GEOMORPHOLOGIA SLOVACA et BOHEMICA

Volume 16 2016 Issue 1

Association of Slovak Geomorphologists
The Czech Association of Geomorphologists
Institute of Geography, Slovak Academy of Sciences

Volume 16, 2016 – Issue 1 August, 2016

Redakcia / Editorial Office
Geomorphologia Slovaca et Bohemica, Štefánikova 49, 814 73 Bratislava
Elena Zabadalová, e-mail: geogezab@savba.sk; tel. č.+421 02 575 10 216

Issues per year: 2

Articles are peer-reviewed

Evidence number: 3561/09 Ministry of Culture Slovak Republic
ISSN 1337 — 6799
IČO 31 781 195

GEOMORFOLOGICKÉ PROCESY A ZMENY KRAJINY

GEOMORPHOLOGICAL PROCESSES AND LANDSCAPE CHANGES

Zborník abstraktov
Book of Abstracts

9. vedecká konferencia Asociácie slovenských geomorfológov pri SAV
Zuberec 4. – 6. 10. 2016

Editor: Ján Novotný

Asociácia slovenských geomorfológov pri SAV
Geografický ústav SAV

OBSAH/CONTENTS

FROST AND FLUVIAL PROCESSES IN THE DEVELOPMENT OF RIVERBANKS

KAROL AUGUSTOWSKI, JÓZEF KUKULAK

Pedagogical University of Cracow, Institute of Geography, Podchorążych 2, 30-084 Kraków, Poland, karolaug@up.krakow.pl; jkukulak@up.krakow.pl

Erosion of the river banks in the hydrological year 2013-2014 by erosion pins was monitored. Retreat of riverbanks was investigated in the foreland of the Tatra Mountains. In the winter half-year erosion of riverbanks caused mainly by frost processes - needle ice and ice lenses, while in the summer half-year by fluvial processes and mass movements – undercutting and landslides. In the annual balance of riverbank erosion (average 71 cm) share of fluvial processes was 4 times greater than the frost processes.

Increased erosion of the riverbanks surface as a result of the activity of the frost processes in the winter half-year were indicated in the upper parts of the banks (built with fine-grained alluvium). The effects of fluvial erosion in the summer half-year were the highest in the lower parts of the banks (built with gravels).

Key words: frost processes, fluvial processes, multigelation, erosion pins, riverbanks

OBJECT-BASED DEFINITION OF MORPHOSTRUCTURES FOR THE REFINEMENT OF GEOMORPHOLOGICAL DIVISION OF SLOVAKIA

PETER BANDURA, JOZEF MINÁR

Comenius University in Bratislava, Faculty of Natural Sciences, Department of Physical Geography and Geoecology, Mlynská dolina, Ilkovičova 6, 842 15 Bratislava 4, Slovakia, peter.bandura@uniba.sk; jozef.minar@uniba.sk

Currently used traditional geomorphological division of Slovakia was elaborated in scale 1: 200 000 and published in scale 1:1 000 000 already in the last century (Mazúr and Lukniš 1978). Since its first publication, it has been reprinted in form of several maps in scale 1:500 000 (e.g. in the Atlas of the Slovak Socialistic Republic in 1980, or more recently in the Atlas of the Slovak Republic in 2004). Moreover, update of this division in terms of vectorisation, refinement of boundaries as well as adding some new division, was carried out in scale 1:50 000 (Urbánek et al. 2009). Although this work brought more accuracy to the boundaries and provided useful digital form of this division, it still suffers from ambiguity of boundaries´ course, and, similarly to the original division, subjective decisions of the authors played great role here. Moreover, this update is still not fully completed.

Therefore, we want to propose possibility of using object-based image analysis (OBIA) based on DEM and its derivatives for the purposes of further refinement of this traditional geomorphological division. As a result of several segmentations of geomorphometric characteristics such as slope gradient, vertical dissection and elevation in a multi-level manner, relatively homogeneous objects, mainly in terms of terrain roughness, were delineated. They can be labelled as either morphometric individuals or morphometric-morphostructural individuals, since the shape of morphostructures of Slovak territory is well reflected in terrain morphology. Even though majority of boundaries of the delineated objects (ca. 60 %) are not quantitatively compatible with the traditional geomorphological division, they still have a morphostructural meaning. The most compatible boundaries are in highly contrast areas (e.g. high mountains surrounded by relatively flat intramontane basins), and most of the mismatch is in less contrast areas or due to using different criteria for delineation of traditional regions (e.g. geology or expert knowledge).

Consequently, using this automated approach we should be able to provide objective alternative for this traditional division mainly in the fuzzy and questionable areas on several hierarchical levels and thus contribute to the ongoing discussion of its update.

References:

Mazúr, E., Lukniš, M. (1978). Regionálne geomorfologické členenie SSR. *Geografický časopis*, 30, 1, 101 – 125.

Urbánek, J., Beták, J., Jakál, J., Lacika, J., Novotný, J. (2009). Regional geomorphological division of Slovakia: Old problem in new perspectives. *Geographia Slovaca*, 26, 237 – 259.

Acknowledgements: This work was supported by the Slovak Research and Development Agency under the contract No. APVV-0625-11 and No. APVV-15-0054, by the Scientific Grant Agency of the Ministry of Education, science, research and sport of the Slovak Republic and the Slovak Academy of Sciences (VEGA) under the contract No. 1/0602/16. and by the Comenius University in Bratislava under the contract No. UK/137/2015 and UK/246/2016.

Key words: OBIA, multi-resolution segmentation, morphometric-morphostructural individuals, objective mapping, compatibility assessment

MULTI-LEVELLED CAVE SYSTEM AND ASSOCIATED MORPHOLOGICAL SEGMENTS IN THE CONTACT MIDDLE-MOUNTAIN KARST: THE CASE STUDY FROM THE DEMÄNOVÁ CAVES, THE NÍZKE TATRY MTS.

PAVEL BELLA[1,2]

[1] *Catholic University in Ružomberok, Faculty of Education, Department of Geography, Hrabovská cesta 1, 031 04 Ružomberok, Slovakia, Pavel.Bella@ku.sk*
[2] *State Nature Conservancy of the Slovak Republic, Slovak Caves Administration, Hodžova 11, 031 01 Liptovský Mikuláš, Slovakia, pavel.bella@ssj.sk*

The well-known Demänová Caves in the Demänovská dolina Valley on the northern side of the Nízke Tatry Mts. belong to the typical localities of cave levels development in correlation with river terraces on the surface. The Demänová Caves system (the Demänovská jaskyňa Slobody Cave, the Demänovská jaskyňa Mieru Cave, the Demänovská ľadová jaskyňa Cave, the Pustá jaskyňa Cave, the Vyvieranie Cave, the Jaskyňa trosiek Cave, the Demänovská medvedia jaskyňa Cave, the Údolná jaskyňa Cave, the Jaskyňa pod útesom Cave and other speleologically connected smaller caves) is long more than 40.8 km. This cave system is genetically connected with the Štefanová Cave (14.8 km), the Okno Cave (2.2 km), the Suchá jaskyňa Cave (1.4 km), and some other inactive river caves. The karst of the Demänovská dolina Valley, formed mainly in the Middle Triassic Gutenstein limestones of the Krížna Nappe, presents a contact dissected karst of monoclinal crests and ridges in the middle-mountain positions of the Western Carpathians Mts. The dominant multi-levelled cave system on the right side of the valley originated mainly by sinking allochthonous streams. Main levelled passages in the throughflow and outflow parts of the cave system are featured by oval phreatic and epiphreatic morphology, in several places with wall channels or meander notches. Mostly in the outflow and throughflow part of the cave system, cave levels were connected by steep to vertical outflow conduits (so-called *undercaptures* or *soutirages*) probably originated in the epiphreatic zone when a hydraulic gradient was steepened by downward shift of the resurgence. Within the contact zone of non-karst and karst area, inflow drawdown inclined or cascaded vadose passages lead from permanent or invasion ponors to lower levelled passages in consequence of a vertical hydraulic gradient among water inputs and underground water table. Throughflow and outflow parts of the cave system include not only water table levelled passages but also conduits with a mixture of phreatic loopsed and water table levelled segments. Several side fissure branches are featured by different morphology (blind hollows, spongework cavities and similar forms) without rock forms sculptured by intensively flowing water. Their morphology is mostly a result of corrosion by slowly flowing phreatic waters or repeated floods that penetrated along mostly diagonal tectonic cracks and faults from the main drained passages. After the downcutting of Demänovská dolina Valley, levelled passages were connected by vertical vadose conduits formed by autochthonous brooklets that are sinking at hanging contact of overlying dolomites and underlying limestones in the upper part of side valleys.

Acknowledgements: This work was supported by the Slovak Research and Development Agency under contract APVV-0625-11 and the grant VEGA No. 1/0430/15.

Key words: karst geomorphology, speleology, cave, morphology, evolution level

ACTIVITY OF BODAKI LANDSLIDE (BESKID NISKI MTS.) IN 2 YEARS PERIOD USING TERRESTRIAL LASER SCANNING

JAROSŁAW CEBULSKI

Polish Academy of Sciences, Institute of Geography and Spatial Organization, Department of Geoenvironmental Research, cebulski@zg.pan.krakow.pl

Highland regions have a high activity of exogenic processes, which directly influence on their relief. The area of the Polish Carpathians flysh is heavily transformed by mass movements, especially by the landslides. An area of 19 600 square kilometres has over 55 500 landslides charted, which gives on average 3 landslides per square kilometre. A large number of them at the same time have been causing a huge damage by the activation. Therefore this subject is addressed in numerous domestic and foreign literature. The Bodaki Landslide is located on the Bartnianka Stream left bank and was created in autumn 2013. This form has a length of 83 m, and is in direct contact with the riverbed, the landslides toe. For the reactivation of landslides are responsible high sum of participation and high water level in the Bartnianka Stream. In period 2014 – 2016 were performed a series of measurements (April, June, September, November 2014, April, November 2015 and April 2016) using terrestrial laser scanner Riegl VZ 4000. The results obtained in the form of a "cloud points" are treated in order to remove the layer of vegetation and have been generated digital terrain model (DTM). Comparative analysis of terrain models from different periods laid the quantitative and spatial changes in the landslide. The biggest changes were recorded in the period April-June 2014. During this period, through the erosion of the Bartnianka Stream landslide has been removed ca. 2,000 m³ of material. Other periods of partial changes were minor, evidenced about a stabilization of the landslide. Only still in the period of June-September 2014 within the landslide registration activation of the parts of the landslide, was particularly the landslide toe which was responsible for the erosion of the Bartnianka Stream. The results were correlated with the sums of precipitation from meteorological station located 5 km from analysed landslides. This helped to determine the height at which precipitation occurs activation of landslides.

Key words: landslides, river erosion, terrestrial laser scanning, the Beskid Niski Mts., South Poland

HYDROLOGICAL AND GEOMORPHOLOGICAL EFFECTS OF EXTREME PRECIPITATION IN MAY 2014 IN THE SKAWICA CATCHMENT (POLAND)

PAWEŁ FRANCZAK

Jagiellonian University, Institute of Geography and Spatial Management ul. Gronostajowa 7, 30-387 Cracow, Poland, p.franczak@uj.edu.pl

Mountain streams are subject to continuous modelling of river beds during floods. The greatest changes occur within them, however, during the catastrophic floods caused by sudden rainfall. The increase in the intensity of transformation occurs in forest areas, where the wooden logs carried by the swollen streams create a dumping ground, around which there is a greater accumulation of transported material and the formation of an increased mosaic of geomorphological forms.

The study was conducted in the Skawica Stream catchment (Western Beskidy Mountains, Poland). On 15 and 16 May 2014, the Skawica Stream flooded following a heavy rainfall with a total of 216.5 mm recorded over three days, 138 mm of which fell on 15 May. With the mean rainfall intensity reaching 9.1 mm/h, the upper part of the catchment on the slopes of the Babia Mountain was most affected: the peak discharge at Zawoja was 76.6 m^3s^{-1} while the maximum specific discharge ranged from 1.15 to 2.15 $m^3s^{-1}km^2$. This resulted in a sudden flooding in several streams that significantly changed the morphology of their channels and valley floors. Stream channels and floodplains where most affected, whereas adjacent hillslopes were transformed only moderately.

