potysz, Marek Kasprzak, Wioleta Porębna, Aleksandra Michniewicz, Barbara Woronko, Jerzy Raczyk, Francesco Sauro

We tackled the problem of deciphering the genesis of ruiniform relief and its controls by investigating a small cave system in the Stołowe Mountains, SW Poland. We demonstrate that the formation of slots and corridors progresses through speleogenesis and the process is controlled by geological and environmental factors. The former include thick sandstone beds with subhorizontal alignment, well-developed vertical jointing and coarse grain size. The dominance of quartz and kaolinite in mineral composition, together with the type of vegetation cover, result in the development of permeable and very acidic soils making for efficient rainwater percolation, production of chemically aggressive acidic soil solutions and supporting a dominance of fungi among soil microorganisms. The development of corridors of ruiniform relief is associated with structure-controlled topographic depressions upon the plateau surface, which act as sinks. There, the percolation of soil solutions enriched with fungi causes dissolution of clay minerals and quartz, increasing rock porosity and making sandstone deteriorated en masse. The arenized rock is subject to grain-by-grain removal. Cavities below the depressions propagate upwards until the emergence of unroofed corridors.

The research was part of the 2020/39/D/ST10/00861 project of the National Science Centre, Poland.

Short-term meander bank retreat in different vegetational setting: a UAV-SfM study in Poodri PLA

Veronika Kapustová, Dominik Kula, Tomáš Galia

Biogeomorphic interactions in meandering rivers have been relatively neglected in fluvial geomorphology research thus far. To assess the impact of vegetation on short-term meander bank erosion, we conducted repeated UAV surveys on six meanders along the Odra River meander belt, located southwest of Ostrava City, Czechia. Each meander exhibits different vegetational settings determined by the presence, type, and density of riparian vegetation, as well as the presence of in-channel large wood. Our survey started with two meanders in 2022, expanding to include all six meanders in spring 2023, and concluding with a UAV campaign covering all six meanders in spring 2024. We generated detailed digital surface models and orthophotos from each survey using Agisoft Metashape Professional software and compared them in ArcGIS Pro. We documented several morphologically effective discharge events between each survey campaign, none of which exceeded the discharge of 1-year recurrence interval. However, even with these relatively low

discharge events, we observed notable bank retreat on the order of meters in areas lacking riparian vegetation. The effect of in-channel large wood varied depending on its positioning, either exacerbating or mitigating lateral erosion by redirecting flow towards or away from the bank.

Application of analysis of tree growth disturbances for landslide hazard assessment

Jan Klimeš, Karel Šilhán, Filip Hartvich, Jan Balek, Petr Tábořík, Jan Blahůt

Complex or compound landslides have sliding planes at different depths and move at different rates. Their reliable hazard assessment is very demanding requiring dense monitoring network of in-situ measurements or application of remotely sensed methods. It is either expensive or nearly impossible in heavily forested areas. We combined several techniques including dendrogeomorphological investigation to describe surface morphology, underground structures and movement dynamics of the compound, deep-seated landslide. Three distinct landforms typical for compound or complex deep-seated landslides in flysch Carpathians were studied (cf., shallow slides, landslide blocks, ridge spreading). Dendrogeomorphological investigation and proved to be reliable for identification of years with accelerated movements as showed comparison with surface movement monitoring results. It showed that the landslide blocks reactivate approximately half as often as shallow slides. Nevertheless, trees were unable to respond to deep-seated (over 10 m in depth) deformations of the spreading ridge where they picked up gravitational deformation of near surface (less than 5 m) differential movements. Despite of that the dendrogeomorphological research provides reliable landslide reactivation frequencies in areas with lacking landslide monitoring data.

Geomorphological mapping of sandstone mesas at the scale of 1:5000 – a study of Ostaš and Hejda, Broumovská vrchovina, Czechia

Maria Kotowska, Kacper Jancewicz

Ostaš and Hejda are tabular hills (mesas), located in north-east Czechia, composed of nearly horizontal sandstone caprock layers overlying finer-grained rocks. In this study we present the results of geomorphological mapping of these mesas, what has never been done at this level of detail before. We propose a key for mapping landforms at the scale of 1:5000 which may be useful for geomorphological studies of other, similar localities, as we focus on providing the information important for the interpretation of processes shaping these mesas in the past and present. The geomorphological maps are based on field measurements supplemented by geomorphometric analysis of digital terrain models. They show a variety of sandstone landforms present within the

upper surfaces and outer slopes of the mesas including rock walls, rock cities and boulder covers. Some landform assemblages had to become a subject of cartographic generalization due to their actual size, morphological complexity, ambiguity of their genesis or indistinct outer boundaries. A relevant example of such issues is cartographic presentation of slope boulder covers – at the given map scale it is hard to present, at the same time, their density, probable origin and size of the boulders.

