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Adapting to Environmental and Social Risk in the Carpathian Mountain Region

Hotel Eger-Park, Eger, Hungary | 15-18 October 2018

BOOK OF ABSTRACTS

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Plenary abstracts

International mountain science and the 2030 Agenda

Jörg Balsiger

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For more than 15 years, the Mountain Research Initiative (MRI) has promoted global change research in mountain regions across borders and disciplines through connection, communication, and collaboration – with a view to supporting pathways towards sustainable mountain development. MRI provides information and services to more than 10,000 people involved in mountain research, management, governmental and non-governmental institutions, and the private sector: it seeks to position mountain matters at the interface between science, policy, and practice. Since 2015, the 2030 Agenda and the Sustainable Development Goals (SDGs) have become a global blueprint to address global challenges and achieve a "better and more sustainable future for all" – but what does this mean for mountain science?

Using illustrations from MRI activities and recent scientific developments, I suggest three key implications. First, the 2030 Agenda's integrated and indivisible character directly relates to the need to reinforce scientific efforts to transcend established boundaries, not only between disciplines but also between highlands and lowlands, between territory and function, and between the meanings of science of, in, and for mountains. Second, the 2030 Agenda's call to localize the SDGs, including through regional and subregional frameworks, highlights the important question of scale and thus the scalar positioning of mountain science and scientific organizing. Third, the 2030 Agenda's transformative ambition should serve to reflect on the role of science in society and societal transformation. I close with some observations relating to the Carpathians.

The potential for social innovation in the revitalisation of Carpathian mountain communities

Bill Slee

James Hutton Institute, SIMRA project, Aberdeen, United Kingdom

Social innovation has been identified as a potentially important means for the revitalisation of remote rural areas where markets are often weak and the public sector at local, regional and national level is confronted by service delivery challenges. It has become the focus for increased research attention, as manifested in the SIMRA project and other major EU projects. But social innovation remains ambiguously defined and perhaps over-used in political rhetoric as an apparent solution to intractable and wicked problems so expectations may have been unreasonably raised. Nonetheless, it is possible to find examples where social innovation is helping to address profound social, economic and environmental challenges in marginal rural areas. Where social innovation is delivering positive outcomes, those outcomes are likely to be contingent on strong social capital at community level. This creates a danger that even greater disparities emerge between communities and that the most disadvantaged communities may slip further behind. Social innovation can be supported by policy means and in some countries, such as Scotland, significant policy infrastructures have been put in place to nurture community empowerment and community asset transfer. Mountain communities have often been places made up of spirited independent people but this may manifest itself in individualism rather than collective activity. Collaborative social innovation may be harder to instigate in places still living in the shadow of state socialism and enforced collectivisation, such as the Carpathians. Nonetheless, the challenged economic situation in many areas, the public good characteristics of the mountain environment, the existence of common pool resources and the limited capacity of the state or markets to deliver sought-after increases in wellbeing for their populations, makes the need for social innovation great and the case for public interventions to help nurture it very strong.

Windstorms and bark beetles – a chance and challenge for managers and conservationists

Jörg Müller

University of Würzburg

Increasing natural disturbances in conifer forests worldwide complicate political decisions about protected area management and beyond. A global overview has shown that post-disturbance removal of trees – the so called salvage logging - is more and more common in protected areas, particular in Europe and Asia. The two main motivations to remove trees in protected areas are timber and pest control. For the latter, bark beetles are the main target groups of such interventions. Investigating the effects of a benign-neglect strategy as well as political motivated salvage logging in Bohemian Forest with two national parks the Bavarian Forest National Park, Germany, and Sumava Nationalpark, Czech Republic, provided new insight in the role of the European spruce bark beetle, windthrows and post-disturbance logging on biodiversity, rare species and community assembly patterns. Overall, bark beetle infestation increased alpha diversity of many taxa. The same was true for red-listed species. Salvage logging of windstorms for bark beetle control consistently reduced richness of wood-depending taxa from lichens, beetles, fungi and birds and changed the natural assemblage pattern. For windblown trees highly attractive for bark beetles the method of debarking was further developed with bark-scratching providing a new method with reduced negative effects on biodiversity, while sufficient reduction of the target bark beetle. Experiments and multispecies approaches including dark diversity revealed new evidence for the complex response of communities to natural and anthropogenic disturbances. In summary the results show that landscape wide outbreaks of the European spruce bark beetle are certainly critical from an economic perspective, but not from a biodiversity and conservation perspective. Therefore, salvage logging must be banned from protected areas, except for relatively limited areas where there is a clear risk to humans or private property.

Traditional ecological knowledge: messages from the IPBES European and Central Asian assessment

Zsolt Molnár

MTA Centre for Ecological Research, Hungary

In 2018 the Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services (IPBES) published its European and Central Asian Regional Assessment [1]. One of the novelties of this assessment is the acknowledgement and efficient inclusion of other knowledge systems. One of these knowledge systems is the so-called Indigenous and Local Knowledge, often also refered to as Traditional Ecological Knowledge [2]. All text in italics in this abstract are quotations from the Summary for Policy Makers of this Regional Assessment.

Indigenous peoples and local communities hold distinct knowledge about nature and its contributions to people that have significant value for many local communities and for the majority of our societies, too. The issue of indigenous peoples in our region is rarely discussed. However, our region is rich in local communities such as (semi-)traditional and long-settled multi-generational farmers and herders. In Central Europe and in the Carpathians, we have a wide range of experiences how local rural communities and their traditional knowledge and traditional land-use practices contribute to the development of our natural and biocultural heritage.

There has been, however, a loss of indigenous and local knowledge about ecosystems and species. Authors of the assessment argue that Seven of nature's contributions to people are known to be declining in Europe and Central Asia, in particular regulating contributions and learning derived from indigenous and local knowledge, and there is a loss of food-related indigenous and local knowledge, too. However, many practices have survived on marginal lands, in protected areas, or as a result of socio-cultural preferences.

Agri-environmental schemes of the European Union may help some to survive. For example, mountain meadows in the Carpathians (examples of the most species rich grasslands on Earth) are mostly abandoned. However, the area under management has been increasing in past decades with the help of targeted subsidies.

Conflicts around conservation has a long history in Europe. A major factor affecting the establishment or successful management of protected areas in Europe and Central Asia relates to the manner in which they navigate local use conflicts arising as a result of protection status and management. Protected area governance and management regimes are often characterized as top-down with low levels or quality of public participation; inflexible responsible authorities and insufficient consideration of the local context; engendering negative public perceptions; and resistance amongst members of local communities.

Regulations introduced to protect such areas often apparently do not consider local world views, or the effects of local practices. This results in the restriction of local people's activities and conflict between locals and the protected area's authority. The adoption of a more integrated, participatory approach to the governance and management of protected areas is suggested as a potential remedy to local use conflicts, particularly in protected areas established in cultural, small-scale, or indigenous landscapes. There is a need for 'hybrid people' who have knowledge of traditional practices and world views, as well as of mainstream nature conservation ideas. Additionally, the introduction of agro-environmental schemes in protected areas can mitigate the loss of traditional management practices and so prevent biodiversity loss accompanying land abandonment. One approach might be

for landscape- and culturally-specific agricultural regulatory frameworks and subsidy systems that include local and traditional knowledge to produce tailored local solutions that respect the strong link between natural and cultural capital.

Authors of the regional assessment conclude that the economic viability of indigenous peoples and local communities can be supported by green tourism, demand for products derived from traditional practices and subsidies for traditional land uses. Agri-environmental schemes, ecological restoration and sustainable approaches to agriculture mitigate some adverse effects of intensive agriculture.

Additionally to the summaries above, in the presentation local case studies on how traditional knowledge and the holders of this knowledge can contribute to the maintenance and development of the cultural landscapes of the Carpathians will be provided.

References:

[1] IPBES, 2018. Regional assessment report on biodiversity and ecosystem services for Europe and Central Asia of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. IPBES secretariat, Bonn, Germany.

[2] Roué M., Molnár Z. (2017) (eds.). Knowing our Land and Resources: Indigenous and local knowledge of biodiversity and ecosystem services in Europe & Central Asia. Knowledges of Nature 9. UNESCO, Paris.

Contributed abstracts

The role of frost processes in erosion of river banks

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River bank retreat is a complex process and its rates depend on many local factors. A significant role in destruction of river banks is ascribed to the processes caused by multigelation (cyclic freezing and thawing). This work aimed to determine the share of frost processes (including the subaerial ones) in the general balance of river bank erosion during one hydrological year. We compared the amounts of bank erosion during the winter half-year (November–April) with the loss of bank material caused by fluvial erosion and mass movements during the summer half-year (May–October). The rate of bank retreat was measured using erosion pins on the alluvial banks of the rivers in the Podhale region (boundary zone between the Central and Outer Carpathians) during the hydrological year 2013/2014.

The study was performed on the Wielki Rogoźnik River and its tributaries in the low-relief part of Podhale within the Orawa Depression (600–650 m a.s.l.) where air temperatures in winter often fall below 0°C. During the winter half-year (November–April), temperatures below 0°C were recorded on 152 days and 89 times these low temperatures persisted for the whole day. Frequent oscillations of temperature around 0°C resulted in cyclical freezing and thawing of the ground. During prolonged periods of strong freeze the ground may become frozen to the depth of 0.8–1.2 m. Snow cover lasts usually 100–110 days and ice on the rivers lasts for 70–100 days. The summer half-year (May–October) sees more than half of the annual precipitation of 600–1200 mm and it is then that the rivers are flooding. The biggest flood on the Wielki Rogoźnik during the study period was in May 2014, when the water level in the river rose by 1.1–2.0 m and the river markedly remodelled its banks. The gradient of the Wielki Rogoźnik over the studied section is gentle — 0.5–0.8‰, and its channel is sinuous with numerous erosional scarps. The river channel is 7–10 m wide on average, and the mean discharge is ca. 1.9 m^3/s. The river banks expose cross-sections of two alluvial terraces, locally with rock basement, elevated 1.5–2 m and 2.5–4 m above the water level. Five study sites were set along the Wielki Rogoźnik and its tributaries. A total of 376 erosion pins in several horizontal rows were inserted. Four sites were situated on undercut banks with various structures with respect to sediment grain size and one site was protected by a high bank against flowing river water. At each site granulometric characteristics of sediments were investigated at the level of row of erosion pins. During the study period we monitored water levels in the Wielki Rogoźnik and Czarny Dunajec rivers at two gauge stations and air temperatures at the nearby station.