Freshet caused by violent rains that occurred on the night of 15th to 16th May 2014. Caused extensive moves within the troughs. The biggest transformation occurred in the Rybny potok Stream catchment drainage dome peak of the Babia Massif. The smallest change occurred in the Czatożanki Stream catchment. Despite the great transformations trough the Rybny potok Stream, there were no significant structural changes, and only came to change the number and size of forms. In the upper part of the catchment has increased the size of forms of erosion, while in the lower section there has been the emergence of many new forms of accumulation, accompanied by erosion forms. In sections shallowly indented trough growth in the size trough forms accompanied by the formation of extensive forms within the floodplain terraces. Contributed to this intensive grassing banks of the riverbed and floodplain by patches of gray alder (Alnus incana) and spruce (Picea abies), which was carried accumulation during the flood wave moving material.

Key words: extreme events, flash flood, geomorphological transformations, Carpathians, forest

INVENTORIZATION, VALORISATION AND NATURE CONSERVATION CAVES IN THE CAVES IN BABIA GÓRA RANGE AND PRZEDBABIOGÓRZE RANGE

PAWEŁ FRANCZAK[1], MICHAŁ ZATORSKI[1], KRZYSZTOF BUCZEK[1], WOJCIECH J. GUBAŁA[2], MAREK GÓRNIK[1], KAROLINA LISTWAN-FRANCZAK[1], TOMASZ MLECZEK[3], CZESŁAW SZURA[2]

[1] *Jagiellonian University, Institute of Geography and Spatial Management, ul. Gronostajowa 7, 30-387 Cracow, Poland, p.franczak@uj.edu.pl; michal.zatorski@uj.edu.pl; krzysztof.buczek@uj.edu.pl; m.gornik@uj.edu.pl; karolina.listwan@doctoral.uj.edu.pl*
[2] *Protection Association Caves „Grupa Malinka" in Wisła, ul. Fedorowska 66, 43-460 Wisła, Poland, wojtekjgubala@gmail.com; szuracz@poczta.onet.pl*
[3] *Speleoklub Beskidzki in Dębica, ul. Szkotnia 5.25, 39-200 Dębica, Poland, speleod@wp.pl*

This paper refers the results of recording and valorization of pseudokarst caves in two mountain areas: the Babia Góra Massif and the Przedbabiogórskie Range. Recording of the caves were carried out by various authors in 1976 – 2015. Consequently, 104 caves with a total length 1270 m were recorded including the largest: the Oblica Cave. Valorisation of the caves was made to determine the most valuable objects and select some of them for legal protection. Majority of the most of valuable caves are located in the Babia Góra Massif (17) and only two of them in the second study area (the Przedbabiogórskie Range). However some of most valuable caves in the Babia Góra Massif (the Polica Range) and the Przedbabiogórskie Range (the Jałowiecki Range) are not legally protected. Groups of the caves in Okrąglica and Łysina landslides should be protected as "stanowiska dokumentacyjne" and the most valuable caves: the Oblica Cave and the Zbójska Dziura Cave should be protected as natural monument.

Key words: caves, speleology, pseudocarst, landslides, geocanservation, the Carpathians, Poland, Slovakia

THE DYNAMICS OF FLUVIOGLACIAL PROCESSES IN THE INTERFLUVE AREA: CASE STUDY IN RZYMSKO ESKER BETWEEN WARTA AND TELESZYNA RIVERS (CENTRAL POLAND)

MAŁGORZATA FRYDRYCH

University of Łódź, Faculty of Geographical Sciences, Department of Physical Geography, Narutowicza St. 88, 90-139 Łódź, Poland, mfrydrych@uni.lodz.pl

The esker in Rzymsko originated in the eastern part of the Turek Upland Plain, between the Warta River and Teleszyna River valleys, during one of the recession stages of the Warta Glaciation (Saalian II). It was formed in a subglacial tunnel, which was a tunnel valley and is currently filled with sediments. Transport and accumulation of sediments in the tunnel took place under variable flow conditions. Variable dynamics of the fluvioglacial processes was recorded in the sediments, whose analysis was the primary goal of the research.

At the initial stage of esker formation, the fluvioglacial processes were characterised by high dynamics. Transport took place under the conditions of hydraulic flow in deep channels, and the accumulated material included sands and gravels in planar and trough cross-bedded structures. Periodically, the flow dynamics increased and gravels and boulders were accumulated. The presence of high-energy flows was recorded in the occurrence of openwork texture and boulders of up to 1 m in diameter. The coarse-grained sediments of the esker are characterised by a very high content of well-rounded local rocks, which provides evidence for the high erosional power of meltwater.

Occasionally, hyperconcentrated flows also occurred in the glacial tunnel. Such flows may be the record of glacial floods caused by increased ice sheet ablation or outburst of small subglacial lakes. These processes left behind massive boulders and matrix-rich gravels.

At the later stage of accumulation, the flows had considerably lower energy, and the deposition concerned mainly sands in tabular and low-angle cross-bedded structures as well as ripplemark sands, sometimes separated by thin layers of coarser sediments.

Key words: fluvioglacial processes, esker, high-energy flow, Central Poland, Warta Glaciation

GEOMORPHOMETRIC ANALYSIS OF A 3-D DIGITAL SURFACE MODEL OF THE DOMICA CAVE

MICHAL GALLAY, ZDENKO HOCHMUTH, JÁN KAŇUK, JAROSLAV HOFIERKA

Pavol Jozef Šafárik University in Košice, Faculty of Science, Institute of Geography, Jesenná 5, 040 01 Košice, Slovakia, michal.gallay@upjs.sk; zdenko.hochmuth@upjs.sk; jan.kanuk@upjs.sk; jaroslav.hofierka@upjs.sk

Geomorphometry has been focused on parameterisation and analysis of surficial terrain. The theoretical and methodological concept has been based on two-dimensional scalar fields, which is sufficient for most cases of the surficial terrain. Therefore, the terrain surface is traditionally modelled with a bivariate function of altitude (elevation) and represented by a raster digital elevation model. However, the cave is a three-dimensional entity therefore a different approach is required for geomorphometric analysis. In this paper, we demonstrate the benefits of high resolution cave mapping and 3-D modelling to better understand the palaeohydrography of the Domica Cave in Slovakia. This methodological approach adopted traditional geomorphometric methods in a unique manner and also new methods used in 3-D computer graphics, which can be applied to study other 3-D geomorphological forms. The results provided quantitative description of the cave surface and defined exact position of specific speleoforms, which reveal new aspects of the speleogenesis of the Domica Cave.

Acknowledgements: "This contribution originated thanks to the financial support of the following research projects: Physically based segmentation of georelief and its geoscience application (APVV-15-0054) and Simulation and dynamic visualization of geospatial processes (VEGA 1/0474/16)."

Key words: laser scanning, digital terrain modelling, detail, speleogenesis, the Silická planina plateau

IMPACT OF REGULATION OF THE VISTULA RIVER IN THE CARPATHIAN FORELAND ON FLOOD RISK IN THE 20TH AND AT THE BEGINNING OF THE 21ST CENTURY

JADWIGA GAWIOR

Pedagogical University of Cracow, Institute of Geography, Podchorążych 2, 30-084 Kraków, Poland, jadwiga.gorajska@gmail.com

The regulation of the Vistula River in the Carpathian foreland had been started in the 19th century and then continued with varying intensity in the 20th century. Its aim was to prepare the Vistula River as a waterway and reduce flood risk, as well as accelerate flood water outflow. As a result, the Vistula River channel underwent deepening along almost its entire course in the Carpathian foreland. The next element of changes in the geometry of the Vistula River channel is increasing height of the river banks. This is not only the result of the channel deepening, but also the increase in thickness of the alluvia in the area of the channel with spurs and floodplain area limited with flood embankments.

The aim of this study is to indicate the impact of the Vistula River regulation in the section between Goczałkowice and Puławy on flood risk in the 20th and early 21st centuries. Disparities in the progress of regulatory works made flood risk vary differently across the subsequent Vistula River sections.

The analysis of frequency of occurrence of over bankfull water stages was determined on the basis of hydrological data coming from 17 water level stations localised along the Vistula River course and characterised by continuous functioning over the last 80 years. The height of river banks during the analysis period was determined according to archival transverse profiles of the Vistula River course in the analysed water level stations. Basing on hydrological data, the number of flood episodes in each year and their average duration, as well as the incidence of over bankfull states in particular months (Fig. 1 and 2) were also determined.

Changes in the channel geometry of the Vistula River caused by regulatory works result in different effects while its floodplain area within the inter-embankment zone is being flooded, and lead to disparities in the number of flood episodes occurring along the analysed section of the river. The sections with the most deepened channel located within the inter-embankment zone are very rarely flooded; sometimes, it was only a few times during the analysis period (Goczałkowice, Kraków). The sections with the most shallowed channel are in turn more frequently flooded than those with the deepened one, which is particularly typical of the Małopolska Vistula Gorge (Zawichost).

However, it should be noted, basing on the conducted analyses, that the assumption of reducing flood risk along the foreland Vistula River course by performing regulatory works have not been fulfilled. A reduction in the number of flood episodes and days with over bankfull states was observed in all water level stations.

Key words: the Vistula River, river regulation, flood risk

GEOMORPHOLOGICAL EFFECTS OF BEAVER ACTIVITIES IN THE CZECHOWSKA STREAM VALLEY (TUCHOLA FOREST, NORTHERN POLAND)

PIOTR GIERSZEWSKI, DARIUSZ BRYKAŁA

Polish Academy of Sciences, Institute of Geography and Spatial Organization, Department of Environmental Resources and Geohazards, Kopernika 19, 87-100 Toruń, Poland, piotrg@geopan.torun.pl

Since last years, after the reintroduction of beavers' (Castor fiber) to the Polish Lakeland, large beaver activity on the Czechowska Stream (the Tuchola Forest) was observed. It expresses in relief transformation of the valley bottom and its slopes. The beavers build dams along the river course. On the stream of the length 5.6 km were identified more than 30 still active and non-active beaver dams. The average width of the dams of channel type is 3 m. The widest is a dam of pond type, which has 13 m width. The active beaver dams dam up the water to 0.2 m, maximally to 0.6 m. Most of older and abandoned dams still dam up water of stream. At the sections of valley between dams many geomorphological forms created by beavers exists and modifies a channel bank. They are: erosional niches, burrows, collapsed beaver burrows, canals, and beaver paths. All these forms stimulate development of side erosion processes, increase supply of material to the channel and influence on agradational character of stream channel. Small ponds created at the back of beaver dams function as local sediment traps. Beaver dams alter water flow conditions and create a series of step-pool profiles of channel.

The most spectacular transformation of the stream channel is related to periodically breaking of beaver dams. The effects of such events were observed in the period between December 2014 and May 2015 in the upper course of the Czechowska Stream. Breaking of dams led to the rapid drainage of beaver pond. Analysis of water levels changes shows that since December 2014 there were nine rapid drainages of beaver ponds located in this section of stream. Damaged dams were very quickly rebuilt, and water in ponds was again stored. The average time of restoration the dam amounts 10 hours, and maximum 3 days. Large energy of water released during pond drainage caused intensive bottom and lateral erosion of channel and a creation of earth falls on the slopes of valley. Products of erosion were accumulated along watercourse at a distance of 200 meters, and also in the channel as a sandy bars. Maximum thickness of dam-break flood deposits, amounts 28 cm. In terms of grain size, flood deposits were represented as fine and medium sands well and moderately sorted.

Acknowledgements: This research has been financed from the Science and Research Funds for 2015 -2016, allocated to a co-financed international project, CONTRACT No. 3500/ICLEA/15/2016/0.

Key words: beaver activity, stream geomorphology, dam breaking, flood forms and deposits, Poland

ORGANIC DEPOSITS FROM PORUBA GATE AS AN ENVIRONMENTAL ARCHIVE OF CENTRAL EUROPEAN SAALIAN COMPLEX

VLASTA JANKOVSKÁ[1], DANIEL NÝVLT[2], EVA JAMRICHOVÁ[1]

[1] *Department of vegetation ecology, Institute of Botany ASCR, v. v. i., Lidická 25/27, 602 00 Brno, Vlasta.Jankovska@ibot.cas.cz; eva.jamriska@gmail.com*
[2] *Department of Geography, Faculty of Science, Masaryk University, Kotlářská 267/2, 611 37 Brno, Daniel.Nyvlt@seznam.cz*

Organic sediments have been found in depths of 5–15 m of several cores during the drilling works for the construction of a new communication in the Poruba Gate (between the Poruba and Palačov villages). The cores were available from the Inset Ltd. Company for our team for a subsequent research.