Risk assessment on dynamic geomorphosites

Lucie Kubalíková

In the recent decades, geomorphological heritage, its protection and management has acquired more attention and particular conservation measures are being continuously implemented in local and regional policies or structures. Despite all these efforts, some threats may occur resulting from the multiple uses, land-use changes or human society demands on particular geomorphosites. Thus, the identification, assessment and management of these threats, risks and conflicts of interest should become an integral part of every geoconservation effort. For this purpose, a two-level risk assessment is applied to identify and evaluate the level and intensity of threats. The first level is based on the already used criteria within geomorphosite concept and the second level is represented by the Risk Assessment Matrix. Using both approaches provides a complex view of the threats and allows to propose particular measures that could contribute to the balance of the different demands and more effective geoconservation management on a specific site. The study is focused on dynamic (active) geomorphosites, namely abandoned sand, clay or loess pits which possess a high intrinsic value and offer numerous geosystem services. Before the proper assessment of the risks and threats, geosystem services of the abandoned pits are identified and classified proving that these sites are of great geoconservation importance. Based on the geosystem services analysis and risk assessment, geoconservation measures are proposed and sustainable use of these sites is designed.

Gneissic tors in the central European upland: Complex Late Pleistocene forms?

Zdeněk Máčka, Piotr Migoń, Olga Belova, Régis Braucher

Bedrock outcrops punctuating regolith-covered surfaces in the summit/upper slope and hillside positions (tors and crags) have long been a subject of inquiry in geomorphology for their evolutionary trajectories and now also as valuable geoheritage sites. Methodological advances in research, such as DTM-based geomorphological analysis and terrestrial cosmogenic nuclide

inventories, create new perspectives to decipher the spatial and temporal context of tor emergence and decay. The shape, structural controls, 10Be inventories and relation to surrounding medium-scale landforms were studied at thirteen conspicuous bedrock outcrops developed in metamorphic and sedimentary lithologies in the Bohemian-Moravian Highland, Czechia. The shapes of studied bedrock outcrops indicate significant litho-structural controls. The general outline is mainly governed by (sub) vertical joints, whereas the inclination of foliation or bedding planes dictates summit and cliff morphology. Some of the tors described in this study developed in exceptionally densely foliated and jointed gneiss, which does not comply with the generally accepted view of tors as massive rock compartments resisting weathering. A series of rock hardness measurements performed at three gneissic tors using Schmidt hammer show statistically significant within-tor variability of R-values, indicating different exposure times to subaerial weathering. The complexity of landform assemblages, within which studied tors/crags are developed, varies from isolated bedrock outcrops surrounded by smooth slopes covered with debris-rich soils to outcrops accompanied by low rock cliffs, debris-covered steps, slope benches, boulder fields and isolated large blocks. The 10Be inventories reveal ages mostly from the Late Pleistocene and rarely from the Holocene. Summit/upper slope tors and hillside crags show considerable variability in maximum denudation rates ranging from 6.4 ± 0.2 to 105.6 ± 4.8 m/Ma. Paired samples from the summits and cliffs of eight outcrops indicate three possible post-emergence evolutionary scenarios with summit downwearing while keeping the outcrop outline, balanced cliff and summit degradation rate, and backwearing as the dominant degradation process.

GIS-Based fluvial flood hazard assessment: A case study of the Gidra river basin municipalities

Soheyl Moradi, Matej Vojtek

The aim of this study is to assess the fluvial flood hazard in municipalities of the Gidra River Basin using the indicator-based approach and geographic information systems (GIS). A composite fluvial flood hazard index (FFHI) was calculated for twelve municipalities whose urban area is completely or partially located in the basin and at the same time a watercourse, belonging to the Gidra River Basin, flows through the municipality. The FFHI was composed of three components: fluvial flood potential index (FFPI), flood frequency, and share of hydraulically modeled flood extent for Q100 on the extent of analyzed municipality. The FFPI was calculated based on six physical-geographical indicators (lithology, slope, curvature, maximum 5-day rainfall, river density, soil texture) and land use/cover indicator. The final FFHI was calculated as an aggregation of the normalized values of FFPI, flood frequency, and share of hydraulically modeled flood extent for Q100 on the extent of

analyzed municipality using the equal weighting. The highest values of the FFHI were recorded in municipalities of Píla, Cífer, Jablonec, and Budmerice, which are located in central and upper parts of the basin.