The role of mass wasting processes in bank retreat was not considered separately as their activity is usually enhanced by and contributes to the effects of both frost and fluvial action. Measurements results are discussed in reference to oscillations of air temperature near the ground in the cold season and variations in water level in rivers in the course of the hydrological year. Erosion pins were inserted at straight sections of channels, in layers of alluvium differing in grain size (muds, sands or gravels), at various elevations above the river level. Similarity of geological and hydrological conditions in the study sites allowed us to compare the intensity of erosion along their vertical extent on the banks and to interpret with more confidence the differences between layers of alluvium of various grain size. By inserting the erosion pins at various heights within the banks we tried to find which fragments of the banks are eroded most effectively by frost phenomena, fluvial processes and mass movements.

During the winter half-year (November–April) bank retreat was caused mainly by processes related to freezing and thawing of the ground (swelling, creep, downfall), while during the summer half-

year (May–October) fluvial processes and mass movements such as lateral erosion, washing out and sliding predominated. The share of fluvial processes in the total annual amount of bank retreat (71 cm on average) was 4 times greater than that of the frost phenomena. Retreat of the bank surfaces resulting from frost phenomena during the cold half-year was greatest (up to 38 cm) on the upper parts of the banks, those composed of fine-grained alluvium, while fluvial erosion during the summer half-year (exceeding 80 cm) affected mostly the lower parts of the banks, composed of gravels.

Frost processes (including subaerial processes and mass movements) eroded the bank surfaces unevenly. The progress of erosion was greater in the upper rows of erosion pins, placed in less consolidated and finer-grained sediments than in the lower rows, placed in coarser and more consolidated sediments. It may be inferred that finer and less consolidated sediments are more readily eroded during the multigelation periods. This is possibly due to the higher content of mud and clay and to the higher wetness. Less destructive was freezing in layers of sandy gravels. The most dynamic and effective phase of bank erosion took place during thawing of bank surfaces. The bank surface retreats slower in its lower parts, moreover erosion is compensated there periodically by accumulation of scree falling from the upper parts of the banks.

The effects of fluvial erosion are marked on the bank slopes in another way. The greatest loss of bank sediment occurs in the lower rows of erosion pins. Bank retreat in the summer half-year is faster at bank bases. Undercutting of the banks by flowing water usually triggers mass movements on the banks, but fallen sediment is systematically removed downstream. This type of erosion is active only during elevated water stages (up to several times during a summer half-year), though the effects may be several times greater than those of the frost phenomena.

The share of frost phenomena (including subaerial processes and mass movements) in annual balance of erosion on the studied river banks was uneven, both at individual sites and along the vertical sections of the banks. Summing up the mean percentage of the frost and fluvial processes (including subaerial ones and mass movements) at individual sites, we can conclude that fluvial erosion had four times greater (79.7%) share in bank erosion of the Wielki Rogoźnik and its tributaries during the hydrological year 2013/14. This was certainly related to the May flood when the water level reached almost to the upper edge of the banks. The intensity of destructive action of frost depended largely on the grain size of the bank sediments. Total effects of these processes were stronger in fine-grained sediments in the upper parts of the banks. The lower parts, built of gravel, were more intensely eroded by fluvial processes in the summer half-year. Two phases of various intensity were marked in the course of erosion caused by frost phenomena. The first involved freezing of the banks, with the growth of ice in the ground, destruction of the sediment structure and formation of freezing cracks. This phase may be considered as preparatory for dynamic erosion occurring during the thawing in the second phase. Various types of mass movements occurred simultaneously during the second phase: solifluction of sand and gravel, fall of clumps of fine-grained sediments and rolling down of separate rock clasts.

Use of high-water marks and effective discharge calculation to optimize bank protection structures in an incised river channel

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In vertically stable rivers, bankfull flow is considered to be the dominant discharge creating a stable channel form. In deeply incised rivers, no bankfull flow can be identified and increasing flows are associated with increasingly large unit stream power and boundary shear stress. However, for practical reasons such as protection of channel banks from erosion, it is important to know whether a flood magnitude can be identified, for which the combination of flow frequency and discharge results in the highest river's efficiency to transport bedload and perform geomorphic work. This question was explored in the study of the Morávka River in the Moravskoslezské Beskydy Mts, Czech Republic, after a flood in May 2014. Since the mid-20th century, the river in its lowest course degraded its bed by up to 7 m and now is deeply incised into the flysch bedrock [1]. Observations of high-water marks performed shortly after the flood passage allowed us to reconstruct the peak water stage in the deeply incised reach. In turn, in the upstream-located, vertically stable reach, the peak flow of the flood was close to bankfull one. These observations, together with post-flood measurements of cross-sectional river geometry and channel slope and the estimates of channel roughness were used in one-dimensional hydraulic modeling with HEC-RAS software aimed to reconstruct a peak flood discharge in 5 cross-sections in the incised reach and 10 cross-sections in the vertically stable reach. The results indicated somewhat greater discharge values for the vertically stable reach despite the closeness of both reaches and the discrepancy was used to calibrate roughness coefficients for the incised channel. A 25-year long series of daily discharges in the upstream-located gauging station and a regional relationship between discharges of given recurrence intervals and catchment area were then used to determine the flow duration curve for the incised river reach. This flow duration curve together with data characterizing channel geometry and roughness in the incised river cross-sections were used to calculate bedload transport at given flood discharges with the Parker [2] equation developed for gravel-bed rivers. These calculations indicated that in the incised channel of the Morávka, the amounts of bedload transported over a few decades by given discharges increase up to a 10-year flow and then stabilize with a further increase in flood discharges (which, however, occur increasingly rare). As this result indicates stabilization of the work performed by the river despite growing flood magnitudes, it can be used for a cost-effective design of the height of bank reinforcements in the incised channel. In the case of the Morávka, such bank protection structures should reach to the level attained by the 10-year flow, i.e. about 2.5 m above the channel bed.

References:

[1] *Škarpich V., Hradecký J., Dušek R., 2013. Complex transformation of the geomorphic regime of channels in the forefield of the Moravskoslezské Beskydy Mts: case study of the Morávka River (Czech Republic). Catena 111: 25–40.*
[2] *Parker G., 1990. Surface-based bedload transport relation for gravel rivers. J. Hydr. Res. 28: 417–436.*

Hydromorphological changes of a mountain river over the last six decades: case study of the Czarny Dunajec, Polish Carpathians

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During the 20th century multi-thread morphology disappeared in many Polish Carpathian rivers [1] and substituting the former wide, multi-thread channels with narrow and straight, regulated channels has resulted in deterioration of river hydromorfological quality [2]. A spectrum of hydromorphological features that can be compared between the past and contemporary states of a river depends on the period for which the changes are determined and on the methods used to determine hydromorphological characteristics of the river. In this study, we verified the potential for analysis of hydromorphological river changes since the mid-20th century using data from archival aerial photos taken at successive decades. The study was performed for the Czarny Dunajec, a gravel-bed river in the Polish Carpathians that was subjected to considerable human impacts during the second half of the 20th century. In that period most sections of the river in the foreland of the high-mountain Tatra massif were subjected to channelization and intense gravel mining conducted in some river sections has induced deep channel incision. At the same time, expansion of riparian forest occurred along most of the river length.

Aerial photos from 7 dates within the period 1954–2009 were used to determine hydromorfological parameters of the Czarny Dunajec River. The aerial photos were transformed into orthophotos at a uniform scale of 1:10000 and together with contemporary orthophotos were analysed using Arc GIS software. The following parameters characterizing hydromorphological quality of the river were determined: number and width of low-flow channels, occurrence of emerged surfaces (bars, islands) within the active river zone and their proportion in the total river area, occurrence of alluvial, bedrock–alluvial or bedrock channel bed, proportion of reinforced channel banks affecting the possibility of lateral channel migration, presence of weirs interrupting longitudinal river continuity for aquatic biota, land use in the floodplain area and proportion of wooded channel banks. The analyses were conducted for 6 river reaches located between bridges and significant tributaries, the location of which did not change over the six last decades.

In the second half of the 20th century, mean and variation of the width of active river zone decreased considerably in all examined reaches of the Czarny Dunajec The decrease in river width was associated with decreasing proportions of emerged channel forms: lateral and mid-channel bars and islands in the total river width. In most river reaches, mid-channel bars and islands were completely eliminated over the study period. These changes together with the transformation of the multi-thread channel into a single-thread one have resulted in a marked reduction in habitat diversity, leading to a deterioration of hydromorphological quality of the river along most of its length. However, in a reach that had generally avoided human pressures, such negative changes did not occur and the number of low-flow channels and the proportion of islands in the active river zone increased during the study period. During the last six decades the alluvial channel bed in the upper river reaches was transformed into a bedrock one, with the change gradually progressing downstream over that period. This markedly reduced the extent of hyporheic zone which is essential for most river organisms. Construction of weirs in two river reaches and particularly of more than 30 weirs in reach 4 disrupted river continuity for river biota, considerably contributing to the deterioration of the hydromorphological river quality. Stabilization of channel banks along most of

the river length in nearly all study reaches also negatively affected the hydromorphological state of the river. In turn, a proportion of wooded banks in the total bank length and forest cover in the floodplain area increased over the analysed period in all study reaches and both these changes were beneficial for hydromorphological river quality.

Although the analysis focused only on some parameters of hydromorphological river quality, it is evident that changes decreasing this quality in the Czarny Dunajec were dominant over the last six decades. This was reflected in reduced abundance and species richness of fish as well as reduced taxonomic richness of benthic macroinvertebrates in single-thread river reaches. Such changes of the river communities are not surprising as ecological research indicated a clear dependence of the condition of these communities on the complexity of flow pattern in the river. The transformation of the multi-thread channel into a single-thread one thus has led to a reduction in the taxonomic richness of fish and macroinvertebrates. Among the observed hydromorphological changes, only the increase in the proportions of forested floodplain area and wooded river banks positively influenced hydromorphological condition of the river, although the impact of the latter changes on the functioning of the river communities is greater in the reaches lacking human activity or with minor anthropogenic alterations. In the incised and channelized reaches, a possibility of large wood recruitment from eroded forested channel banks is much lower than in the reaches with a naturally formed channel. The study confirmed usefulness of archival aerial photos in reconstructing temporal changes in river hydromorphology. Such an approach allows for analysis of the intermediate number of features between contemporary hydromorphological assessments and investigations based on historical maps or paleohydrological analysis.

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References:

[1] Wyżga B., Zawiejska J., Hajdukiewicz H., 2016. Multi-thread rivers in the Polish Carpathians: Occurrence, decline and possibilities for restoration. Quaternary International 415: 344–356.