The Poruba Gate represents the area of the southernmost advance of mid-Pleistocene Northern European ice sheets in the Central Europe (Tyráček 1961, Nývlt et al. 2011). The maximum advance of Northern European ice sheet took place during the older cold phase (stadial) of the Saalian glacial denoted Drenthe (older cold events of the MIS 6) in the Central European stratigraphy basing on the stratigraphic position of glacial deposits and their dating (Nývlt et al. 2008, Tyráček 2011, Nývlt 2016). Organic sediments of lacustrine to marshland origin have recently been found at the Kunín site located ~12 km NNE of the Poruba Gate, where they rest upon the glaciofluvial deposits of the retreat phase of the ice sheet during the Drenthe stadial and are dated at 162.0 ± 9.4 ka by the means of OSL (Nývlt et al. 2008). The stratigraphic position of organic sediments in the Poruba Gate is either immediately above, or just below the sediments corresponding to the first stadial of MIS 6 (Drenthe). Therefore, the organic sediments from the Porube Gate could be chronostratigraphically ranked to the range of MIS 7–6 basing on the stratigraphic position.

The organic layers from the cores J-148 and J-196 were studied in detail. They contained a well-preserved peat layers 1.7 – 2.2 m thick. However, the peat has been often completely decomposed. The studied organic layers show high values of organic carbon, mostly between 35 % and 50 %. Organic-rich layers also reveal increased level of total sulphur, usually in the range of 5 – 9 %.

The organic-rich part of the core J-148 enabled to define three distinct phases of the vegetation development basing on the pollen analyses. During the *Phase I*, representing a cold period, a marsh with the dominance of *Sphagnum* was present at the site of the studied core. The surrounding landscape was probably not forested with occasionally interspersed pines, birches and alders. Herbaceous vegetation with a predominance of grasses suggests a tundra-steppe landscape character in this period. The *Phase II* represents a warmer and a more-humid interval. A moss-dominated marsh with *Sphagnum*, but also with *Ericaceae*, *Vacciniaceae* and willows outlasted at the site. The surrounding landscape has a character of a taiga dominated by spruce and significant proportions of birch, alder and fir, larch was also incidental. A more favourable climatic conditions (higher temperature and humidity) are demonstrated by the rise in shares of a more demanding deciduous trees, such as hazel, elm, linden, oak or ash, the pollen of which might come from more distant areas. The *Phase III* represents the most humid part of the succession, which is separated from the *Phase II* by a hiatus with undetermined spectrum of palynomorphs. Clearly prevails fir, another important tree is alder, which probably grew directly at the site. The fir undergrowth ferns, with a very important finding of *Osmunda regalis* cf. *regalis* fern, together with *Buxus* bushes and probably also *Taxus*. Considerable fir tree crown cover did not allow for greater developments of herbal plants. Interesting is also the disappearance of the *Sphagnum* pollens in the *Phase III*.

We failed to define vegetation development phases in the organic succession of the core J-196 and the overall development is rather monotonous here and relates most closely to the *Phase II* in the core J-148. Marsh with *Sphagnum* and other moss species and pools with aquatic and swamp vegetation, such as *Batrachium*, *Lemna*, *Myriophyllum*, *Typha*, *Caltha* and others occurred at the site. At the same time, we found filamentous algae – *Spirogyra* type and coccal green algae *Botryococus* cf. *neglectus*, in the youngest part of the section also *Pediastrum taxa*, it is worth to mention

P. integrum and cold-demanding *P. kawrayski*. Alder and probably also spruce grew on the wetland. Fir, larch, birch and pine had on the other hand a significant proportion in the surrounding forests. Climatically more demanding deciduous trees could grow in suitable near habitats, but part of their pollen may come from a distant air transport. The climate was warm and humid, as indicated by findings of pollen of *Hedera* and *Buxus*; spores of *Osmunda regalis* cf. *regalis* ferns appeared here only very sporadically.

The variability of documented habitats found in the two cores spaced only a few hundred meters indicates the uniqueness of this material, the processing of which will be done in the near future including the research of organic layers from other cores. The comparison with the previously elaborated Kunín site (Nývlt et al. 2008) shows that this is in terms of vegetation development most similar to the *Phase II* described in the core J-148 and documented also spruce-dominated taiga with the presence of larch, which is more typical for forest-tundra stands.

References:

Nývlt, D. (2016). Comment on "Development of the topography-controlled Upper Odra ice lobe (Scandinavian ice sheet) in the fore-mountain area of southern Poland during the Saalian glaciation" by T. Salamon [Quat. Sci. Rev. 123 (2015) 1–15]. *Quat. Sci. Rev*., 133, 183 – 184.

Nývlt, D., Engel, Z., Tyráček, J. (2011). Pleistocene Glaciations of Czechia. In Ehlers, J., Gibbard, P. L., Hughes, P. D., eds. Quaternary Glaciations – Extent and Chronology, A closer look. *Developments in Quaternary Science*, 15, 37 – 46,

Nývlt, D., Jankovská, V., Víšek, J., Franců, E., Franců, J. (2008). Deglaciační fáze prvního sálského zalednění v Moravské bráně. In Roszková, A., Vlačiky, M., Ivanov, M., eds. *14. KVARTÉR 2008 (Brno, 27.11.2008) – Sborník abstraktů*, 14 – 15, Brno.

Tyráček, J. (1961). Nové názory na rozšíření maximálního zalednění v Moravské bráně. *Přírodověd. Čas. Slez.*, 22, 247 – 254.

Tyráček, J. (2011). Continental glaciation of the Moravian Gate (Czech Republic). J. *Geol. Sci., Antropozoic*, 27, 39 – 49.

Key words: Saalian complex, glaciation, pollen analysis, Poruba Gate, NE Moravia (Czech Republic)

POST-FLOOD PERIOD SERIAL GEOMORPHIC ANALYSIS (POPSEGA) – STRUCTURE AND APPLICATION

ANNA KIDOVÁ, MILAN LEHOTSKÝ, MILOŠ RUSNÁK

Slovak Academy of Sciences, Institute of Geography, Štefánikova 49, 814 73 Bratislava 1, Slovakia, geogkido@savba.sk; geogleho@savba.sk; geogmilo@savba.sk

The post-flood period serial geomorphic analysis (POPSEGA) method is developed for the assessment of geomorphic river response to floods, which enables to reveal general trends of evolution of selected geomorphic parameters during a longer timespan (several decades) using a series of remotely sensed data processed in GIS. These data are chosen so as to register the river situation after a flood. The approach thus requires availability of remotely sensed data. The method consists of the following steps: (i) analysis of maximum annual discharges; (ii) identification of flood periods; (iii) selection of sets of remotely sensed data and their georeferencing in GIS; (iv) extraction of channel and floodplain forms in GIS in each flood period; (v) division of a river course into regular (100-m-long) segments along channel centreline; (vi) disaggregation of landform polygons into sets of landform parameters; (vii) assessment of landform parameter changes at successive time series of floods, i.e., by the comparison of two flood periods; (viii) estimation of Shannon's diversity index and cores for each flood period using GUIDOS and FRAGSTAT softwares; (ix) analysis of nodes as confluence-diffluence pairs for each flood period and for the whole timespan; (x) analysis of erosion and deposition area using erosion/deposition index for each two consecutive flood periods; (xi) aggregation of river segments into larger units (river reaches) based on a statistical analysis of channel parameters; (xii) classification of river reaches using environmental variables (valley setting); (xiii) identification of contraction, stable, or expansion phases of river reaches on the basis of a change in erosion/deposition areas in a particular time series of floods. The application of the POPSEGA approach is illustrated by the case study of a braided-wandering river system.

Acknowledgements: The study was supported by the Slovak Grant Agency for Science No 2/0020/15.

Key words: POPSEGA, method, flood, geomorphic response, braided-wandering river

RECONSTRUCTION OF LARGE LANDSLIDES MASS MOVEMENTS WITH USING THE DENDROGEOMORPHOLOGICAL METHOD (SAWICKI LANDSLIDE EXAMPLE IN BESKID NISKI MTS.)

KRZYSZTOF KISZKA

Polish Academy of Sciences, Institute of Geography and Spatial Organization, Research Station in Szymbark, Szymbark 430, 38-311 Szymbark, Poland, kiszkak@zg.pan.krakow.pl

The Sawicki Landslide is one of the most famous landslides in the Polish Carpathians. It owes its name to geographer - Ludomir Sawicki. He examined and described the famous landslide disaster in 1913 in the Szklarki valley (Sawicki 1917).

The Sawicki Landslide is the biggest landslide in this region. Its area is more than 1.6 km² and its length is 2.5 km (the longest landslide in Poland). It is situated on the southern slopes of the Maślana Hill in the Beskid Niski Mts. Landslide was probably formed in the middle Holocene and as a result of extreme precipitation it was rejuvenated, inter alia, in 1784 and 1913, (Kuropatnicki 1858, Sawicki 1917, Wójcik 1959). It is a detrusive landslide of complex type. Total amount of displaced mass is estimated at 25 million cubic meters (Rączkowski and Zabuski 2008). About 70 % of the landslide area is covered with forest.

The aim of this study was to reconstruct the mass movement within the Sawicki landslide. The dendrogeomorphological method has been applied. The cores of Scots pine (*Pinus sylvestris*) and Silver fir (*Abies alba*) were collected using a increment borer in the years 2013 – 2014 in the lower part of the landslide. Width of annual tree rings were measured for each tree (on both of upslope and downslope side of stump).The indicators of eccentricity, eccentricity index and yearly variation of eccentricity, index were calculated on the basis of Malik and Wistuba (2011) equations.

Periods of high numbers of received landslide signals was considered for moments of activation of the tested landslide parts. These are the years: 1899, 1901, 1905, 1910, 1913 – 1914, 1920 – 1921, 1929 – 1931, 1935, 1937, 1945, 1977, 1979, 1981, 1984 – 1985, 1990, 1992 – 1993, 1997, 2003 – 2004, 2006, 2010 – 2012. A large part of the results shows a correlation with high values of precipitation, although some of the landslide movements took place in dry years. Most periods of landslide activity was triggered by heavy rain during the warm half-year. It was also noted annual delay of landslide signals in the rings of trees in relation to the years with high precipitation.

The results show a partial resemblance to dendrogeomorphological researches made in the middle and upper part of the Sawicki landslide (Krąpiec and Rączkowski 2005, Nawrocka 2014).

References:

Krąpiec, M., Rączkowski, W. (2005). Dendrogeomorfologiczny monitoring ruchów osuwiskowych na obszarze Beskidu Niskiego. In Kotarba, A., Krzemień, K., Święchowicz, J., eds. Współczesna ewolucja rzeźby Polski, VII Zjazd Geomorfologów Polskich, Kraków, 231 – 240.

Kuropatnicki, E. A. (1858). Geografia albo dokładne opisanie królestw Galicyi i Lodomeryi. Lwów.

Nawrocka, N. (2013). Analiza dendrogeomorfologiczne drzew różnych gatunków z obszaru osuwiska „L. Sawickiego" w Szymbarku, Beskid Niski, Karpaty Zewnętrzne. Folia Quaternaria, 81, 175 – 188.

Rączkowski, W., Zabuski, L. (2008). Numeryczne Modelowanie deformacji stoku osuwiskowego - Maślana Góra w Szymbarku k. Gorlic. Geologia, Kwartalnik Akademii Górniczo-Hutniczej, 34, 4, 733 – 742.

Sawicki, L. (1917). Osuwisko ziemne w Szymbarku i inne zsuwy powstałe w 1913 roku w Galicji Zachodniej. Rozpr. Wydz. Mat.-Przyr. PAU, 3, 13, dz. A, 227 – 313.

Wistuba, M., Malik, I. (2011). Indeks dekoncentryczności przyrostów rocznych drzew - narzędzie do identyfikacji współczesnych ruchów osuwiskowych. *Czasopismo Geograficzne*, 82, 4, 401 – 421.

Wójcik, A. (1959). Osuwiska ziemi w Beskidzie Niskim i w Bieszczadach. *Wierchy*, 27, 189 – 194.