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A dendrochronological approach to evaluate the impact of climate change on tree growth at the upper treeline in the Southern Carpathians

Denisa-Tabita Muszkopf, Mircea Voiculescu, Patrick Chiroiu, Ionuţ Duma, Cristian Anghelina, Iosif-Otniel Lopatita

The global trend of increasing temperatures causes diverse responses in environmentally sensitive regions such as alpine environments. Due to global warming, combined with reduced human activity at the tree line, an increase in the elevation of the tree line has been observed in certain high mountain regions. Not only temperatures can influence the position of tree trunks, but also other natural factors such as snow avalanches, high snow layer thickness, high wind speed and some geomorphological processes (creep, landslides) can play a role in changing the upper limit of the forest. Although the spatio-temporal evolution of the tree line is a subject of real interest, intensively studied in the last decades,research on the tree line in the Southern Carpathians is insufficient. The varied range of local environmental conditions and levels of human influence pose challenges in characterizing regional treeline patterns. Therefore, our study aims to evaluate how local tree lines in the Southern Carpathians are affected by some determining factors in the perspective of climate change. Our study presents the preliminary results of a dendrochronological investigation carried out in different mountain areas of the Southern Carpathians, in the Bucegi Mountains, respectively in the Fagaras Mountains based on the tree ring width (TRW) analysis of two tree species - Picea abies and Larix decidua.

Photogrammetry documentation for geological purpose

Jiří Nečas, Vít Baldík, Oldřich Krejčí

Photogrammetry documentation for geological purposes is an affordable way to capture outcrops in its natural structure and texture. Facilitate document landslides, rock outcrops, study areas, protected locality and inaccessible places. Application of drones in combination with efficient software achieve data, whose precision is sufficient. Obtained data are used for preservation data fade away localities, study of 3D models, and study of changes in time. It is used as a visualization

tool that helps geologists better understanding of documented areas, but the natural environment has some limits in dependence on the technique used.

Assessing Black Alder Response to Mining Subsidence Through Dendrogeomorphological Analysis

Lucie Polášková, Radek Tichavský, Eva Jiránková

Mining operations can have significant environmental impacts, including surface lowering and deformation due to overburden disturbance, commonly referred to as mining subsidence. Despite extensive investigation in engineering studies, the dendrogeomorphic approach offers additional insights into this phenomenon. This study investigates the response of black alder (Alnus glutinosa (L.) Gaertn) to subsidence, specifically focusing on tree-ring eccentricity. Geodetic monitoring conducted between 2012 and 2015 measured subsidence caused by active mining operations. Tree-ring data from zones with varying subsidence rates were analysed. Contrary to expectations, no distinctive differences were found in tree growth response across different subsidence rates. It can be concluded that the use of dendrogeomorphology and tree-ring eccentricity provides valuable insights into subsidence activity. However, persistent challenges remain, particularly concerning secondary processes such as landslide activity or residual subsidence, as well as the consideration of different methodological approaches.

Tree-ring based analysis of shallow creep: possibilities and limits on a case study on flysch rocks

Filip Schlesinger and Karel Šilhán

This study presents a dendrogeomorphic investigation of shallow creep movements on flysch rock slopes, using tree-ring eccentricity as a proxy for activity. A total of 136 increment cores from 68 Norway spruce (Picea abies) trees were analysed, revealing the spatio-temporal dynamics of shallow creep and its relationship with slope morphometry and weathering mantle thickness. The eccentricity values were spatially interpolated to visualize the evolution of creep activity over decades, showing significant spatial variability. Statistical analyses, including Pearson's and Spearman's correlation coefficients, were employed to examine the relationships between tree-ring eccentricity and various environmental factors. Results indicated that tree age influences the sensitivity to creep signals, with older trees showing increased eccentricity, suggesting a heightened response to creep movements. The study also explored the impact of precipitation on creep activity, identifying a weak, non-significant positive relationship. This comprehensive analysis enhances the understanding of shallow creep mechanisms and contributes to the broader field of dendrogeomorphology.

Geomorphometric conditions of block covers on the northern hillslope of Mt. Ślęża (Sudety Foreland)

Andrzej Traczyk

On the northern slope of Mt. Ślęża (718 m asl), there is a Pleistocene periglacial block cover. In the altitude zone of 555-400 m asl, there is a geological boundary between gabbro and granite on this hillslope. Gabbro builds the summit of Mt. Ślęża with numerous crags - the main block material source. The block cover reaches a minimal elevation of 220-240 m asl. Significantly, it consists mainly of gabbro rock fragments, and only to a minimal extent of granite blocks. Block streams have formed at the base of Mt. Ślęża, in the marginal zone of the mentioned cover, penetrating the upper parts of the valleys which cut off the granite bedrock. These tongues' textural features indicate that coarse weathered mantle displacement occurred when it was consolidated with ground ice (Traczyk, Żurawek 1999). The availability of high-resolution LiDAR DEM (1x1 m) allows us to determine the geomorphometric parameters of a hillslope with a block cover. The GIS analysis (SAGA GIS, WhiteBox: e.g. parameters Wetness Index, Flow Accumulation, Multiscale Elevation Residual Index) shows that a significant spread of gabbro blocks (maximum over 2.8 km from the gabbro outcrop) was facilitated by: (1) hillslope curvature - generally rectangular (LL) with local linear-concave (LC) sections (shallow hillslope niches); (2) high potential surface wetness and significant flow accumulation.