[2] Hajdukiewicz H., Wyżga B., Zawiejska J., Amirowicz A., Oglęcki P., Radecki-Pawlik A., 2017. Assessment of river hydromorphological quality for restoration purposes: an example of the application of RHQ method to a Polish Carpathian river. Acta Geophysica 65: 423–440.

Impact of the restoration of a mountain stream on fluvial processes

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Construction of a high check dam on mountain Krzczonówka Stream, Polish Carpathians, in the mid-20th century resulted in a number of detrimental changes to the downstream reach. Entrapment of bed material behind the dam caused long-lasting sediment starvation of the downstream reach leading to channel incision and transformation of the former alluvial channel into a bedrock–alluvial or bedrock channel. High flow capacity of the incised channel was reflected in high values of flow velocity, unit stream power and bed shear stress associated with flood discharges of given recurrence intervals, which prevented in-channel deposition of bed material delivered from the upstream reach. Concentration of flood flows in the incised channel considerably reduced floodwater retention in the floodplain area, hence contributing to rapid downstream passage of flood waves and to an increase in their peak discharges. Finally, hydromorphological quality of the stream was degraded as a result of morphological, sedimentary and hydraulic changes in the downstream reach coupled with the disruption of longitudinal stream continuity for aquatic biota caused by the check dam.

In the early 2010s a restoration projected was initiated to lower the check dam and make the structure passable for fish. To trap the sediment flushed out from above the dam in the incised channel, several boulder ramps were constructed in 2013, before the onset of the works on the check dam. The check dam was lowered in 2014 and when the works were underway, a major flood occurred on the stream, flushing out a considerable amount of sediment from the dam. The sediment was efficiently trapped by the boulder ramps in the downstream reach. Inventories carried out before, during and after the restoration works documented changes that occurred in the downstream reach of the stream. This study aims at investigating how the environmental problems caused by the long-term sediment starvation of the stream were mitigated by the restoration works.

Surveys of channel morphology and physical habitat conditions in the stream were performed prior to restoration activities (2012), after the installation of boulder ramps but with the still existing check dam (2013), during (2014) and after the check-dam lowering (2015). They were done in 10 cross-sections delimited in the downstream reach of the stream. Data about cross-sectional stream morphology, channel slope as well as channel and floodplain roughness were used for one-dimensional hydraulic modelling of flood conditions typifying the stream before (2013) and after (2015) the bed material entrapment by the boulder ramps. The modelling was performed using HEC-RAS software. Hydromorphological quality of the stream was evaluated in 2012 and 2015 using the River Hydromorphological Quality (RHQ) method especially suitable for the assessment of effects of river restoration activities [1].

Deposition of the sediment flushed out from above the lowered check dam caused burying of the boulder ramps on the distance of ca. 1.2 km from the dam, whereas the sediment wave reached 1.6 km from the dam. About 17000 m^3 of bed material were retained in the stream, resulting in re-establishment of alluvial channel bed and an average increase in bed elevation amounting to 0.44 m.

A maximum increase in bed elevation in the surveyed cross-sections equalled 0.8 m at a distance of 470 m from the dam, whereas a maximum increase of the water surface at low flows reached 1 m. Bed aggradation reduced flow capacity of the channel and increased water stages attained at given flood discharges. These changes significantly decreased unit stream power and bed shear stress in the total cross-section and in the channel zone. They also increased the proportion of the total flow conveyed over the floodplain and retention potential of the floodplain, although these effects were largely dependent on the amount of bed aggradation in the study cross-sections.

Hydromorphological assessments performed before the restoration works placed only 1/5 of the evaluated stream cross-sections in good quality class, whereas after the works 4/5 of the cross-sections fell in this class of hydromorphological quality. The improvement in the hydromorphological stream quality mainly reflected changes in bed substrate, erosional and depositional channel features and longitudinal stream connectivity.

Inventories performed before and after the restoration works conducted in the deeply incised Krzczonówka Stream documented effectiveness of boulder ramps in the entrapment of gravel flushed out from above the lowered check dam. With the deposition of the material, the channel bed considerably aggraded and changed from bedrock to alluvial one. The bed aggradation changed hydraulic conditions of flood flows, reducing flow velocity and shear forces within the channel and increasing floodwater retention in the floodplain area. Hydromorphological quality of the stream improved, with 3/5 of the evaluated cross-sections upgraded from moderate to good quality class.

References:

[1] Hajdukiewicz H., Wyżga B., Zawiejska J., Amirowicz A., Oglęcki P., Radecki-Pawlik A., 2017. Assessment of river hydromorphological quality for restoration purposes: an example of the application of RHQ method to a Polish Carpathian river. Acta Geophysica 65: 423–440.

[2] Wyżga B., 1999. Estimating mean flow velocity in channel and floodplain areas and its use for explaining the pattern of overbank deposition and floodplain retention. Geomorphology 28: 281–297.

[3] Czech W., Radecki-Pawlik A., Wyżga B., Hajdukiewicz H., 2016. Modelling the flooding capacity of a Polish Carpathian river: A comparison of constrained and free channel conditions. Geomorphology 272: 32–42.

Island development in a mountain river subjected to restoration: the Raba River, Polish Carpathians

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Investigations of islands in an undisturbed reach of the Czarny Dunajec River in the Polish Carpathians indicated that islands are very dynamic landforms and greatly contribute to the overall plant diversity of the river corridor [1]. This was the basis of the hypothesis that re-establishment of islands may be an important factor in the restoration of hydromorphologically degraded mountain rivers. This hypothesis was verified in a study of the Raba River, Polish Carpathians. In the 20th century the Raba was heavily channelized and incised deeply in its mountain course [2], but about 10 years ago an erodible river corridor was established in its 2.5 km-long reach. Resignation from the maintenance of channelization structures and the passage of two large floods in 2010 and 2014 resulted in up to threefold increase in channel width, re-establishment of a multi-thread channel pattern and development of islands in the river reach in the erodible corridor.

Morphometric parameters and species composition of islands in the freely developing river reach were monitored every year between 2011 and 2017. Islands were divided into pioneer and building islands depending on their age; established islands were absent. Island perimeter and area were measured with Trimble R4 GPS receiver using RTK satellite navigation. Standard dendrochronological dating was applied to determine the age of particular islands. An inventory of vascular plant species on the islands was carried out in the middle of each summer. In some years, plant species were also surveyed on 10 plots of riparian forest adjacent to the channel in the reach. Plant species were classified into different life-form categories: annual plants, biennial plants, perennial herbaceous plants, shrubs and trees. Regression analysis was performed to test the statistical significance of hypothesized relations between the number of plant species on individual islands and morphometric parameters and age of the islands. Statistical significance of differences between the total number of plant species as well as the number of species from particular life-forms on pioneer and building islands and plots of riparian forest was determined with a Kruskal-Wallis test. In order to reveal hydraulic conditions of flood flows underlying development of islands within the erodible corridor, hydraulic modelling was performed with one-dimensional HEC-RAS software. River morphology in 8 freely developing river cross-sections with islands and 8 river cross-sections in adjacent channelized river reaches was surveyed with a level. Data about cross-sectional river morphology, channel slope and roughness of particular parts of river cross-sections were used as input data to the hydraulic modelling.

Observations indicated that the formation of pioneer islands in the freely developing river reach is connected to the occurrence of major flood events, but evolution and expansion of already existing islands takes place also during the years with low and medium flood flows. Pioneer islands originate as a result of vegetative regeneration of living driftwood. Before the start of our investigations, numerous large wood accumulations were deposited on gravel bars in the reach during a large flood in 2010, giving rise to many pioneer islands. A generally stable pattern of bars and low-flow channels in the reach during the next 3 years allowed the survival of these initial islands; during that period, the number, total area and species diversity of the islands increased significantly. This development of islands was the effect of germination of seeds of herbaceous plants in the hydraulic shadow of existing islands as well as of re-

sprouting of willow and poplar driftwood deposited by smaller floods. In 2013 a rapid growth of *Alnus incana* seedlings took place around the oldest building island, leading to a considerable increase in its area. However, these young seedlings were completely destroyed by a large flood in 2014. This flood delivered to the reach much living willow, poplar and alder driftwood, the re-sprouting of which resulted in the development of numerous new islands.

Between 2011 and 2017 the number of islands in the studied river reach increased from 28 to 50, average island age from 2.8 to 5.9 years, total island area from 0.3 ha to 4.5 ha and average island area from 139 m^2 to 893 m^2. However, the increases in these parameters were not steady but moderated by processes of island erosion by flood flows, island establishment shortly after major floods (increasing the number and reducing the average age and area of islands) and island coalescence in the years without major floods (with the opposite effects on the island parameters). Deposition of numerous small fragments of Salicaceae along low-flow channel margins has led to the development of many narrow, elongated islands of uniform age structure. Proximity to water table creates favourable conditions for the growth of herbaceous plants on these islands, but their species diversity is low.

The total number of vascular plant species on islands fluctuated in the years 2011-2017 between 142 and 202. An inventory of plant species performed on islands and plots of riparian forest indicated that islands supported similar total numbers of plants species to the riparian forest and that particular islands supported a significantly greater number of biennial and annual plants than riparian forest plots.

Hydraulic modelling of flood flows indicated the values of mean water depth, flow velocity, unit stream power and bed shear stress in the freely developing reach to be significantly lower than in the adjacent narrow, channelized reaches. Such hydraulic conditions of flood flows in the erodible river corridor promote deposition of living driftwood on gravel bars, initiating island development, and reduce the probability of erosion of existing islands.

Observations in the Raba River confirmed the previous findings from the Czarny Dunajec that in a highly dynamic mountain river, islands originate as a result of deposition and re-sprouting of living driftwood of Salicaceae. Hydraulic conditions of flood flows in the widened reach within the erodible river corridor facilitate inception and preservation of islands. Our results suggest that in early phases of island re-establishment in a mountain river, when the availability of propagules dispersed by hydrochory is limited, the contribution of islands to the overall species richness of the riparian corridor can be highly variable depending on hydrological conditions and the state of islands in a given year.

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References:

[1] Mikuś P., Wyżga B., Kaczka R.J., Walusiak E., Zawiejska J., 2013. Islands in a European mountain river: Linkages with large wood deposition, flood flows and plant diversity. Geomorphology 202: 115–127.

[2] Wyżga B., 2008. A review on channel incision in the Polish Carpathian rivers during the 20th century. In: Habersack H, Piégay H, Rinaldi M (Eds.), Gravel-bed Rivers VI: From Process Understanding to River Restoration. Elsevier, Amsterdam, pp. 525–555.