Key words: Sawicki landslide, dendrogeomorphology, eccentricity index, *Pinus sylvestris, Abies alba*

THE IMPACT OF INTENSIVE FOREST MANAGEMENT ON A LARGE LANDSLIDE IN THE POLISH FLYSCH CARPATHIANS

KRZYSZTOF KISZKA

Polish Academy of Sciences, Institute of Geography and Spatial Organization, Research Station in Szymbark, Szymbark 430, 38-311 Szymbark, Poland, kiszkak@zg.pan.krakow.pl

Over 30 % of the Szymbark area is covered with landslides - it's one of the highest landslide area index in the Polish Flysch Carpathians. Most landslides are small, but there are also a few of large area. The largest of them is located on south slope of the Trzy Kopce Massif (753 m a. s. l.). It is the most northerly part of the Beskid Niski Mts. Long and steeply inclined (25 – 40°) southern slopes are heavily transformed by landslides and coombs. The L. Sawicki Landslide is the biggest landslide in this region. Its area is more than 1.6 km² and its length is 2.5 km (the longest landslide in Poland). The substrate is built by Carpathian Flysch, which consists mainly of shales and sandstones of the Magura Nappe. Above it there are the gleyic brown soils, characterized by high water absorption and humidity.

About 70 % of the landslide area is covered with forest. Intensive forest management is constantly implemented within whole the mountain massif. Despite the difficult and unfavourable terrain, diversified topography, numerous wetlands and high soil moisture, there is a very complex and dense network of roads within landslide. A substantial portion of all the roads is in bad condition or completely destroyed. High soil moisture facilitates the deep erosion process, which affects the fast surface dissection and level reduction of roads. Finally deep ruts are formed. They are intensively deepening during the trees transport using heavy vehicles. Short period of the roads usefulness and rapid degradation their surface make it necessary to build new transport routes. As a result of it, whole the landslide area is covered by a dense road network. The side roads are formed in the impassable road sections. When also the side roads become completely impassable, another side roads are created next to their. In this way the vast areas with deep ruts and substantial hollows are formed. Rainwater is collected in them during the rain, and poorly permeable surface prevents the soil infiltration. Colluvium masses are becoming more and more waterlogged, and their weight increases. The earth masses, plasticized by rainwater and groundwater can be easily moved under the influence of gravity. However in the steep slope areas, the roads function as river channels. Initially, they disperse rainwater during precipitation, but with the gradual deepening of the ruts, they act as a permanent river network.

Key words: forest management, Sawicki landslide, soil moisture, roads, ruts

NATURAL AND ANTHROPOGENIC FACTORS AFFECTING GEOMORPHOLOGICAL PROCESSES IN THE SINO-TIBETAN MOUNTAINS (SICHUAN, CHINA)

KRZYSZTOF KISZKA[1], JAROSŁAW CEBULSKI[2]

[1] *Polish Academy of Sciences, Institute of Geography and Spatial Organization, Research Station in Szymbark, Szymbark 430, 38-311 Szymbark, Poland, kiszkak@zg.pan.krakow.pl*
[2] *Polish Academy of Sciences, Institute of Geography and Spatial Organization, Department of Geoenvironmental Research, Św. Jana 22, 31-018 Cracow, Poland, cebulski@zg.pan.krakow.pl*

The dynamic development of the Chinese economy in recent decades has led to a significant transformation of valleys and mountain slopes. Electricity demand management, flood control, and water supply of growing cities are the main causes of multibillion-dollar investments in the construction of new water reservoirs on the rivers in the Dudu River valley and the Min River valley (the Sino-Tibetan Mountains).

The Dudu River valley is one of the main routes between the Tibet and Sichuan Basin. It has a length of 1155 km. Currently, there are 9 active reservoirs on the river, and another 26 are under construction or are being planned. Main roads have been relocated to the tunnels located 10 – 150 m above the natural valley bottoms. The Min River (735 km long) was divided by a 15 dams, and there are plans of opening another 27 reservoirs in subsequent years. Flooding of valley floors and building of roads along steep slopes led to the activation of a number of landslides and debris flows. Centrally planned economy of this area has led to a significant transformation of the natural mountain environment, and the existing and planned investments will contribute to the growth of environmental degradation.

Key words: anthropopression, water reservoirs, tunnels, landslides, debris flows, Sino-Tibetan Mts., Sichuan, China

NEOTECTONIC, CLIMATIC AND ANTHROPOGENIC TRANSFORMATIONS OF FLUVIAL PATTERNS; NORTHERN FORELAND OF THE ZLATOHORSKÁ VRCHOVINA MTS., CENTRAL EUROPE

KAZIMIERZ KLIMEK[1], BEATA WOSKOWICZ-ŚLĘZAK[1], DARIUSZ CISZEWSKI[2]

[1] *University of Silesia, Earth Sciences Faculty, ul. Będzińska 60, 41-200 Sosnowiec, Poland, klimek@us.edu.pl; beata.woskowicz-slezak@us.edu.pl*

[2] *University of Science &Technology, Faculty of Geology, Geophysics and Environmental Protection, Department of Environmental Protection, al. Adama Mickiewicza 30, 30-059 Kraków, Poland, ciszewski@geol.agh.edu.pl*

About 280km long, the mid-mountain Sudetes Mts. in Central Europe span between 49°35' and 50° N latitude. The N-E part of the Eastern Sudetes Mts. – the mid-mountain ridge – the Zlatohorská vrchovina Mts. – follows the border of the Czech Republic and Poland. From a geological point of view it is a part of the Moravo-Silesian Basin (Cymerman 2004). The eastern part of this ridge, between the Zlaty potok Creek valley in the West and the Osoblaha River valley in the East, over the distance of about 20 km, decreases its elevation from 890 m a. s. l. (the Biskupia kopa Hill) to 362 m a. s. l. (the Wężowa góra Mt.). This is a part of a Devonian & Carboniferous Basin (Żelaźniewicz et al. 2011). The western part of this ridge is built up of Devonian and Carboniferous tuffs and quartzite, which penetrate eastward under Devonian greywacke (Bobiński et al. 1995). The northern foreland of this ridge is dissected by a few transversal or oblique, presumably second order, faults. About 16-20 km north of the ridge there runs a parallel, first order of magnitude Alpine dislocation – the Prudnik fault with amplitude of a few hundred meters (Cymerman 2004). Geodetic investigations of the Earth's crustal deformation indicated that this part of the Prudnik catchment is situated within a zone of vertical movements reaching up to – 2 mm/year (Kowalczyk 2006). The horizontal strait field reaches here up to a few mm/100 km/year. In the neighbourhood of the Prudnik fault it has a W-E orientation and south of this dislocation – a SW-NE orientation (Cacoń and Konty 2011).

During the cool periods of the Pleistocene the Scandinavian ice sheets reached the northern foothill of this part of the Sudetes twice (Anders 1939). During the last cool period of the Pleistocene the ice sheet reached 150 – 180 km north of the ridge. In periglacial climatic conditions the elevated part of mountain slopes were covered with thick mantel of regoliths as the depressions filled with redeposited glacigenic or washed-down fine-grained deposits.

The drainage pattern of the northern foreland of the Zlatohorská vrchovina Mts. is distinctly related to the tectonic lines. The upper section of the Prudnik River, running from W- E direction with a longitudinal slope of 4 m/km, follows the Prudnik fault zone. Downstream the confluence with a mountain tributary - the Zloty potok Stream - instead of crossing the fault zone the valley floor of the Prudnik River increases its longitudinal slope to 8 – 10 m/km. A few km downstream to the east its longitudinal slope stabilizes reaching ‹0.9 m/km. The mountain tributaries of the Prudnik River, draining the Zlatohorská vrchovina Mts. ridge, run from SW to SE following the secondary faults. The Prudnik River catchment lies within the temperate climatic zone of Central Europe. Rainfall in the highest part of the ridge ranges from 850 to 1000 mm/year, and in its northern foreland – 650 – 750 mm/year. The snow cover duration on the ridge reaches 100-120 days/year, while in its northern foreland - 60-80 days/year (Šafář 2003). It was only in the first half of 13th century that the historical sources mentioned the first settlements (Fig.1). The incorporation of Bohemia to the Holy Roman Empire led to intensive colonization by German settlers (Klimek 2010). In deforested areas periglacial covers were eroded and transferred to the streams, particularly with rainwater. Heavy summer rainfall caused severe floods registered in the past centuries. For example between July 5th and 9th 1997 reached ›312 mm at the foot of the ridge (Jarnołtówek) and 200 mm at its northern foreland (Prudnik city). As a result in the forested catchment (36 km^2) the specific run-off reached 1.126 l/sec/km^2 and in the Prudnik River catchment (134 km^2) which has much more arable fields -1.455 l/sec/km^2. The topographical maps of the Prudnik River (Messtischblatt 1884) show that downstream of a confluence with its tributary – the Trzebionka River – the present channel decreased its sinuosity. Further downstream, near Slezske Pavlovice, there appear traces of former semi-anastomosing channel pattern, which survived there until at least 1840 (Fig.1).

After an engineering correction before 1931/1933 the straight channel started to incise into previously deposited alluvia and later returned to its lateral activity. This exposed about 2-2.5 m thick sequence of alluvia. In its lowermost part there occur structureless loams, which contain fine sands whose content increases towards the top of these sequences. In some places, in the lower levels, there occur vertical stems of former riparian bushes with roots embedded below the low water stage. The ^{14}C dating (Ki- 15286 and 15287) indicated their age as 1.750±60 years BP and 1.740±40 years BP (cal. 210-250 years CE). This was a time preceding the Migration period, possibly with remnants of the Corded Ware Culture settlements. The semi-lacustrine environment confirms the neo-tectonic subsidence of the Prudnik fault zone. This caused the development of an anastomosing pattern of the Prudnik river channel. It is therefore conceivable that the riparian communities may have appeared here at least 1.5-2 ky ago.

The Zlaty potok Creek – the main tributary of the Prudnik River - has its source area within the geological border between the Moravo-Silesian Basin and the Vrbno Unit -composed of Devonian epi-metamorphic volcano-sedimentary complex. Lensoidal bodies contain mineralization of Pb-Zn and Cu. The Zlate Hory mining district contain ore deposits of, among others, galena and native gold. Placer gold in the foothill was probably mined by Celtic tribes since the Iron Ages. Documented gold mining started there in the Middle Ages. Ore mining peaked here in the 16th century. Along the Zlaty Potok Creek valley the concentration of certain heavy metals within the alluvia slowly decreases downstream. About 1 km downstream of a tailing pond the concentration of Cu, Zn, Pb exceeds ~100 times the values typical of the natural background (Ciszewski et al. 2014). These concentrations decrease downstream of the confluence of the tributary draining the loess-covered foreland. In the lower section of the investigated Prudnik River valley, with a formerly anostomosing channel pattern, the concentration of these metals is different up to vertical sequences. This is a result of either differrent sources of delivery of fine sediment from arable areas or their redeposition.

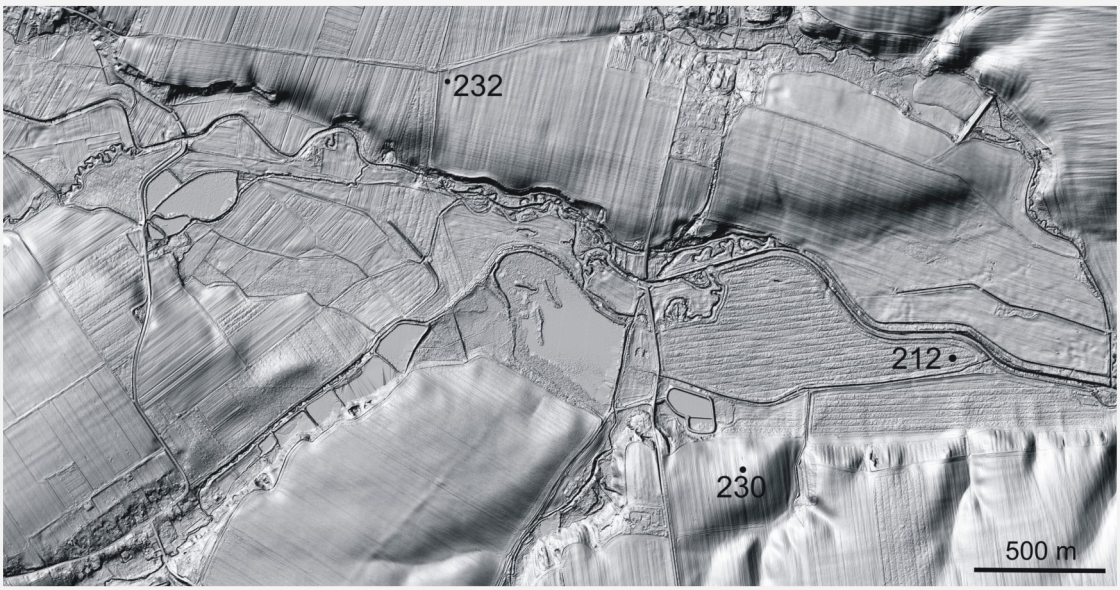

Fig. 1 Traces of former semi-anastomosing channel pattern near Slezske Pavlovice

References:

Anders, G. (1939). Zur Morphologie der Ostsudeten. Veroff. Schles. Ges. F. Edkunde, Breslau, 31, 1 – 124.

Bobiński, W., Badura, J., Przybylski, B. (1995). Detail Geological Map of Poland, 1:25 000. Panstwowy Instytut Geologiczny, Warszawa.

Cacoń, S., Konty, B. (2011). Recent, natural and anthropogenic deformation of the Earth crust surface in Lower Silesia, SW Poland (in Polish). In Żelaźniewicz, ed. Tectonic regionalization of Poland (in Polish). WIND, Wrocław, 78 – 81.

Ciszewski, D., Bijata, P., Klimek, K. (2014). Reconstruction of post-mining attenuation of heavy metal pollution in sediment of the Zlaty Potok, Eastern Sudety Mts. Carpathian Journal of Earth and Environmental Sciences, 9, 4, 109 – 120.

Cymerman, Z. (2004). Tectonic map of the Sudetes and the Fore-Sudetic block, 1:200 000. Panstwowy Instytut Geologiczny, Warszawa.

Klimek, K. (2010). Past and recent interaction between the catchment and the valley floor: Upper Osoblaha basin, NE Sudetes slope and foreland. Quaternary International, 220, 112 – 121.

Kowalczyk, K. (2006). Model of the vertical crustal movements in the area of Poland. Ph.D. thesis, University of Warmia and Mazury in Olsztyn, Olsztyn, Poland.

Messtischblatt (1884). Topographic map 1:25 000, ser. Messtischblätter.

Šafař, J. ed. (2003). Chráněná území ČR. VI., Olomoucko. Agentura ochrany přírody a krajiny ČR, Praha, 454 p.

Żelaźniewicz, A., ed. (2011). Tectonic regionalization of Poland (in Polish). WIND, Wrocław.

Key words: Central Europe, Eastern Sudetes Mts. foreland, neotectonic, fluvial pattern

LANDSLIDES ON RIVER BANKS IN THE WESTERN PART OF PODHALE (CENTRAL CARPATHIANS, POLAND)

JÓZEF KUKULAK, KAROL AUGUSTOWSKI

Pedagogical University of Cracow, Institute of Geography, Podchorążych 2, 30-084 Kraków, Poland, jkukulak@up.krakow.pl; karolaug@up.krakow.pl

The authors studied landslides in alluvial sediments on undercut steep banks of the rivers flowing in the western part of the Podhale region. The landslides are of rotational type. Landsliding processes are complex and they differ from those on solid rock slopes because of the heterogeneous lithology of the alluvial sediments in the banks (muds, sandy gravels, clays) and because of uneven degree of their consolidation. Their course depends on the mode rate of water infiltration into the sediments. Multiannual observations of changing landslide surfaces and measurements of scarp surface with erosion pins indicate that each type of sediment behaves in a different way during the sliding. The layers of mud in the highest parts of the banks slid down in blocks and soon became fragmented, soaked and washed away. Sandy gravels slid as whole layers or separate fragments. The more compact the alluvium, the more compact was the resulting colluvium. The thick layers of massive claystones underlying the alluvial sediments at the bank bases were mobilized by landsliding only to the depth to which they became plastic. The claystones appeared the most resistant to landsliding among the bank materials. The surfaces of rupture were shallow and uneven where poorly consolidated layers of alluvium lied horizontally (landslides at Chochołów and Ludźmierz). In areas where alluvial sediments were more consolidated and inclined, and the layers of clay alternated with sands and gravels, the surface of rupture occurred deeper and was smooth (Stare Bystre landslide). Landslides in undercut river banks are an important source of debris in fluvial channels.

Key words: landslides, river banks, Podhale, Carpathians

TIMBERLINE AT THE BABIA GÓRA MT. (THE WESTERN CARPATHIANS) AS A RESULT OF THE INTERACTIONS AMONG ABIOTIC ENVIRONMENT, FOREST AND HUMAN ACTIVITY

ADAM ŁAJCZAK[1], BARBARA SPYT[2]

[1] *Pedagogical University of Cracow, Institute of Geography, Podchorążych 2, 30-084 Kraków, Poland, alajczak@o2.pl*
[2] *University of Silesia, Faculty of Earth Sciences, Będzińska 60, 41-200 Sosnowiec, Poland, barbaraspyt@wp.pl*

The investigations on the course of timberline were carried out at the Babia Góra Mt. ridge (1725 m a. s. l.) in the Western Carpathians built of flysch deposit and modelled by landslides. A difference in the course of timberline is visible between a gently sloping upper part of the southern slope where pasturing used to occur, and a precipitous high northern slope where pasturing has never occurred. Basing on field investigations, aerial photographs and LiDAR data the courses of the timberline, forestline, treeline, and Krumholtzline were analysed and the lowest located sites of a dwarf pine in the spruce forest were found. These lines were compared with the maps showing landslide limits, avalanche tracks, debris flows and limits of different slope deposits. Basing on historical sources, the limits of pasturing and large-scale forest clearance were reconstructed. This revealed that the timberline at the northern slope shows its natural course, whereas in in southern slope it became lowered due to pasturing and has not reverted to the previous state. As a result, the timberline runs in a wide altitude section, from 1106 to 1508 m a. s. l. The timberline in the northern slope is locally lowered mainly by avalanches, as well as landslides, edaphic factors and minimally also by debris flows. In the southern slope where regeneration of timberline occurs, the influence of avalanches and edaphic factors is inconsiderable.

Acknowledgements: The work was conducted as part of the research project of the Polish National Science Centre NN 306 070640 – "Natural and anthropogenic conditioning of the occurrence of the timberline on Babia Góra Mountain, and its dynamics over the last 200 years". The authors would like to thank the Authorities of the Babiogórski National Park for access to the Airborn Laser Scanning data.

Key words: timberline, slope processes, avalanches, spruce forest, dwarf pine, former pasturing, the Babia Góra Mt., the Carpathians, Poland, Slovakia

AVALANCHES ON THE BABIA GÓRA MT. IN THE LIGHT OF GEOMORPHOLOGICAL AND DENDROLOGICAL INVESTIGATIONS AND THE LIDAR DATA

ADAM ŁAJCZAK[1], BARBARA SPYT[2]

[1] *Pedagogical University of Cracow, Institute of Geography, Podchorążych 2, 30-084 Kraków, Poland, alajczak@o2.pl*
[2] *University of Silesia, Faculty of Earth Sciences, Będzińska 60, 41-200 Sosnowiec, Poland, barbaraspyt@wp.pl*

The asymmetric ridge of the Babia Góra Mountain (1725 m a.s.l.) of W-E course shows the most favourable conditions in the flysch Western Carpathians for avalanche development. Prevailing strong winds (10 m.s-1) in winter from SW sector blow the snow from the upper gently sloping part of the southern slope which overtops the timberline and direct it to the precipitous northern slope and locally to the headwalls located at the southern slope. Along the edge of the northern slope and above the headwalls at the southern slope, snow brows develop which become source areas for avalanches. 55 avalanche tracks were determined at the both slopes of the ridge, including 44 at the northern slope. The avalanches usually go down along gullies and torrential cones and penetrate to spruce forest. Avalanche tracks and statistical analysis of their parameters were investigated basing on field studies and LiDAR date (timberline course). The longest avalanche tracks at the northern slope reach 1 km, and exceed the altitude 1100 m a.s.l. Former pasturing caused the lowering of timberline in a vast area and decrease of dwarf pine density which triggered avalanche activation, especially on the southern slope. The progressing regeneration of timberline which started 60 years ago has not shortened the range of avalanches yet. The frequency of avalanches during the last two centuries were determined basing on dendrological investigations.

Acknowledgements: The work was conducted as part of the research project of the Polish National Science Centre NN 306 070640 – "Natural and anthropogenic conditioning of the occurrence of the timberline on Babia Góra Mountain, and its dynamics over the last 200 years". The authors would like to thank the Authorities of the Babiogórski National Park for access to the Airborn Laser Scanning data.

Key words: avalanches, snow cover, wind, timberline, spruce forest, dwarf pine, former pasturing, the Babia Góra Mt., the Carpathians, Poland, Slovakia

ALTERATION IN HYDROLOGICAL AND SEDIMENTARY CONNECTIVITY (THE SLOVAK PART OF THE DANUBE RIVER ANABRANCHING REACH)

MILAN LEHOTSKÝ[1], IGOR MATEČNÝ[2], MILOŠ RUSNÁK[1]

[1] *Slovak Academy of Sciences, Institute of Geography, Štefánikova 49, 814 73 Bratislava 1, Slovakia, geogleho@savba.sk; geogmilo@savba.sk*
[2] *Comenius University in Bratislava, Faculty of Natural Sciences, Department of Physical Geography and Geoecology, Mlynská dolina, Ilkovičova 6, 842 15 Bratislava 4, Slovakia, matecny@fns.uniba.sk*

The Slovak-Hungarian section of the Danube River is classified as a sub-section represented by the inland delta of the section type four "Lower Alpine foothills Danube" of the Danube River classification. In the past it was characterized by meandering, anabranching and braided channels. The dominant substrates consist of medium to coarse gravels overlain by sand and loam in the accumulation zone of the Danube Lowland. In 1992, a massive hydroelectric power project went into operation on the study reach. Damming effectively abolished the active connection between the old main channel and its floodplain side arms, and water now has to be supplied to former side channels via an artificial recharge system. The area incorporates a gradient of laterally connected habitat types ranging from highly dynamic waters in the main channel, through less dynamic waters of the side arms, to stagnant zones. Based on the analysis of aerial photographs from time horizons 1980, 1986, 1990, 1996, 2003 and 2010 the classification of channel hydrological connectivity has been worked out. The changes in areas of connectivity classes, bank shifts and benches areas in bypassed channel as responses to water level lowering were estimated by time horizons. The morphostratigraphic approach was applied for the identification of changes in channel/bank sediment connectivity (vertical accretion) through an bench developed after channel bypassing. Grain-size analyses of accreted sediments and suspended load data have been used for understanding the operation of bench vertical accretion and its spatial variability under different flood magnitudes. For demonstration of changes in landscape diversity, its ecological consequences and vegetation succession land cover landscape metrics for the whole study area as well as for an bench/new floodplain have been computed in FRAGSTAT and GUIDOS softwares. Two kinds of scenarios of the anabranching system remediation are presented.

Acknowledgements: The study was supported by the Slovak Grant Agency for Science No 2/0020/15.

Key words: connectivity, changes, the Danube River, the Gabčíkovo water work

CHANNEL/VALLEY MORPHOLOGY AND MACROINVERTEBRATES – INSIGHT INTO LONGITUDINAL ZONATION AND SEASONAL VARIABILITY

MILAN LEHOTSKÝ[1], ZUZANA PASTUCHOVÁ[2], EVA BULÁNKOVÁ[3], IGOR KOKAVEC[3]

[1] *Slovak Academy of Sciences, Institute of Geography, Štefánikova 49, 814 73 Bratislava 1, Slovakia, geogleho@savba.sk*
[2] *Zaježová 7, Pliešovce 962 63, Slovakia, zpastuchova@gmail.com*
[3] *Comenius University in Bratislava, Faculty of Natural Sciences, Department of Ecology, Mlynská dolina, Ilkovičova 6, 842 15 Bratislava 4, Slovakia, bulankova@fns.uniba.sk; kokavec@fns.uniba.sk*

The aim of the study is to analyse variability in macroinvertebrate communities between two different morphological sequences–shallow (riffle/ run/step/) and deeper (pool) channel-bed morphological units on the background of the environmental parameters (local relief, slope, channel confinement ratio, channel-valley walls connectivity, floodplain continuity and channel abut, channel sinuosity and predominant land cover of riparian zone) of seven valley segments (functional process zones) in two seasons of the year (spring and autumn). The longitudinal-downstream gradient research was conducted on the semi-natural upland headwater brook in the Malé Karpaty Mts. (9,330 m long, average gradient 2.8 %) at 15 morphological sequences (30 sampling points). Each sampling point in spring as well as in autumn was characterised by mean flow velocity, discharge, water depth, channel width, channel bottom particle size, and flow types. The results showed that differences in zonation of benthic invertebrates between seasons are more apparent than seasonal variability between pools and riffles. Spring samples followed the increasing gradient of total dissolved solids downstream with characteristic families for upper and lower stretch. The disruption of macroinvertebrates zonation was more evident in autumn samples with greatest effects in pools. Based on RDA, the distribution of families was driven by three significant variables in riffles and four in pools. Alike environmental factors of pool sequences in the middle and upper reaches were responsible for similarity in macroinvertebrate structure.