Spatial and temporal variation of ground beetle communities in a passively restored mountain river: the Raba River, Polish Carpathians

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In recent years, increasing recognition of the concept of erodible corridor among river managers in southern Poland has led to its first applications in the rivers of the region. Abandonment of maintenance of bank reinforcements in the upper Raba River, Polish Carpathians, enabled its recovery promoted by the passage of two moderately large floods in 2010 and 2014. Our study of the effects of the passive river restoration on the composition and diversity of ground beetle assemblages indicated that ground beetles were significantly more abundant and richer in species in unmanaged (UN) than in channelized (CH) cross-sections, but no significant differences in carabid diversity indices between the two cross-section types were recorded [1]. Here, we aim to identify the most important environmental variables determining the distribution of ground beetles in the study cross-sections. So far, the effects of restoration projects have been evaluated by exploring differences between UN and CH cross-sections without looking into the variability among particular sampling sites located within such cross-sections [1, 2]. In consequence, the question remains as to the environmental variables of microhabitats, which are most responsible for the occurrence patterns of riparian carabids in the restored river. It is likely that some environmental variables responsible for species occurrence may have been overlooked in river restoration strategies, because they were simply not recorded or used as qualitative data with high generalization. In addition, ground beetles were usually sampled only once or over a short time interval (e.g., one week in summer) [2, 3], which means that temporal changes in species occurrence and their impact on the conclusion about restoration success could not have been correctly assessed. Therefore, exploring the effect of phenological season on the abundance and richness of carabid beetles of the Raba River subjected to restoration was the second aim of the present study.

We surveyed 12 cross-sections, with 6 cross-sections located in the unmanaged reaches and 6 in the channelized reaches. In each cross-section, 12 sampling sites of 1 m^2 each were selected. Thus, a total of 144 sites were sampled and characterized by surface slope, the distance from and the height above the nearest low-flow channel, the presence/absence of actively eroded cutbank(s), sediment size class and the degree of plant cover. Additionally, bankfull channel width was determined for each cross-section. The environmental variables were determined only once as no flood occurred between sampling campaigns of ground beetles. Ground beetles were sampled three times during low-flow conditions: in spring (mid-May), summer (turn of June and July) and autumn (turn of September and October) of 2015 to avoid missing those species which are periodically absent because of their phenology and/or breeding type. Ground beetle assemblages at given sites were described using the number of collected species, the number of individuals and the following diversity indices: the Margalef richness index, the Berger–Parker dominance index and the Shannon–Wiener diversity index.

A principal component analysis (PCA) of environmental variables indicated three main gradients of the variables among the sampling sites. The first axis of the PCA explained 28% of the total variation in habitat characteristics and correlated positively with surface slope (r = 0.83) and the number of

cutbanks (r = 0.89). The second axis explained 23% of the total variance and correlated positively with the distance of sites from the nearest low-flow channel (r = 0.75) and their height above low-flow water level (r = 0.73).

A stepwise forward selection of the environmental variables in the partial redundancy analysis indicated the number of cutbanks and the site height above the nearest low-flow channel as significant variables (p = 0.002) explaining the variation in the abundance and species richness of ground beetles among the sampling sites. The first ordination axis explained 34.4% of variance of the dependent variables and 97.4% of variance of the relationship between the species richness and abundance of ground beetles in particular sites and environmental variables. The second ordination axis explained below 1% of the variation in the dependent variables, but 2.6% of their relationship with environmental variables.

Altogether, 3997 individuals representing 79 species were collected. *Bembidion decorum* (26%) and *Bembidion varicolor* (18%) constituted 44% of the total number of individuals. However, these two species represented 20.2%, 39.8% and 60.4% of all individuals collected in spring, summer and autumn, respectively. *Nebria picicornis*, a large specialist of mountain rivers, represented 15.4% of all individuals collected in May but was almost absent in the other seasons. Nineteen species were recorded with only one individual. In general, 45% of the total number of collected species were absent in summer. The change in the composition of beetle assemblages in different sampling seasons substantially affected the results of comparison between UN and CH cross-sections. In spring beetle abundance (Mann–Whitney test; p = 0.02) and richness (p = 0.025) were significantly higher in the UN cross-sections than in the CH cross-sections and significant differences in the Shannon–Wiener (p = 0.013) and the Berger–Parker (p = 0.013) indices were found. In contrast, no significant differences in any of the determined biotic metrics between the two cross-section types were recorded in summer (p > 0.2), whereas in autumn the only significant difference was found for the number of individuals (p = 0.013). When the ground beetles collected during the three seasons at all sites of a given cross-section were combined into one sample, UN cross-sections were richer in beetle species (p = 0.037) and hosted more individuals (p = 0.013) than CH cross-sections, but no significant differences in any of the three diversity indices between the two cross-section types were recorded.

This study demonstrated that the variation in the abundance and species richness of ground beetles among the study sites was mainly driven by the presence/absence of actively eroded cutbanks and differences in the site height above the nearest low-flow channel. Moreover, only surveys encompassing the whole period of beetle activity provide a sufficiently complete picture of differences between channelized and restored river cross-sections. Sampling beetles only once by exposing traps for a week in summer, as it was done in many previous studies [2, 3], may substantially affect conclusions about the effectiveness of river restoration activities.

References:

[1] Bednarska A.J., Wyżga B., Mikuś P., Kędzior R., 2018. Ground beetle communities in a mountain river subjected to restoration: The Raba River, Polish Carpathians. Sci. Total Environ. 610–611: 1180–1192.

[2] Jähnig S.C., Brunzel S,. Gacek S., Lorenz A.W., Hering D., 2009. Effects of re-braiding measures on hydromorphology, floodplain vegetation, ground beetles and benthic invertebrates in mountain rivers. J. Appl. Ecol. 46: 406–416.

[3] Januschke K., Brunzel S., Haase P., Hering D., 2011. Effects of stream restorations on riparian mesohabitats, vegetation and carabid beetles. Biodivers. Conserv. 20: 3147–3164.

Glacial cirques in the Romanian Carpathians and their climatic implications

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This presentation summarizes a morphometric analysis of glacial cirques from the Romanian Carpathians, further inferring climatic information from spatial patterns of morphometric traits. Results derived from the detailed statistical analysis of a comprehensive database of glacial cirques are presented briefly. The distribution of cirques by altitude, aspect, size, classification (cirque grade) and geology is presented and related to controlling factors. New contributions concerning the palaeoglaciation level during Late Pleistocene in the Romanian Carpathians, and the direction of prevailing winds during glaciation are provided. Statistical distributions of cirque size and shape are outlined and illustrated. A comprehensive data base of all glacial cirques in the Romanian Carpathians is now available to guide or substantiate further comparative or/and interdisciplinary studies. It is also possible to rank the mountain ranges by the degree of glacial modification.

Impact of prospective climate changes on future distribution of ecoclimate belts in Ukrainian Carpathians

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Prospective climate changes is an urgent environmental problem for mountainous areas leading to potential significant shifts of bioclimatic belts and ensuing ecosystems extent, natural habitats, and conditions for various economic and social activities. Correct predictions of major effects of climate changes and the risks for biodiversity, human society and economy are a prerequisite for appropriate adaptation measures to climate changes. Ukrainian Carpathians already experience a set of urgent environmental issues resulting from present and former mismanagement of land and natural resources. Thus, proper efforts for adaptation to climate changes should come hand in hand with solving current issues like illegal logging and poaching and lack of proper consideration for environment protection from development projects.

Prediction of the effects of climate changes is a complicated task that involves several steps each of which entails its own uncertainty. There are a set of different global climate models giving projections for different emission scenarios, each of the latter reflecting a certain mode of global society behavior towards carbon sustainability. The projections from these models are rather coarse–scaled, thus they should be downscaled to reflect regional and local spatial variability due to terrain and land cover features. Downscaling coarse climate surfaces is a complex problem by itself. Lastly, relationships between climatic characteristics and their ecological responses like biome and habitat boundaries are far from simple.

While current climatic characteristics of Carpathian region are studied rather well and have been mapped recently in the form of moderate-resolution gridded database [3], their future changes and impacts on ecological conditions remain mostly obscure. To project future climatic conditions for Ukrainian Carpathians, WorldClim database has been used as an information source for coarse-scale climate variation [1]. It provides free-access 1 km-scale global surfaces of a set of "bioclimatic" variables, characterizing various aspects of thermal and precipitation regime. Climatic surfaces can be downscaled by taking into consideration dependencies between climatic characteristics and terrain parameters like aspect and convexity/concavity, which can be derived from analysis of digital elevation models (DEM) [2]. The prospective climatic surfaces for middle-XXI c. have been derived in this manner from WorldClim data and SRTM DEM. While predictions of future precipitation remain rather unreliable, only variables that characterize temperature levels and annual variation has been considered.

Three major ecoclimate belts has been distinguished in Ukrainian Carpathians and their spatial distribution has been compared with the distribution of the bioclimatic variables for 1960-1990 period. Statistical modeling allowed to determine the degree and the form of relationships between the former and the latter. The derived statistical model has been then used to predict the future distribution of ecoclimate belts, accounting for the uncertainty present in the models.

Consideration should also be given to the impact of climate changes on human well-being and socioeconomic activities. Rising temperatures will certainly be detrimental to winter sports, while at the same time facilitating some agricultural land uses like viticulture, probably increasing their spatial extent. Precipitation changes that are hard to predict can be critical for agriculture as well as for the spatial distribution of species habitats and ecosystems.

References:

[1] Hijmans R. J., Cameron S. E., Parra J. L., Jones P.G. and Jarvis A., 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25: 1965-1978.

[2] Mkrtchian A., 2016. Annual precipitation data proccessing and interpolation for the weather stations of Western Ukraine. In: Proceedings of GeoMLA, Geostatistics and Machine Learning, Application in Climate and Environmental Sciences (21–24 June 2016), Belgrade, Serbia, pp. 61–66.

[3] Spinoni J., Szalai S., Szentimrey T., Lakatos M., Bihari Z. et al., 2015. Climate of the Carpathian Region in the period 1961–2010. Climatologies and trends of 10 variables. Int. J. Climatol. 35: 1322–1341.

Climate change and air pollution effects on forest ecosystems status located in Southern Carpathians - Romania

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The research carried out in the Retezat and Bucegi-Piatra Craiului mountain forests (Southern Carpathians) provides scientific support for Romanian long-term ecosystems research (LTER) and is of multi- and transdisciplinary nature. It includes monitoring and evaluation of forests ecosystems status under air pollution and climate change effects [1]. During the last period 2009-2017, forests in the Retezat LTER site were moderately affected by excessive drought, high temperatures, air pollution and other natural stress factors, resulting in 12.1 – 11.6% of trees as damaged (crown defoliation greater than 25%). In Bucegi - Piatra Craiului LTER site the percentage of damaged trees decreased from 22.5% (2009) to 16.2% (2017). European beech (*Fagus sylvatica*) was the least affected species, with 8.0-10.6% of trees in defoliation classes 2-4 in Retezat and 9.8 % (2009)- 10.9% (2017) in Bucegi - Piatra Craiului site, while Norway spruce (*Picea abies*) were more stressed both in Retezat (12.9 – 12.6%) and Bucegi - Piatra Craiului (27.7 – 18.4%), Mountains. Also, results emphasize that in Romanian Carpathians LTER forest sites there is not a significant influence of climate change and air pollution on forest ecosystem status. Volume growth of forests is correlated with mean defoliation percentage recording a decreasing while crown defoliation increase. In Romanian Carpathians LTER forest sites forest health status is not significantly affected by climate change and air pollution [2]. Volume growth of forests is correlated with mean defoliation percentage recording a decreasing while crown defoliation increase. Phytotoxic pollutants (O3, NO2, NH3) recorded low concentrations and once again was noticed that, during the study period, in Retezat LTER site, ozone recorded the lowest values at the south Carpathians level. At mean levels higher than 40 ppb, in Bucegi NP, ozone positively correlates with mean defoliation, indicating a possible negative effect on forests health status in that region. For other pollutants, although significant positive/negative correlations appear, their levels are too low to have a real influence on forest health status. Positive values of net throughfall, especially for Sulphur anions, show the important filtering role that the Carpathian forests have.

High diversity and evenness specific to the stand type's structures and local climate conditions were observed within the herbaceous layer, indicating that biodiversity of the vascular plant communities was not compromised.

***Keywords**: climate change, air pollution, Sothern Carpathians, ILTER, crown defoliation, forest ecosystem status*

References:

[1] Badea, O., 2013. Long-term ecological researches on representative forest ecosistems of Bucegi Natural Park, Editura Silvică, ISBN 978-606-8020-34-1, 200p
[2] Bytnerowicz A, Badea, O., Popescu F, et al. 2005. Air pollution, precipitation chemistry and forest health in the Retezat Mountains, Southern Carpathians, Romania. Environmental Pollution, 137 (3): 546-567pp.

Assessing the impact of climate change on forest growth

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It is very likely that the growing conditions of forests become less favourable in the Central European region due to climate change [1]. Increasing frequency and duration of heat and drought stresses will constrain yield potentials of industrially important species [2]. For this reason a statistical evaluation of the growth of main stand forming species in Hungary was made involving climate and site variables. According to the work hypothesis that growth of trees depends on climate and other site factors e.g.: soils [3], there must be a statistically significant relationship between properly chosen site factors and yield classes of forest stands. Taking into account yield potential of all individual forest stands in the country with their corresponding site characteristics (bioclimatic and soil) it should be possible to compile limited empirical models for medium term yield predictions. The study involved more than 100 000 geo-referenced species records from the national forestry database. The presented process focused on the data of unmixed stands of 3 main stand forming species. Climate variables were represented by the Climate EU database using different time windows [4]. The period of 1961-1990 was considered as the reference period. Recent period was regarded as the years between 1981 and 2009. Finally, future climate conditions were represented by the RCP 4.5 scenario based climate models for the period of 2041-2070. Soil and site data were added to the database from the most recent spatial soil database of Hungary [5]. Stochastic models were built using random forest classifiers to predict yield classes of forests on the basis of soil and bioclimatic variables for the reference period. The results of the models for the recent period were tested on permanent yield monitoring plots and it was found that predictions' accuracies reached a relatively high 65-88% depending on species. Models were run using future climate datasets for the period of 2041-2070 in order to assess changes in future yield potentials of forests. Results showed that models reacted in different ways according to species and regions, which corresponds well to the results of similar studies [6]. However, irrespective of the species it was found that West Hungary would remain the most suitable region for forest management while lowland and other forested regions showed significant drop in yield potentials according to the results.

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References:

[1] Mátyás Cs., Sun G. 2014. Forests in a water limited world under climate change. Environ Res Lett 9:085001. doi: 10.1088/1748-9326/9/8/085001

[2] Jump AS, Hunt JM, Peñuelas J. 2006. Rapid climate change-related growth decline at the southern range edge of Fagus sylvatica. Glob Chang Biol. doi: 10.1111/j.1365-2486.2006.01250.x

[3] Skovsgaard, J. P. & Vanclay, J. K. 2008. Forest site productivity: a review of the evolution of dendrometric concepts for even-aged stands. Forestry: An International Journal of Forest Research, Volume 81, Issue 1, 1 January 2008, Pages 13–31, https://doi.org/10.1093/forestry/cpm041

[4] Hamann A, Wang T, Spittlehouse DL, Murdock TQ 2013. A comprehensive, high-resolution database of historical and projected climate surfaces for western North America. Bull Am Meteorol Soc 94:1307–1309. doi: 10.1175/BAMS-D-12-00145.1

[5] Pásztor L, Laborczi A, Bakacsi Z, et al 2018. Compilation of a national soil-type map for Hungary by sequential classification methods. Geoderma. doi: 10.1016/j.geoderma.2017.04.018

[6] Nothdurft A, Wolf T, Ringeler A, et al 2012. Spatio-temporal prediction of site index based on forest inventories and climate change scenarios. For Ecol Manage 279:97–111. doi: 10.1016/j.foreco.2012.05.018

Large-scale growth patterns in primary *Picea abies* forests imply increasing drought sensitivity along the Carpathian arc

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Tree growth responses to climate variability modulate an important feedback between atmospheric carbon concentrations and terrestrial carbon sequestration. Tree-ring studies, especially in climate-sensitive high-altitude forests, have informed much of our understanding in climate driven growth patterns, but typically do not integrate whole-population growth variability along environmental gradients, limiting our able to anticipate the global change responses of biogeographic regions. We analysed spatiotemporal patterns in growth-climate associations in 10 thousand tree core, distributed among 520 forest inventory plots, nested within 36 primary forest stands, distributed among four different sub-regions along the Carpathian mountain range (Slovakia, Ukraine, Northern Romanian and Southern Romania). Ordination analysis indicated that a prominent macroclimatic signal was present throughout the whole region. A secondary component (11%) was linked almost entirely to latitude (R^2 = 0.88). Pronounced latitudinal and altitudinal variability was detected in climatic drivers of growth. Correlation function analysis for the entire region indicated that June-July temperatures are the leading constraint on ring width, following by temperature of the preceding October and monthly precipitation during December, January and March. Repeating the analysis for each subregion demonstrated that southern most sites had the lowest sensitivity to growing season temperature and uniquely exhibited a negative response to August-September temperatures and positive response to August precipitation. Temporal analysis of correlation functions and ring-width synchrony indicated that higher precipitation variability in the 20th century appears to be promoting increased synchrony and thus higher climatic regulation of large-scale growth. We encountered geographic variation in temperature vs. moisture limitation of growth rates, indicating the potential divergence among northern and southern subregions in climate change response. However, increasing temperatures appear to be amplifying drought susceptibility throughout the region.

Increased sensitivity to drought across successional stages in natural Norway spruce (*Picea abies* L.) forests of the Calimani Mountains

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Droughts are predicted to become more frequent and hotter, and they may become lethal under warming conditions [1]. The considerable influence of climate change on natural disturbance regimes in forests has been recognized for the past two centuries [2] and an increase in their frequency and severity is expected [3]. To understand the possible consequences of climate change on future forest growth, it is necessary to characterize current and past drought-growth relationships.

Ongoing climate change has yielded increasing temperatures and changes in precipitation regimes [4]. In a warmer world, intensification of the hydrologic cycle is expected [5]. A simple climatic water balance can be represented by the standardized precipitation evapotranspiration index (SPEI) [6], which uses monthly differences between precipitation and potential evapotranspiration. When considering climate sensitivity, identifying periods of tree suppression related to natural dynamics is critical to distinguish the climate signal and noise from disturbances [7]. Forest structure is governed by disturbance regime [8], and directly influences the potential water retention capacity of a forest. After canopy removal, changes in water balance may range from short term soil moisture and river discharge alterations to long-term shifts in ground water.

We focused on drought-growth relationship of Norway spruce (*Picea abies* L.) in the Calimani National Park in the Romanian Carpathians. Stand structure of these forests is determined by a natural mixed severity disturbance regime, with windstorms and bark beetle outbreaks as the primary disturbance agents [9]. We examined whether structural reorganization after natural disturbances alter the forest growth-drought sensitivity of Norway spruce in the Eastern Carpathians of Romania. We used two SPEI indices (3- and 12-month timespans) to study the short and long term drought impacts in period 1903 – 2010. The observational period was split into two periods of equal length. To investigate the growth response of Norway spruce to drought in each period along successional stages, we applied a bootstrap static correlation function between ring width index (RWI) and drought indices. We then selected the monthly indices to which tree growth responded significantly and carried out a closer investigation with a moving. We observed a shift in the drought-growth seasonality between the periods 1903-1956 and 1957-2010. The positive response to moisture conditions at the beginning of the vegetation period, from March to May, was replaced by the positive response to the amount of water stored before growth beginning, from the previous November to April. Above that, we observed a clear effect of increased growth to high winter precipitation at the end of the twentieth century. The observed increased sensitivity to water stored during the winter at the end of the twentieth century occurred in all studied successional stages independent of stand structure. This finding in a landscape shaped by a mixed severity natural disturbance regime implies that drought stress initiated by a changing climate and an accompanying increase in vegetation period length is likely not manageable through thinning or other forest structure changes, thus it seems unlikely that the impacts of climate change cannot be mitigated at

the stand level. Our results show that with the further increasing temperatures [4], a prolonged vegetation period, and shifts in snow melting periods, drought sensitivity of the Norway spruce might occur in mountain areas across forest structures variety.

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References:

[1] Allen, C. D., Breshears, D. D., & McDowell, N. G. (2015). On underestimation of global vulnerability to tree mortality and forest die-off from hotter drought in the Anthropocene. Ecosphere, 6, 1–55.

[2] Schelhaas, M.J., Nabuurs, G.J. and Schuck, A., 2003. Natural disturbances in the European forests in the 19th and 20th centuries. Global Change Biology, 9(11), pp.1620-1633.

[3] Seidl, R., Thom, D., Kautz, M., Martin-Benito, D., Peltoniemi, M., Vacchiano, G., Wild, J., Ascoli, D., Petr, M., Honkaniemi, J. and Lexer, M.J., 2017. Forest disturbances under climate change. Nature climate change, 7(6), p.395

[4] IPCC, 2013. Summary for policymakers. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth assessment report of the intergovernmental panel on climate change.