Acknowledgements: The study was supported by the Slovak Grant Agency for Science No 2/0020/15 1/0255/15, 1/0119/16.

Key words: riffle/run/step, pool, headwater; seasonality, macroinvertebrate, the Vydrica River

PRELIMINARY ANALYSIS OF THE GEOLOGICAL STRUCTURE OF EROSIONAL-DENUDATIONAL VALLEYS IN THE VICINITY OF LĘBORK (ŁEBA-REDA URSTROMTAL, NORTHERN POLAND)

MAREK MAJEWSKI

Pomeranian University in Słupsk, Institute of Geography and Regional Studies, Partyzantów 27, 76-200 Słupsk, Poland, marekmajo@o2.pl

The survey area is located 5 km north-west of Lębork, in Czarnówko situated in the Łeba-Reda Urstromtal (Northern Poland). The edge zone of the Urstromtal is intersected by a number of dry valleys of erosional-denudational origin the formation of which is generally thought to have begun in the Late Vistulian period. Surveys conducted in recent years have demonstrated that these formations are underlain by sediments dated to 21970±1000 and 23200±710 BP (valley G). This may suggest that the beginnings of their origin are somewhat older than is generally accepted and reach back to the anaglacial phase of the most recent ice age.

In the above-dated sediments of valley G as well as in other formations, a rock and gravel series with an admixture of sand is found most often. The material recognized in this series is highly weathered, which may indicate that it was formed under periglacial conditions.

The next level consists mostly of brownish sandy sediments with a slight admixture of fine gravels. Presumably, and in line with surveys conducted in other areas of Northern Poland, these are deluvia formed at the turn of the Late Vistulian and the Holocene. The climatic changes at the time resulting in lower temperatures and changes in vegetation contributed to intensified ablation and movement of sandy sediments down the slopes. They were subsequently accumulated in the lower sections of the slopes and partly also at the bottom of the valleys.

Deposited at the shallowest depth are sandy sediments with an admixture of black silt. The stratigraphic position of these deluvia and one identified date of C-14 230±100 BP (valley C) associated with this series suggest that these sediments were formed in the Neoholocene period. By reference to similar examples existing in Northern Poland and the results of archaeological studies conducted in Czarnówko, it may be assumed that these deluvia are primarily a result and a record of human interference with the natural environment caused by economic activity, predominantly agriculture. It is known that, due to favourable conditions for settlement, this region was inhabited by sizeable populations from the Bronze Age until the early Middle Ages and into modern times, as evidenced by numerous and rich archaeological sites discovered in the Czarnówko area.

The youngest recognized deluvia quite often contain pieces of wood charcoal the dating of which will enable a detailed reconstruction of the earliest stages of the evolution of the surveyed valleys.

Key words: dry valleys, Late Vistulian period, Neoholocene, deluvia, human interference, Northern Poland

RECORD OF PREHISTORIC AND HISTORIC ANTHROPOGENIC DENUDATION BASED ON AN EXAMPLE OF TWO CLOSED DEPRESSIONS IN THE AREA OF LAKE JASIEŃ (NORTHERN POLAND)

MAREK MAJEWSKI, ALEKSANDRA DROZDOWSKA

Pomeranian University in Słupsk, Institute of Geography and Regional Studies, Partyzantów 27, 76-200 Słupsk, Poland, marekmajo@o2.pl

The surveys conducted in the area of the Jasień Lake (Northern Poland) indicate that the intensity of slope processes increased significantly in this area in the 5th and 6th centuries. Analysis of the geological structure of endorheic depression ZS2 permits the conclusion that after 1600±50 BP (416 – 535 cal. BP) an intense vertical growth of sediments in the form of sandy deluvia occurred in this area. The clearly noticeable intensification of slopewash processes in this period should probably be associated with human activity. The beginning of the early Middle Ages, that is the 6th century A.D., marks the commencement of early settlement in Pomerania. Archaeological studies (the Archaeological Photograph of Poland) enabled recognition, in areas adjacent to the surveyed closed depressions, of traces of human presence dating back to exactly the early Middle Ages. The population inhabiting the lakeland zone applied the slash-and-burn cultivation technique which hastened the ablation processes down the slopes. It should be emphasized that the slopewash phenomena were also supported at the time by a climatic change resulting in a wetter and colder environment.

A younger recorded intensification of slopewash processes occurred around the 15th-16th centuries. This is indicated by a series of slope sediments recognized in closed depression ZS1 overlaying pieces of wood charcoal dated to 470±70 BP (1395 – 1491 cal. BP).

It cannot be ruled out that also in this case the clearly noticeable intensification of slopewash processes was associated with two factors. One of them was human economic (agricultural) activity which enhanced ablation down the slopes and contributed to the formation of slope sediments. It should be noted that the depression in question is located merely approximately 1 km from the village of Jasień. According to historical sources, the village was founded at the end of the 14th century, and the development of the settlement was probably accompanied by the process of acquisition of new land for agricultural purposes. A map of this area drawn in the 2nd half of the 19th century indicates that areas directly adjacent to the depressions under analysis were at the time used as farmland. Hence it cannot be ruled out that already in the 16th century the situation was similar. The other factor that intensified the slopewash processes was the climatic change associated with the Little Ice Age which began in the mid-16th century.

Anthropogenic denudation in this area slowed down and eventually disappeared in the 1st half of the 20th century due to afforestation of the areas used previously for a long period of time as farmland.

Key words: prehistoric and historic anthropogenic denudation, closed depressions, Northern Poland

SPATIOTEMPORAL CHANGES OF LANDSCAPE STRUCTURE IN LANDSLIDE-AFFECTED AREA (CASE STUDY OF ĽUBIETOVÁ, CENTRAL SLOVAKIA)

ALŽBETA MEDVEĎOVÁ

Matej Bel University in Banská Bystrica, Faculty of Natural Sciences, Department of Geography and Geology, Tajovského 40, 974 09 Banská Bystrica, Slovakia, alzbeta.medvedova@umb.sk

The paper deals with analysis of spatiotemporal changes in landscape structure based on the selected archive aerial photographs (1949, 1986, 2006) and satellite images (2013) and detailed terrain mapping (conducted during period of 2015 – 2016). Studied region represented by north-west part of the Ľubietová municipality cadastral territory (2155 ha) is located in neovolcanic region of The Central Western Carpathians (Slovakia) at the periphery of the Poľana stratovolcano. This peculiar region has undergone significant changes due to its environmental history: geologic development, ore-mining, pottery, controversial land use in second half of 20-th century and catastrophic landsliding (1977). Significant changes in the spatial structure of the territory were caused by synergistic action of political, ecological, environmental and economic factors during the past six decades. The basis for categorization of patches were landscape structure classes of Masný (2015). The main goal was to assess the different changes lasting on the landslide affected areas comparing the stable areas. Research outcomes show persistent broadening of build-up areas (especially at landslide affected areas). Spreading of the settled patches also goes with orchard reduction and decreasing extent of meadows and pastures. Ongoing trend is persisting large size of large-scale arable land. Most worrisome results are current extent of large-scale arable land (42,83 ha) respectively of settled patches (19.86 ha), both covering landslide affected areas.

Reference:

Masný, M. (2015). Zmeny využívania krajiny v rámci vybraného územia prechodnej zóny Biosférickej rezervácie Poľana. PhD thesis, Fakulta prírodných vied, Univerzita Mateja Bela v Banskej Bystrici, Banská Bystrica, Slovakia.

Key words: landscape structure, spatiotemporal changes, development trends, land-cover maps, landslide, geohazard

CURRENT STATE OF RELIEF OF THE LANDFILL OF SLUDGE FROM THE PRODUCTION OF NICKEL AT SERED IN SLOVAKIA

EVA MICHAELI[1], MARTIN BOLTIŽIAR[2], VLADIMÍR SOLÁR[1], MONIKA IVANOVÁ[1]

[1] *Department of Geography and Applied Geoiformatics, Faculty of Humanities and Natural Sciences, University of Prešov in Prešov, 17. Novembra 1, 081 16 Prešov, Slovak Republic, eva.michaeli@unipo.sk*
[2] *Department of Geography and Regional Development, Faculty of Natural Sciences, Constantine Philosopher University in Nitra, Trieda A. Hlinku 1, 949 74 Nitra, Slovak Republic, mboltiziar@ukf.sk*

Relief is complicated structure, which is located at the interface three spheres the lithosphere, atmosphere and the hydrosphere. It is an integral component of the landscape. The landforms of relief are formed by the action of geomorphological processes. All geomorphological processes consume energy. The Sun and depths of Earth are primary sources of energy which are transformed into different types of energy e.g. the energy of the linear flowing water and the energy after the surface flowing water, energy of wind, waves, energy of magmatic processes, gravitational energy, the energy of human activity etc. The main objective of paper is to highlight the current geomorphological processes and forms of relief which incurred on landfill from waste sludge of nickel production over the past 23 years after completion of the landfilling at the former Nickel smelter in Sereď. The landfill of sludge the waste from production of nickel is man-made landforms it is industrially convex non-flammable table mountain of large dimensions. Today is it actually anthropogenic bearing of iron ore. From geomorphological processes that here underway are it mainly anthropogenic geomorphological processes (which ones have energy in human activities) and those accompanies the mining of sludge and second group represent the geomorphological processes typical for the particular climatic zone.

Acknowledgements: This work was supported by the by Scientific Grant Agency the Ministry of Education, Science, Research and Sport of the Slovak Republic projects VEGA No. 1/0159/15 and VEGA No. 1/0116/16.

Key words: geomorphological processes, man-made landforms, landfill waste from nickel production

METHODS TO ASSESS LARGE WOOD DYNAMICS AND THE ASSOCIATED FLOOD HAZARD IN POLISH CARPATHIAN WATERCOURSES OF DIFFERENT SIZE

PAWEŁ MIKUŚ[1,4], BARTŁOMIEJ WYŻGA[1,4], VIRGINIA RUIZ-VILLANUEVA[2], JOANNA ZAWIEJSKA[3], RYSZARD J. KACZKA[4], MARKUS STOFFEL[2]

[1] *Polish Academy of Sciences, Institute of Nature Conservation, al. Mickiewicza 33, 31-120 Kraków, Poland, mikus@iop.krakow.pl; wyzga@iop.krakow.pl*
[2] *dendrolab.ch, University of Bern, Institute of Geological Sciences, Baltzerstrasse 1+3, CH-3012 Bern, Switzerland, virginia.ruiz@dendrolab.ch, markus.stoffel@dendrolab.ch*
[3] *Pedagogical University of Cracow, Insitute of Geography, ul. Podchorążych 2, 30-084 Kraków, Poland, zawiejska.joanna@gmail.com*
[4] *University of Silesia, Faculty of Earth Sciences, ul. Będzińska 60, 41-200 Sosnowiec, Poland, kaczka@wnoz.us.edu.pl*

Applicability, advantages and limitations of a range of methods applied to determine large wood dynamics in the Kamienica Stream and the Czarny Dunajec River, the Polish Carpathians, are discussed. Results of a 6-year-long monitoring suggest an increased rate of wood recruitment to the Kamienica Stream caused by recent bark beetle infestation of the spruce forests in the valley. However, both monitoring of wood transport and wood inventories indicate that the mobility of large wood in the stream is low and can increase only during major floods. Thus flood hazard to downstream valley reaches potentially resulting from the considerable amounts of large wood stored in the upper stream reach is limited. In the Czarny Dunajec River, wood inventories, a tracking experiment with logs tagged with radio transmitters, and numerical modelling indicated high potential for wood transport in the narrow river reaches formed by channelization or channel incision, and high potential for wood deposition in the wide, multi-thread channel. Vegetative regeneration of living willow wood considerably reduces its remobilization by subsequent floods. Efficient transport of large wood along narrow river reaches implicates that during floods substantial amounts of wood may be delivered from distant sources to the channel sections located downstream of the narrow reaches. Wide, multi-thread reaches operate as natural wood traps, considerably limiting further transfer of wood to vulnerable sites/reaches.

Acknowledgements: This work was supported by the Polish-Swiss project FLORIST (Flood risk on the northern foothills of the Tatra Mountains, PSPB No. 153/2010).

Key words: large wood dynamics, flood hazard, wood inventory, wood monitoring, numerical modelling, wood tracking

SPATIAL AND TEMPORAL VARIABILITY OF RIVER CONNECTIVITY AT THE CATCHMENT SCALE (THE VÁH RIVER CASE STUDY)

JÁN NOVOTNÝ

Slovak Academy of Sciences, Institute of Geography, Štefánikova 49, 814 73 Bratislava 1, Slovakia, jan.novotny@savba.sk

Fluvial geomorphic processes could be generally seen as a combination of erosion, transport and deposition of sediments by flowing water. Ascertaining the sediment fluxes within the river systems is therefore vital for understanding their evolution and functioning. Connectivity in this context means linkage of sediment through the system and its research requires identifying sediment sources and storage zones (Hooke 2003).

This contribution is focused on analysing spatial and temporal variability of river connectivity within the Váh River catchment, which has been strongly modified by human activity. These changes, including damming, channelling and river training, have affected also transfer of sediments within the whole river basin. The approach proposed by Fryirs et al. (2007), based on slope threshold analysis in GIS, interpreting aerial photos of different time horizons and mapping the landforms that impede sediment conveyance, proves to be useful. The results document differences in connectivity among the Váh River zones and subcatchments and show significant decrease of degree of connectivity within the whole river system.

References:

Fryirs, K. A., Brierley, G. J., Preston, N. J., Spencer, J. (2007). Catchment-scale (dis)connectivity in sediment flux in the upper Hunter catchment, New South Wales, Australia. Geomorphology, 84, 3 – 4, 297 – 316.

Hooke, J. M. (2003). Coarse sediment connectivity in river channel systems: a conceptual framework and methodology. Geomorphology, 56, 1 – 2, 79 – 94.

Acknowledgements: This research was supported by the Slovak Scientific Grant agency VEGA (Project No. 2/0020/15).

Key words: fluvial geomorphology, river connectivity, river catchment, the Váh River

THROUGH ART TO THE PROMOTION OF GEOMORPHOLOGY: EXAMPLES FROM EASTERN SLOVAKIA

PAVOL PAPČO, DOMINIKA VOJTÁŠOVÁ

Catholic University in Ružomberok, Faculty of Education, Department of Geography, Hrabovská cesta 1, 034 01 Ružomberok, Slovakia, pavol.papco@ku.sk; vojtasova.d@gmail.com

Geomorphology is called by some "royal discipline" of Natural Sciences, today, however, we see loss of interest in study of geomorphology at universities (at least in Slovakia). The problem may be in an offering image of the discipline in society that can be changed in various ways. The greatest importance has, of course, applied research useful in a variety of warning systems of the geomorphological hazards. Other way is to introduce geomorphology also as an aesthetically attractive (geo)science. This is the aim of the contribution to present the specific art focusing on the geomorphologically interesting objects (on examples from eastern Slovakia). Combination geomorphology - art is not new but neither more known nor onwards developed (and almost not at all in Slovakia). The resulting pictures can be presented and used in tourist guidebooks or leaflets and thus can promote geomorphology (geosciences in general) as well as geotourism.

Acknowledgements: This work was supported by the Grant Agency of the Faculty of Education (Catholic University in Ružomberok) under contract No. 3/12/2015.

Key words: an art, promotion of geomorphology, geotourism, eastern Slovakia

GEOMORPHOLOGICAL CONDITIONS AND EFFECTS OF SNOW AVALANCHES IN THE TATRA MTS.

ZOFIA RĄCZKOWSKA[1], MICHAŁ LEMPA[2], RYSZARD J. KACZKA[2], ELŻBIETA ROJAN[3]

[1] *Institute of Geography and Spatial Organisation, Polish Academy of Sciences, Department of Geoenvironmental Research, Św. Jana 22 str., 31-018 Krakow, Poland, raczk@zg.pan.krakow.pl*
[2] *University of Silesia, Faculty of Earth Science, 60 Będzińska Str., 41-200 Sosnowiec, Poland, 92michal.lempa@gmail.com; ryszard.kaczka@us.edu.pl*
[3] *University of Warsaw, Faculty of Geography and Regional Studies, Department of Geomorphology, Krakowskie Przedmieście 30, 00-927 Warsaw, Poland, erojan@uw.edu.pl*

Snow avalanches, especially dirty avalanches, are important processes modifying relief of high mountains, while relief is one of main factor conditioning their activity. The aim of the research was the recognition of geomorphologic conditions for snow avalanches and assessment of the morphogenetic role of avalanches, taking into account temporal changes in avalanches dynamic. The studies encompassed the whole Tatra Mts. For recognition of geomorphological conditions of snow avalanches activity was made map of avalanches paths, based on historical maps of snow avalanches, air- photos and digital terrain model. More than 3,770 avalanche paths were identified. Over 70 % of the avalanche paths occur on slopes 26 – 550. Influence of microrelief of particular parts of avalanche path on course and extent of snow avalanches was recognized based on dendrogeomorphological analysis.

A four-year monitoring of morphodynamic of slopes was conducted in four chosen avalanche paths. Measuring points of erosion, transport and accumulation were checked two times a year. Erosion niches developing within avalanche starting zones are most exposed to these processes. Results of monitoring showed that in period with absence of dirty avalanches, the efficiency of secular geomorphological processes is low (max. a few cm/year). Erosion prevails both in winter and summer half of year. Morphogenetic role of dirty avalanche was confirmed by analyses of erosion niches on historical orthophotomaps. Impact of snow avalanches on talus cones and avalanche talus cone were identified based on morphometric analysis.

Acknowledgements: The study are supported by the National Science Centre, project no. 2011/03/B/ ST10/061.

Key words: relief, snow avalanches, slope morphodynamic, Tatra Mts.

THE INFLUENCE OF FLUVIOGLACIAL PROCESSES ON VALLEY FORMATION: EXAMPLES FROM CENTRAL POLAND

ZBIGNIEW RDZANY, MAŁGORZATA FRYDRYCH

University of Łódź, Faculty of Geographical Sciences, Department of Physical Geography, Narutowicza St. 88, 90-139 Łódź, Poland, zbigniew.rdzany@uni.lodz.pl; mfrydrych@uni.lodz.pl

The research conducted so far into the origins and development of the relief of river valleys in Central Poland indicates an important role of numerous factors, such as climatic changes, dynamics and morphology of the older substratum, glacigenic processes and sediments of the most recent glaciation of this area and, in the Holocene, also human activity.

In the paper, the authors examine the significance of such fluvioglacial processes of the Warta glaciation that revealed considerable diversity and complexity. The discussion includes the following cases related to the activity of meltwater in different zones of its operation:

- in the foreland of the Warta ice-sheet: a valley formed along the line of proglacial outflow with valley outwash plains – an example section of the Warta River valley;
- in a subglacial trough, as a preliminary form for the development of a river valley – examples: the Krzemionka River valley (the Bzura River catchment basin), the Teleszyna River valley (the Warta River catchment basin);
- in a pre-Wartanian interplateau basin, filled with kame sediments (kame terraces, kame hills) – examples include the Rawka River valley and secondary interkame valleys, where areal deglaciation took place.

The analysed examples prove the regularity that valley formation during the post-Wartanian period in Central Poland was frequently dominated with the outcomes of glacigenic processes, particularly with a characteristic spatial distribution of fluvioglacial lithosomes. In addition, these sediments indirectly influence the course of fluvial processes, e.g. through shaping the hydrogeological conditions in the valleys.

Key words: glacial geomorphology, fluvial landscape, fluvioglacial sediments, river valleys, tunnel valleys, Central Poland

INFLUENCE OF THE ROCKS PURITY ON KARST CORROSION PROCESS (CASE STUDY OF THE SLOVENSKÝ KRAS MTS. – EASTERN PART)

IMRICH SLÁDEK

Comenius University in Bratislava, Faculty of Natural Sciences, Department of Geology and Palaeontology, Mlynská dolina, Ilkovičova 6, 842 15 Bratislava 4, Slovakia, sladeki@fns.uniba.sk

The Slovenský kras Mts. consists of several karst plateaus. In the eastern part the Jasovská planina Plateau, which is very different, compared to other plateaus of the Slovenský kras Mts. There are lower density and size parameters of surface karst forms (e.g. dolines) in this plateau. Here we present preliminary results of our research on karst corrosion process in this area. The basic prerequisite for karst corrosion process is chemical purity of karst rocks (e.g. limestone, dolomite etc.). In our research we analysed quantity of $CaCO_3$ and $MgCO_3$ in 10 rock samples. The analysis was carried out in particular by classical methods of analytical chemistry (neutralizing titration and determining the loss on ignition of more than 900 °C), but also by instrumental methods (atomic absorption spectrometry). Finally, based on the ratio of $CaCO_3$ and $MgCO_3$ (degree of dolomitization) we attempted to determine the susceptibility of individual samples of rocks to karst corrosion process. In most cases it is "pure limestone", in three cases it is "slightly dolomitic" limestone. Since the impurity of dolomite component is not high, its significant impact on karst corrosion process is not expected. Because we were not able to take larger number of samples, our results are only indicative and will need to be complemented by other analyses. Preliminary results suggest that the northern and southern parts of the Jasovská planina Plateau are not so geological different that it would affect different formation of surface karst forms (e.g. dolines).

Key words: karst, karst corrosion process, rock purity, limestone, dolomite, chemical analysis

HIGH RESOLUTION AERIAL MAPPING OF RIVER LANDSCAPE (CASE STUDY OF THE BELÁ RIVER)

JÁN SLÁDEK, MILOŠ RUSNÁK, ANNA KIDOVÁ, MILAN LEHOTSKÝ

Slovak Academy of Sciences, Institute of Geography, Štefánikova 49, 814 73 Bratislava 1, Slovakia, geogslad@savba.sk

The aim of this paper is to introduce preliminary results of high resolution mapping of the Belá River executed in the October of 2015. For obtaining high resolution data we used Remotely Piloted Aircraft System (RPAS). Since last few years the RPASs in hand in hand close range photogrammetry became very popular and useful tool also in the field of geomorphological researches. Fluvial geomorphology is not an exception Geomorphological mapping was realized on 1.4 km long and very dynamic segment of the Belá River near Vavrišovo village. The aim of mapping was to identify river landforms e.g. river bed, banks, bars, channels, benches etc. and its connectivity with floodplain. On the left side of bank is undercut by the river 30 m high landslide. Large amount of sediments are eroded and feeding river system. At this stage was built a "stage 0" for next monitoring of this dynamic segment. We used Hexakopter XL RPAS for data acquisition. Set of more than 1800 aerial pictures taken by Sony NEX 6 camera were inputs for data processing. The result of image processing was point cloud with more than 150 mil points. These points were classified and filtered. The result is a mesh consisted of 30 mil. faces. This mesh was filtered and textured so we could create textured 3D model of river channel and its surrounding. Also a hi-resolution ortophotomosaic was created. Pixel resolution reaches approx. 5 cm. Whole scene was spatially assigned into S-JTSK coordinate system based on 38 GCP (Ground Control Points). GCP were measured by Leica Zeno5 RTK GPS. From final products as orthophotomosaic and dense point cloud we can obtain relevant data for research of river channels, river bed, benches dynamics and succession of vegetation canopy inside river channel, monitoring of landslide, bank erosion and volume changes.

Acknowledgements: The research was supported by Science Grant Agency (VEGA) of the Ministry of Education of the Slovak Republic and the Slovak Academy of Sciences; 02/0020/15.

Key words: RPAS, fluvial geomorphology, close range photogrammetry, the Belá River

DETERMINATS OF GRAINS SIZE COMPOSITION OF MADAS - CONCEPTUAL MODEL

JACEK B. SZMAŃDA

Institute of Geography, Pedagogical University of Cracow, Podchorążych 2, 30-084 Kraków, Poland, jszmanda@up.krakow.pl

It is widely assumed that overbank alluvia (madas) are geological deposits having the physical character of mud. The results of the analysis of grain size composition of the Danube River, the Vistula River, the Drwęca River and the Tążyna River madas. I examined negate this widely adopted understanding. This study shows that the sand fraction is the dominant fraction of madas, rather than fine-grain fractions (silt or clay). Moreover, I proved: (1) The grain size composition of overbank deposits is more varied than channel deposits; (2) Depending on the change of flow conditions on the floodplain surfaces, cobbles, gravels, sands silts and clay grains can accumulate in different proportions; (3) Either the sand fraction or the silt fraction may locally slightly prevail in most alluvia deposited in floodplains.