[5] Dore, M.H., 2005. Climate change and changes in global precipitation patterns: what do we know?. Environment international, 31(8), pp.1167-1181.

[6] Vicente-Serrano, S.M., Beguería, S., López-Moreno, J.I., Angulo, M. and El Kenawy, A., 2010. A new global 0.5 gridded dataset (1901–2006) of a multiscalar drought index: comparison with current drought index datasets based on the Palmer Drought Severity Index. Journal of Hydrometeorology, 11(4), pp.1033-1043.

[7] Rydval, M., Druckenbrod, D.L., Svoboda, M., Trotsiuk, V., Janda, P., Mikoláš, M., Čada, V., Bače, R., Teodosiu, M. and Wilson, R (in press). Influence of sampling and disturbance history on climatic sensitivity of temperature limited conifers. Agricultural and Forest Meteorology.

[8] Frelich, L.E. and Lorimer, C.G., 1991. Natural disturbance regimes in hemlock-hardwood forests of the upper Great Lakes region. Ecological monographs, 61(2), pp.145-164.

[9] Svoboda, M., Janda, P., Bače, R., Fraver, S., Nagel, T.A., Rejzek, J., Mikoláš, M., Douda, J., Boublík, K., Šamonil, P., Čada, V., Trotsiuk, V., Teodosiu, M., Bouriaud, O., Biris, A.I., Sýkora, O., Uzel, P., Zelenka, J., Sedlák, V., Lehejček, J., 2013. Landscape-level variability in historical disturbance in primary Picea abies mountain forests of the Eastern Carpathians, Romania. Journal of Vegetation Science. 25, 386–401.

Long-term variability of air temperature and precipitation conditions in the Polish Carpathians

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Mountain regions are sensitive to climate changes, which makes them good indicators of climate change. Several studies have confirmed the recent warming of mountain regions at a rate of approximately three times the global average. This increase has been particularly pronounced since the 1980s and at different vertical zones, but with regionally differentiated intensity.

The aim of this study is to investigate the spatial and temporal variability of air temperature and precipitation in the Polish Carpathians. Analyses were conducted for two key study periods, the historical period of 1851-2010 and future projections of 2021-2100. The climatological standard period 1961-1990 was determined as a reference period. To obtain monthly temperature and precipitation data for the period 1851-2010, three main data sources were incorporated: 1) the CARPATCLIM gridded database (1961-2010) with a spatial resolution of 0.1°, 2) gridded temperature by Luterbacher and Xoplaki (1850-1998) and precipitation by Pauling et al (1851-1998), both with a 0.5° spatial, and 3) in-situ measurements obtained from the Krakow meteorological station (1851-2010). Future climate projections were calculated for two greenhouse gas concentration trajectories (Representative Concentration Pathways), RCP 4.5 and RCP 8.5. The monthly mean temperature and precipitation data for the period 2021-2100 at a spatial resolution of 0.11° were obtained from the EURO-CORDEX database for five different GCM-RCM model chains.

The results [1] confirm that the noticeable year-to-year precipitation variability has no statistical significance for the entire period under consideration but that there has been significant warming of the area and that this warming has been particularly pronounced over the last few decades and will continue in the oncoming years. The spatial trend of warming intensity increasing with altitude is observed in summer months (JJA). However its magnitude, due to atmospheric instability over the mountains, is modest. In winter, characterized by more significant warming over the whole region, the foothills experience and are projected to be afflicted with a more intense temperature increase. Although climate change is most evident in the foothills, these are the highest summits which have experienced the most intensive increases in temperature during the recent period. The distinct spatial and temporal temperature trend differences between distinguished vertical zones prove that there is sensitivity to temperature changes at high elevations in the Polish Carpathians, which is also confirmed by the upward shift in borderlines, a trend that is reflective of general European long-term temperature variability patterns in mountainous areas. The distribution of the annual temperature contour lines modelled for selected periods provides evidence of the upward shift of vertical climate zones in the Polish Carpathians, which reach approximately 350 meters, on average.

The present study proves that the Western Carpathian region has been warming faster than the global or hemispheric averages; however, it must be noted that the magnitude of these changes, as well as their additional environmental impact, is seasonally and elevation dependent. The proven upward shift in climatic vertical zones suggests that in the forthcoming time-periods, one can expect temperature-driven changes in the environmental structure. However, since the humidity conditions, as expressed by the precipitation amount, are trendless and highly spatially differentiated, increasing temperature will drive more intense evaporation and might ultimately

cause moisture failure. Since the expected feedbacks are mostly connected to the growing season, the possible expansion of thermophilic species might only result in a reduction of hydrophobes.

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References:

[1] Wypych A., Ustrnul Z., Schmatz D.R., 2018, Long-term variability of air temperature and precipitation conditions in the Polish Carpathians. Journal of Mountain Science, 15(2), 237-253.

The effect of spruce stands decay on spring water chemical properties in the Skrzyczne Range in the Silesian Beskid Mountains

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The spruce stands decay in the Silesian Beskid Mountains including the Skrzyczne Range has been spreading since the 1990s. As a result, clearcuts were performed on the immense areas of mountain slopes in the last decade, which initiated a number of changes in the local ecosystems. The aim of the study was to recognize the effect of plant cover changes (clearcuts, forest crops establishment) on spring water chemical properties. The study covered sampling of spring waters during different water conditions in 2009, 2011 and 2012 from springs affected by deforestation and located in not deforested areas. A total of 751 spring water samples were analyzed for: temperature, conductivity, pH, sum of ions and Li^+, Na^+, NH_4^+, K^+, Ca^{2+}, Mg^{2+}, F^-, Cl^-, NO_3^-, SO_4^{2-}, PO_4^{3-}, HCO_3^- concentrations. Principal Component Analysis and comparison of the values of the investigated parameters between sampling campaigns and between the defined categories of tree stands with Friedman and Kruskal-Wallis tests were performed. It was found that although the chemical properties of spring water were mostly determined by abiotic factors such as geology and precipitation, deforestation caused a substantial disturbance in the water cycle in the ecosystem and contributed to changes in the chemical composition of the spring waters. The increased concentration of NO_3^-, reduced concentrations of K^+, Cl^-, NH_4^+ and a greater number of statistically significant differences between the sampling campaigns were observed in the water from springs under the influence of deforestation compared to not deforested areas. The springs under the influence of forest crops were characterized by significantly lower concentration of NO_3^-, SO_4^{2-}, Na^+, K^+ and Cl^- than in the other tree stands categories. Those phenomena were interpreted considering such processes as organic matter decomposition, ions washing out from the canopy, loss of forest retentive function and intensive nutrients uptake by a new tree generation.

Additional classes in the Shchukarev-Priklonsky classification according to two schemes of air pollution influence on spring waters chemistry in the Western Carpathians

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Shchukarev-Priklonsky classification was created in order to present chemical structure of underground water. It includes 49 classes which are featured by percentage of ions concentration within sum of anions or cations and for its simple methodology and clear interpretation, the classification is widely applied in hydrological studies [1]. In previous decades the underground water stayed mostly uncontaminated [1] and the ions taken into the Shchukarev-Priklonsky classification, which are only: Na+, Mg2+, Ca2+, Cl-, SO42- and HCO3-, were enough to present accurate structure of underground water. However, in last years the share of NO3- and NH4+ ions above 20% in underground and spring water was frequently noted [2, 3, 4, 5], which causes that the Shchukarev-Priklonsky classification gives incorrect image of water structure. To assess if including NO3- and NH4+ ions in the Shchukarev-Priklonsky classification is justified, research was conducted in two forested regions in the Western Carpathians: within the Skrzyczne Range (1257 m a.s.l.) and on the slope between Jaworzyna Kamienicka (1288 m a.s.l.) and Gorc (1228 m a.s.l.). The Skrzyczne Range is under bigger pressure of air pollution coming from Ostrawa and Upper Silesia industrial districts, whereas the second study area is located in the Gorce Mountains National Park and the air pollutants which get there mostly come from the Krakow and Nowy Sącz agglomerations. The spatial diversity of NO3- and NH4+ concentrations within the study areas was enhanced by organic matter decomposition after spruce stands dieback and intensive uptake of nutrients by a new tree generation. According to a modified Shchukarev-Priklonsky classification, 10 new classes were used: 5 including NO3- (number: 6.1, 9.1, 27.1, 39.1 and 52), 3 including NH4+ (number: 5.2, 6.2, 27.2) and 2 including both NO3- and NH4+ ions (number 6.12 and 21.12). Two of the classified spring water samples had only NO3- ion among the anions. In the Skrzyczne Range, the percentage of NO3- concentration was high during sampling campaigns with both high and low water level, with the mean ranging from 9.2% to 15.3% in periodic springs and from 7.5% to 11.4% in constant springs. In the Gorce National Park, the percentage of NO3- increased distinctly after snowmelt and precipitation periods: mean values from a sampling campaign rose from about 1% to about 3%. The share of NH4+ ions above 20% was noted only in 6 springs in the Skrzyczne Range. The newly extracted classes were used to classify up to 35% of periodic springs and 20% of constant springs in the Skrzyczne Range and up to 11.7% of periodic springs and 4.7% of constant springs within the study area in the Gorce National Park. Because of the continuous accumulation of nitrogen compounds from air pollution in ecosystems [6], the share of nitrates and ammonium ions in underground water and spring water is likely to continue to increase. The proposed modification of hydrochemical classification is a good tool to track changes in the chemistry of spring and underground water.