Based on the analysis of literature and results of my own research I distinguished several factors affecting the particle size composition of madas. Factors can be divided into two groups: factors affecting the flow conditions and factors affecting the characteristic of the source material. In the first group I identified: (1) flood plain morphology - mainly its breadth, decline, and topographical profile diversity, (2) a decrease in flow velocity with increasing distance from the river bank, (3) changes of mineral material transport during the flood flow, (4) land cover and land use type on the floodplain, (5) hydraulic engineering infrastructures. In the latter one I recognised: (1) diversification of weathering mechanisms, common in nature, (2) catchment lithology, (3) land use and land cover of the river catchment.

There are six factors I determined in the conceptual model of determinants of the deposition conditions of the overbank alluvia: (1) Reducing of a flow velocity with increasing distance from the river bank; (2) Variation of the elevation of floodplain caused by morphology and increasing of deposition of alluvia on the floodplains, and consequently, in the higher parts of floodplains accumulated material is coarser; (3) Changes of foresting of river catchments; (4) Changes of slope of a floodplain; (5) Changing width of a floodplain. (6) Change of the flow velocity on the flood plain during a single flood.

Key words: grain size composition analyses, overbank deposits, madas, fluvial sedimentation

INFLUENCE OF WŁOCŁAWEK DAM ON CHANGES OF THE LOWER VISTULA RIVER CHANNEL PATTERN

JACEK B. SZMAŃDA[1], PIOTR J. GIERSZEWSKI[2], MAŁGORZATA LUC[3]

[1] *Institute of Geography, Pedagogical University of Cracow, Podchorążych 2, 30-084 Kraków, Poland, jszmanda@up.krakow.pl*
[2] *Institute of Geography and Spatial Organization, Polish Academy of Sciences, Kopernika 19, 87-100 Toruń, Poland, piotr.gierszewski@geopan.torun.pl*
[3] *Institute of Geography and Spatial Management, Jagiellonian University in Krakow, Gronostajowa 7, 30-387 Kraków, Poland, mluc@gis.geo.uj.edu.pl*

Contemporary multiple-channel fluvial system of the lower Vistula River is an example of a river transportation from a sand-bed single channel - braided river system into a sand-bed multiple channels - anabranching river system. Since the 70th of the last century this transformation has been taking place under the influence of anthropopression caused by the functioning of the Włocławek Dam and reservoir. Two fragments of the valley: ca. 10 km downstream from the dam and another one in 70-80 km upstream from the dam which is in the area of the reservoir backwater, were analysed. Changes of the river channel pattern as well as the types and sizes of inter-channels forms were traced on a series of aerial photographs from the period before the dam construction and 40 years later. Geomorphometric analysis of the channel pattern and the channel and the floodplain forms were carried out with the use of the Brice and Blodgett (1978) methods.

The conclusions of that study are: (1) the number and size of channel forms (central bars) were decreased; (2) sandy bars were transformed to islands; (3) islands increased their surface area by evolving towards the inter-channel areas the number of inter-channel forms (island and inter-channel areas) were declined; (4) the number of inter-channel forms (island and inter-channel areas) were declined; (5) extensive inter-channel areas were turned into the floodplain as a result of the disappearance of side channels; (6) surprisingly, the main channel upstream the dam reduced its width whereas the channel downstream the dam got widened; (7) finally, the multiple-channel fluvial system has been gradually forming, similarly to the anabranching sand-dominated island forming the river system.

The Vistula River channel pattern, under the influence of functioning of the Włocławek Dam are changing from the braided to the anabranching fluvial system.

Reference:

Brice, J. C., Blodgett, J. C. (1978). Counter Measures for Hydraulic Problems at Bridges. 1. Analysis and Assessment. Report No. FHWA-RD-78-162. Fed. Highway Admin., Washington.

Key words: channel pattern analysis, fluvial system evolution, the Włocławek Dam, the Vistula River

HUMANS OR CLIMATE? DEVELOPMENT OF SVRATKA RIVER ALLUVIAL PLAIN DURING HOLOCENE

LENKA VEJROSTOVÁ[1], LENKA LISÁ[2], DAVID PARMA[3], ALEŠ BAJER[4]

[1] *Faculty of Science, Department of Physical Geography and Geoecology, Charles University, Albertov 6, 128 43 Praha 2, Czech Republic, vejrostova.lenka@gmail.com*
[2] *Institute of Geology, Academy of Sciences of the Czech Republic, Rozvojová 269, 165 00 Praha 6, Czech Republic, lisa@gli.cas.cz*
[3] *Archaeological Heritage Institute Brno, Kaloudova 30, 614 00 Brno, Czech Republic, parma@uapp.cz*
[4] *Department of Geology and Pedology, Faculty of Forestry and Wood Technology, Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic, bajer@mendelu.cz*

The Svratka River alluvial plain, including Brno – Přízřenice site, is a very important from geomorphological and archaeological point of view. The environmental archive hidden in the alluvial plain is a key source of archaeological information with enormous interpretative potential. The high sedimentation rates have allowed the preservation of archaeological situations (e.g. buried soil horizons or organic artefacts) with little or no change. On the other hand, these sites are not easy to find and be investigated to a satisfactory extent. Besides the technical predicaments, the research is frequently complicated by difficulties with the site's archaeological interpretation and its chronology. The studied site was continuously and for a long time occupied during the Late Neolithic, the Early Eneolithic, and the Bronze Age (4500–1000 BC), which implies that the site was not flooded for more than 3500 years. This fact may be more likely interpreted as a result of the limited source of alluvial deposits rather than as a consequence of climatic changes that resulted in lower precipitation for such a long period. The dark layer buried under the two metres of alluvial deposits has been described as "dark soil/dark earth" and has signs of a leached, intensely anthropogenically-influenced, Mollisol type of soil. It is definitely neither of wash-out origin nor of flood origin, because of the unsorted sedimentary material. The unsorted material might suggest colluvial formation, but the layers are horizontal and the relatively flat geomorphology of the site excludes colluvial deposition. Regarding the extent of the "dark earth" and longterm-stable development with no signs of flooding, it is highly improbable that this could be an infilling by features of extensive origin. The provenance of its material compares to that of the background lithology, and the lobe-like transition of the dark earth and its underlying layer strongly support the idea of it being an in situ layer that developed on flood sediments thanks to pedogenic processes. The presence of settlement, agricultural and pedological processes has been confirmed by a range of analytical methods.

Key words: floodplain, geoarchaeology, Brno – Přízřenice

HUMAN-INDUCED VARIATION IN THE HYDRAULIC CONDITIONS OF FLOOD FLOWS ALONG A POLISH CARPATHIAN RIVER

BARTŁOMIEJ WYŻGA[1], ARTUR RADECKI-PAWLIK[2], WIKTORIA CZECH[2], PAWEŁ MIKUŚ[1], JOANNA ZAWIEJSKA[3], VIRGINIA RUIZ-VILLANUEVA[4]

[1] *Polish Academy of Sciences, Institute of Nature Conservation, al. Mickiewicza 33, 31-120 Kraków, Poland, wyzga@iop.krakow.pl; mikus@iop.krakow.pl*
[2] *Department of Hydraulics Engineering and Geotechnique, University of Agriculture, al. Mickiewicza 24/28, 30-059 Kraków, Poland, rmradeck@cyf-kr.edu.pl; vviki7@o2.pl*
[3] *Pedagogical University of Cracow, Insitute of Geography, ul. Podchorążych 2, 30-084 Kraków, Poland, zawiejska.joanna@gmail.com*
[4] *dendrolab.ch, University of Bern, Institute of Geological Sciences, Baltzerstrasse 1+3, CH-3012 Bern, Switzerland, virginia.ruiz@dendrolab.ch*

Channelization and channel incision have considerably modified channel morphology of the Czarny Dunajec River, Polish Carpathians, and now it varies from a single-thread, incised or regulated channel to an unmanaged, multi-thread channel. Effects of these distinct channel morphologies on the conditions for flood flows were investigated in a study of 25 cross-sections from the middle river course. Cross-sectional morphology, channel slope and roughness were used as input data for the 1D steady-flow hydraulic modelling performed for discharges with recurrence interval between 1.5 and 50 years. Adjustment of roughness coefficients to obtain the agreement between simulated and observed peak levels of the 2014 flood allowed calibration of the model for particular cross-sections. As a result of differences in flow widths, cross-sectional flow areas and channel slope, flood flows in the three river reaches differ in unit stream power and bed shear stress, with the highest values of the parameters recorded in the incised reach, intermediate values in the channelized reach and the lowest values in the multi-thread reach. The recognised differences in the flow power and in tractive forces exerted on the flow boundary underlie and explain different evolutionary tendencies of particular river reaches during the past decades. Stabilization of river banks in channelized reaches induces a progressive increase in floodplain elevation; sedimentation in the analysed channelized cross-section of the Czarny Dunajec River have reduced its initial flow conveyance by half and elevated water stages at given flood discharges by about 0.7 m during 30 years since the river channelization.

Acknowledgements: This study was completed within the scope of the Research Project DEC-2013/09/B/ST10/00056 financed by the National Science Centre of Poland.

Key words: hydraulic modelling, river channelization, channel incision, overbank deposition, flow conveyance

LOG TRANSPORT AND DEPOSITION IN INCISED, CHANNELIZED AND MULTI-THREAD REACHES OF A WIDE MOUNTAIN RIVER: TRACKING EXPERIMENT DURING A 20-YEAR FLOOD

BARTŁOMIEJ WYŻGA[1, 2], JOANNA ZAWIEJSKA[3], PAWEŁ MIKUŚ[1, 2], VIRGINIA RUIZ-VILLANUEVA[4], WIKTORIA CZECH[5]

[1] *Polish Academy of Sciences, Institute of Nature Conservation, al. Mickiewicza 33, 31-120 Kraków, Poland, wyzga@iop.krakow.pl; mikus@iop.krakow.pl*
[2] *University of Silesia, Faculty of Earth Sciences, ul. Będzińska 60, 41-200 Sosnowiec, Poland*
[3] *Pedagogical University of Cracow, Insitute of Geography, ul. Podchorążych 2, 30-084 Kraków, Poland, zawiejska.joanna@gmail.com*
[4] *dendrolab.ch, University of Bern, Institute of Geological Sciences, Baltzerstrasse 1+3, CH-3012 Bern, Switzerland, virginia.ruiz@dendrolab.ch*
[5] *Department of Hydraulics Engineering and Geotechnique, University of Agriculture, al. Mickiewicza 24/28, 30-059 Kraków, Poland, vviki7@o2.pl*

Tracking of logs tagged with radio transmitters was used to investigate differences in depositional conditions and the length of log displacement during a 20-year flood between channel reaches of different morphology in the Czarny Dunajec River, Polish Carpathians. During the rising limb of the flood, three sets of logs were placed into the river at the beginning of incised, channelized, and multi-thread reaches. The incised, channelized, and multithread reaches retained 12.5 %, 33 %, and 94 % of tagged logs introduced to these reaches respectively. Significant differences in the length of displacement existed between the logs delivered to the river at the three locations, with logs placed into the river at the beginning of the incised reach moving the longest distance and those delivered at the beginning of the multi-thread reach moving the shortest distance before deposition. One-fourth of the logs were deposited in a low-flow channel or on channel margin, one-fifth on the floodplain and more than half on gravel bars. After the flood, river cross sections with deposited logs and a set of cross-sections without any wood deposits were surveyed to collect data for 1-dimensional modelling of hydraulic conditions at the flood peak. The cross sections with deposited logs were typified by significantly greater flow width and flow area, and significantly smaller mean flow depth, mean velocity, mean bed shear stress and unit stream power. The experiment indicated that in a wide mountain river wood can be transported long distances in a narrow, single-thread channel, whereas it is preferentially deposited in a wide, multi-thread channel. The hydraulic modelling provided a physical justification for the observed differences in wood behaviour between the distinct channel morphologies.

Acknowledgements This work was supported by the Polish-Swiss project FLORIST (Flood risk on the northern foothills of the Tatra Mountains, PSPB No. 153/2010).

Key words: large wood, log displacement, radio tracking, hydraulic modelling

GEOMORPHOLOGIA SLOVACA ET BOHEMICA

Volume 16, 2016 — Issue 1

ISSN 1337–6799