References:

[1] *Macioszczyk A. Dobrzyński D., 2007. Hydrogeochemia. Strefy aktywnej wymiany wód podziemnych. Wyd. Naukowe PWN, pp. 448 (in Polish).*
[2] *Krakowian K. 2017. The Effect of Deforestation Caused by ecological Disaster on Springs Occurance and Spring Water Chemical Properties in the Skrzyczne Range in Silesian Beskid Mountains. Ph. D. dissertation in Department of Forest Ecology and Reclamation, Faculty of Forestry, University of Agriculture in Krakow, pp. 162 (in Polish).*
[3] *Jasik M., 2015. The impact of environmental conditions on spatial diversity and changes in spring water chemistry in the upper parts of Jaszcze and Jamne catchments (Gorce Mountains). Ph. D. dissertation in Department of Forest Ecology and Reclamation, Faculty of Forestry, University of Agriculture in Krakow, pp. … (in Polish).*
[4] *Żelazny M., 2012. Czasowo-przestrzenna zmienność cech fizykochemicznych wód Tatrzańskiego Parku Narodowego. Instytut Geografii i Gospodarki Przestrzennej UJ, Kraków, pp.1–285.(in Polish).*
[5] *Moussa A. B., Zouari K., 2011. Hydrochemical Investigation of Groundwater Contamination in the Grombalia Shallow Aquifer, Cap Bon Peninsula, Tunisia: Impact of Irrigation with Industrial Waste Water In book: Waste Water - Evaluation and Management pp.239-252*
[6] *http://www.emep.int/*

The impact of climate change on runoff trends in the upper Vistula River basin

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River runoff trends are closely related to changing hydrologic and meteorologic conditions that determine water resources. The volume and structure of river runoff depend on a variety of environmental factors which may be further altered by human water use. In recent years, research on the volume and structure of river runoff has become more focused on climate change and its impact on water resources on a global scale and a regional scale. The Upper Vistula River Basin is located in a transition zone between areas experiencing streamflow increases (Northern Europe) and areas experiencing streamflow decreases (Southern Europe). In addition, a generally increasing trend is observed in the winter months and a decrease in the spring and summer [1, 2, 3]. Therefore, the aim of the study is to identify and assess trends in river runoff in the Upper Vistula River Basin for three periods: 1961–2014, 1971–2014 and 1981–2014. Additionally, the data of precipitation, temperature and snow cover were considered to better understand the impact of climate change on runoff regime.

The studied area covers three geographical regions: the Carpathian Mountains, the Subcarpathian basins and the Lesser Poland Uplands. In our analyses we used the following data: daily river flow records from 86 stream gauges, daily precipitation totals from 71 rain gauges, daily mean temperature and snow cover from 33 weather stations. The Upper Vistula River Basin covers over $50 \cdot 10^3$ km^2 but the smallest catchment area included in the study is 59 km^2. Due to different geographical conditions, the average elevations of selected catchments range from 212 m a.s.l. to 1602 m a.s.l. and the average annual runoff ranges from 99 mm to 1574 mm. Runoff, precipitation, temperature and snow cover tendencies were evaluated using the nonparametric Mann-Kendall test and the Theil-Sen estimator. A trend-free pre-whitening procedure was used for series exhibiting serial correlation [4]. The level of significance assumed in all analyses in this study was $p \leq 0.05$.

The median annual river runoff increase was observed in 30% of the studied catchments (mostly located outside the Carpathians) in the period 1981–2014. Similarly, low annual runoff ($Q_{10\%}$) has increased in recent decades. The decrease of low seasonal runoff was mainly observed in the summer in the western part of the Upper Vistula River Basin, while the increase of low seasonal runoff dominated in winter across the whole basin. High annual runoff tendencies ($Q_{90\%}$) in the studied periods were not consistent – decreasing trends in high runoff dominated in the period 1961–2014 but in the period 1981–2014 more increasing trends occurred. Our research has shown clear increasing trends in median of annual and seasonal (spring, summer) temperature in the period 1961–2014 in over 80% of the studied catchments. However, there were no significant trends in winter temperature as well as in snow cover duration. The analysis of annual precipitation totals has shown increasing trends in 54% of catchments in the period 1981–2014 but the most of seasonal trends in precipitation were not significant. Thus far, the increase of temperature and precipitation totals has resulted in the noticeable increase in annual runoff in the Upper Vistula River Basin. Furthermore, the increase of evapotranspiration and higher ratio of rainfall to snowfall may have affected the seasonal changes in runoff – the decline in summer runoff and the increase in winter runoff, respectively. Similar results were obtained for mountain ranges of the Alpine-Carpathian chain [1,2].

References:

[1] *Birsan M.V., Zaharia L., Chendes V., Branescu E., 2014. Seasonal trends in Romanian streamflow. Hydrological Processes 28: 4496–4505.*
[2] *Stahl K., Hisdal H., Hannaford J., Tallaksen L., Van Lanen H., Sauquet E., Demuth S., Fendekova M., Jordar J., 2010. Streamflow trends in Europe: Evidence from a dataset of near-natural catchments, Hydrology and Earth System Sciences 14: 2367–2382.*
[3] *Wilson D., Hisdal H., Lawrence D., 2010. Has streamflow changed in the Nordic countries? – Recent trends and comparisons to hydrological projections, Journal of Hydrology 394: 334–346.*
[4] *Yue S., Pilon P., Phinney B., Cavadias G., 2002. The influence of autocorrelation on the ability to detect trend in hydrological series, Hydrological Processes 16: 1807–1829.*

(Mis)management of floodplain vegetation: the role of invasive species on vegetation roughness and flood levels

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The primary function of floodplains is to convey floods, however, it could be decreased by various processes, which reduce the volume of the storage capacity (e.g. by overbank aggradation) or drop the flow velocity of floods by increasing the roughness (e.g. dense vegetation, constructions). In the early 21st c. several extreme high floods appeared in the Tisza River (Hungary), without increase in discharge. At the same time, the vegetation of the floodplain changed from plough fields and pastures to forest plantations, and invasive species (e.g. *Amorpha fruticosa*) became widespread. The aims of the research were (1) to evaluate the long-term land-use changes from the point of view of floodplain roughness, (2) to calculate the vegetation density with and without the invasive *Amorpha* (applying the Parallel Photograpic method), and (3) to model (in HEC-RAS) the present flood conveyance and in case of managed vegetation (eliminating invasives).

In the late 18th century wetlands (67-97 %) covered the area, but as the result of mid-19th c. regulation works the floodplain became drier (due to channel incision), thus pastures and plough fields (60-94%) became widespread and riparian forests (2-25%) appeared. In the late 20th c. poplar plantations (78-83%) replaced them, which provided perfect habitat for invasive species. As the result of these land-use changes the mean vegetational roughness of the floodplain increased from 0.033-0.041 (1784) to 0.068-0.104 (2017).

However, our at-a-site measurements reflect considerably higher vegetation roughness values (0.096-0.120) if the invasive *Amorpha* is also considered. The natural forests are less contaminated by *Amorpha*, than forest plantations or fallow lands, and its abundance also changes along the river. In case of clearance of the invasive species, the vegetational roughness could be decreased by up to 79%.

Based on our modeled data, the height of floods could be decreased by 13-34 cm by proper management of floodplains (e.g. clearance of invasives). However, this value is influenced by the floodplain slope and the characteristics of the flood wave. The clearance of smaller patches will not have considerable effect on flood heights, only the management of longer sections. In these cases the upstream part of the managed section will have greater peak-flood reduction, though at the downstream end (where the flood wave must enter into the unmanaged forest again), the flood level increases due to impoundment.

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15 years of the Carpathian Convention

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The Framework Convention on the Protection and Sustainable Development of the Carpathians (Carpathian Convention) was adopted by the seven Carpathian countries in 2003. It is not a prohibitive or normative convention, nor does it aim to add extra burdens to its parties; its role is rather to act as a platform on several issues in order to bring together stakeholders, catalyze and harmonize action and cooperation in the region. Since its adoption, the Carpathian Convention has been supplemented with four protocols (biodiversity, tourism, transport, forestry) and has enabled many projects, activities and networks. Although the text of the Convention and its protocols set out grand aims and specify concrete actions to be taken, the actual effectiveness of the agreement is not so clear.

Collaborative governance theory claims that in cases where socio-economical boundaries cut through ecosystem boundaries, such as the case of the Carpathian Mountains, successful conservation of natural resources will depend on international collaboration. Collaborative governance theory underlines the need for strong horizontal and vertical linkages among actors going beyond cooperation [1].

The current presentation will share findings of a research project that has been ongoing since 2014. The overarching aim of the research project is to analyze how a regional convention can contribute to ecosystem-based transboundary biodiversity governance systems, by focusing on the experiences of the establishment and 15 years of the Carpathian Convention. It builds upon multiple data sources from social network analysis, through qualitative in-depth interviews to participant observation.

The presentation will focus on the roles of the actors of the Carpathian Convention, the evolution of their networks, perception and their actions. Firstly, it will show what processes led to the emergence of the Carpathian Convention: the political dynamics of the fall of the Iron Curtain created a momentum for change that allowed the emergence of non-governmental organizations (NGOs) and transboundary networks, brought new goals and inspirations for many actors, and made governments receptive to suggestions of international organizations and people coming from the west. These were all necessary ingredients for the emergence of the Carpathian Convention. There is not a single initiative, event or person that created the Carpathian Convention, as Frits Schlingemann, who was head of UNEP's Regional Office for Europe at that time put it: "the climate was really good for that".

Secondly, it will present how the network of the actors have changed over time. Social network analysis is a quantitative analytical method that can, amongst others, describe the characteristics of a social network and its individual actors, and thus can be used as a tool to assess certain characteristics of collaborative governance systems [2]. The research built upon meeting affiliation data from 47 meetings that took place since 2003. The findings show that a very central role in the Carpathian governance system is played by some NGOs and a research institute – actors that are not usually so much central in multilateral environmental agreements. Beyond the social network data, the presentation will also show the ideas that drive the Convention forward, such actors' motivation to access to project funding, the push to gradually broaden the scope of the Convention, and the role of science and science-based decision-making will also be discussed and analysed in the presentation.

Finally, the presentation will pull the threads together and critically elaborate what the Carpathian Convention has delivered in reality: a well designed legal text, nexus approach to governance, cross sectoral discussions, innovative governance solutions and training and capacity building in the region. It will also reflect on how the Carpathian Convention's case study contributes to our theoretical understandings of regional governance.

References:

[1] *Emerson, Kirk, Tina Nabatchi, and Stephen Balogh. 2012. "An Integrative Framework for Collaborative Governance." Journal of Public Administration Research and Theory 22 (1): 1–29. doi:10.1093/jopart/mur011.*

[2] *Bodin, Örjan, and Christina Prell, eds. 2011. Social Networks and Natural Resource Management: Uncovering the Social Fabric of Environmental Governance. Cambridge, UK: Cambridge University Press.*

Setting priorities for the management of primary forest areas: the importance of a harmonized inventory for supporting regional conservation and restoration efforts

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Woodland and forests of the Carpathian Mountains constitute the largest continuous temperate forest ecosystem in Europe and at the same time a major biodiversity hotspot [1]. Although forestry is one of the main pillars of economic and cultural life, large extents of primary forest forests, namely primeval, virgin, quasi virgin and old growth forests still occur. These areas represent an important natural capital resource, providing a wide range of ecosystem services that contribute to improve the human well-being. The major threats on primary forests in the Carpathians are forest cover changes due to urban and agriculture expansion and, more importantly, unsustainable forest management including illegal logging. Several regional management and policy efforts to conserve this natural capital of Europe are currently being implemented, including the "protocol for sustainable forest management", signed by Carpathian Convention Parties, as well as several European (Nature Directives) and global policies (Aichi targets 14 and 15). The work presented here is part of the initiatives undertaken by the Carpathian Convention Secretariat (CCS), the Environmental European Agency (EEA) and the European Topic Centre on Urban, Land, and Soil systems (ETC/ULS) under the Protocol framework.

Within this agreement, we present the latest developments in the establishment of a harmonized geodatabase of primary forest which is then used for a proximity analysis based on forest condition indicators which results aim to provide support to regional authorities for prioritizing restoration and conservation efforts.

The first inventory on virgin forests relies on official input data provided by the Carpathian Parties about their distribution in the Carpathian countries. The input data was then collated into the first Carpathian-wide virgin forest layer based on official data. This layer was made available through an on-line web platform as part of this collaboration. The attributes of the layer include important information on the state of protection, ownership, geolocation. From this regional baseline, ETC/ULS further consolidated the spatial database and implemented some harmonization work using a common classification system for the Carpathian forest types to allow regional comparability and to enable further analysis.

A crosswalk between the different national forest classifications has been developed to reach a common classification scheme of forest types over the whole Carpathian virgin forest area, also based on the revision of the participating Member States. The European Nature Information System (EUNIS) has been chosen as reference nomenclature since it's an international classification (European nature information system, https://eunis.eea.europa.eu/) which, compared to the Habitat Directive one, is periodically subject to updates and revisions based on European vegetation plot data.

The official inventory presented here is the base layer for a spatial assessment of priority areas and targets for regional management plans aimed to restoration and conservation activities over the whole Carpathian region.

For this scope, the official inventory has been enriched with ancillary information such as the quasi forest sites provided by Member States or unofficial data provided by NGOs and integrated in a complementary geodatabase. A proximity analysis has been developed around the primary forest areas included in the extended inventory with the aim to improve the regional governance of forests in the Carpathian region and providing insights on management efforts needed to conserve, protect, and prioritize forest restoration and conservation in the region.

Restoration and Conservation potentials have been defined as a function of several spatial indicators. Being the Carpathian Environment Outlook (KEO) region [1] a pilot study for the European approach, specific spatial indicators have already been produced by EEA-ETC/ULS with the aim to support forest condition monitoring and the identification of High Nature Value (HNV) forest [3] and, ultimately, to develop a governance tool to support international and regional efforts, such as the Carpathian Convention.

For our purposes, also based on preliminary results [4], a series of sustainable forest indicators, is proposed for assessing conservation and restoration priorities: *a)* Fragmentation, *b)* Naturalness and *c)* Disturbance Indicators [5].

The model is calibrated for each location to identify the extent of the buffered area in which management measures for conservation or restoration would need to be prioritized.

The integration of the forest indicators and the primary forest locations and their surrounding areas encompass a holistic and comprehensive assessment to support sustainable forest management strategies. At the same time, the proximity analysis offers an insight into the current distribution of forest HNV components also allowing for further assessments of spatial trends, providing key elements in the multicriteria assessment for the identification of HNV forest areas, as expressed in IEEP [6]. This will support the analysis and the assessment of relevant instruments for current EU and regional policies on biodiversity, in view of both the use of wood for bioenergy and the reform of the Common Agricultural Policy (CAP).

References:

[1] UNEP 2007 Carpathians Environment Outlook. Geneva, Switzerland. United Nations Environment Programme. 2007.pp 232

[2] http://www.carpathianconvention.org/tl_files/carpathiancon/Downloads/03%20Meetings%20and%20Events/COP/2014_COP4_Mikulov/Follow%20Up/DOC11_Forest%20SAP%20FINAL_26SepCOP4.pdf

[3] EEA 2014 Developing a forest naturalness indicator for Europe Concept and methodology for a high nature value (HNV) forest indicator. European Environment Agency. EEA Technical report No 13/2014. pp. 64

[4] Mancosu E., Abdul Malak D., Sanchez Espinosa A. 2016 Setting a forest data platform to support sustainable forest management in Carpathian area. In: Conference abstracts. Forum Carpaticum, 2016. Future or the Carpathians: Smart, Sustainable, Inclusive. Sept. 28 – 30, 2016. Bucharest, Romania, pp.22

[5] Griffiths P., Kuemmerle T., Baumann M., Radeloff V.C., Abrudan I.V, Lieskovsky J., Munteanu C,. Ostapowicz K., Hostert P. 2014 Forest disturbances, forest recovery, and changes in forest types across the Carpathian ecoregion from 1985 to 2010 based on Landsat image composites, Remote Sensing of Environment, 151, 72-88

[6] IEEP, 2007, Final Report for the Study on HNV Indicators for Evaluation, Institute for European Environmental Policy (http://www.ieep.eu/ assets/350/hnv_indicator_report.pdf) accessed 19 March 2014.

Modification of Hungarian Forest Code – new challenge for nature conservation?

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WWF Hungary as a green NGO follows the changes and effects of Forest Code of Hungary – one of the most important legislation related to forest management and also conservation – for more than ten years. Modification of Forest Code in 2017 significantly decreases the scale, application range and extent of restrictions related to nature conservation, which could influence the opportunities of biodiversity protection.

One of the most prominent achievements of Forest Code – came into effect in 2009, valid until 1st of September, 2017 – was the introduction of so-called forest naturalness categories, which, together with specification of silviculture systems and forest functions enabled to differentiate management principles in forests of different state. With specific suggestions WWF Hungary also contributed to these achievements.

Modification of Forest Code in 2017 changed the system of silviculture methods and forest functions as well. Based on forest naturaleness, scope of forests where nature conservation restrictions can be applied – e.g. protection of residual tree groups, amount of left deadwood, size of protection zones around bird's nests are drastically decreased. Roughly in half of protected and Natura 2000 forest – including valuable lowland oak forests, coppice forests in colline and montane areas – fundamental restrictions disappear. Extent of restrictions are also decreasing compared to the former situation, and relevance of maximum extents from conservation scientific point of view are highly questionable.

WWF Hungary would like to raise awareness that modification of Forest Code decrease the level of protection on major part of forest area in Hungary, which can cause forest degradation, and consequently decrease in naturalness and also biodiversity.

References:

[1] http://www.kozlonyok.hu/nkonline/MKPDF/hiteles/MK17075.pdf, pp. 7757-7756 (in Hung.)

Universities as potential facilitators of participatory governance

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The complex challenges of sustainable development, which society is facing today, call for integration of knowledge and approaches from various disciplinary fields, and a closer cooperation among science, policy and practice. This is reflected both in the Sustainable Development Agenda adopted by the United Nations [1] and in the academic community [2]. In order to be successful and fair governance processes should involve participation and co-management by all relevant stakeholders.

The traditional role of scientific institutions, such as universities is to create and provide scientific knowledge to support governance processes. However, they have responded to sustainability challenges by reconsidering their role in knowledge creation. A new field of Sustainability Sciences has emerged [3, 4], which employs transdisciplinary methods of research and teaching, aimed not only at crossing disciplinary boundaries, but also at looking beyond academic expertise and cooperating with practical experts, policy makers and lay public [5, 6]. Moreover, the role of science is envisioned as an active facilitator of and contributor to transformation processes [2]. Stronger collaboration between science, the general public, non-academic experts and policy-makers does not only serve to produce more socially robust knowledge, but can also facilitate integration of this knowledge into practical application and decision-making, as well as support their implementation, enhancing transformative potential of research [6]. Universities - centers of knowledge production and education - are positioned as key actors in leading towards societal transformation in the context of sustainable development [7]. Moreover, via transdisciplinary research and teaching, they can contribute to the empowerment of "individuals and local communities through their direct involvement in the research process" [8].

An example of a transdisciplinary case study course, developed within the project *CaucaSusT – Transdisciplinarity for Sustainable Tourism Development in the Caucasus Region* and implemented in 2018 in Georgia and Armenia will be presented, with a focus on the experience in Georgia. The authors propose that similar approaches could be applied by the universities in the Carpathian countries, in order to support participatory governance in the field of sustainable development.

References: *(example)*

[1] United Nations. (2015) "Transforming Our World: The 2030 Agenda for Sustainable Development. Resolution Adopted by the General Assembly on 25 September 2015." United Nations General Assembly. http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E.
[2] Schneidewind U, Singer-Brodowski M, Augenstein K (2016) Transformative Science for Sustainability Transitions in H.G. Brauch et al. (eds.), Handbook on Sustainability Transition and Sustainable Peace, Hexagon Series on Human and Environmental Security and Peace 10, DOI 10.1007/978-3-319-43884-9_5.
[3] Mochizuki Y, Yarime M (2015) Education for Sustainable Development and Sustainability Science: Re-purposing Higher Education and Research. In: Barth M, Michelsen G, Rieckmann M, Thomas I (eds). Routledge, London
[4] Abson DJ, Fischer J, Leventon J, et al (2017) Leverage points for sustainability transformation. Ambio A Journal of the Human Environment 46:30–39. doi: 10.1007/s13280-016-0800-y.

[5] Pohl C, Krütli P, Stauffacher M (2017) Ten Reflective Steps for Rendering Research Societally Relevant. GAIA 26:43 – 51. doi: 10.14512/gaia.26.1.10.
[6] Lang DJ, Wiek A, Bergmann M, et al (2012) Transdisciplinary Research in Sustainability Science: Practice, Principles, and Challenges. Sustainability Science 7:25–43. doi: 10.1007/s11625-011-0149-x.
[7] Larrán Jorge M, Andrades Peña FJ (2017) Analysing the literature on university social responsibility: A review of selected higher education journals. Higher Education Quarterly 71:302–319. doi: 10.1111/hequ.12122.
[8] Buffel T, Skyrme J, Phillipson C (2017) Chapter 7. Connecting Research with Social Responsibility: Developing 'Age-Friendly' Communities in Manchester, UK. In: Shek DTL, Hollister RM (eds) University Social Responsibility and Quality of Life A Global Survey of Concepts and Experiences. Springer Nature, Singapore.

The human-wildlife conflict in the Alps, from problem to opportunity. Special focus on the return of the Wolf in South Tyrol (Italy)

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The great socioeconomic transformations that have interested Europe in the last century got a great acceleration in the last decades, due to relevant changes in the economic activities, in the localization of living spaces and in the relationships between rural and urban communities.

Also the Alps, a macro-region formed by countries with different histories, cultures and traditions, have been part of this transformation and deserve a special attention for its peculiarities. In the Alps, local communities have been always directly dependent on the mountain ecosystems. Although these environments could be inhospitable and physically fragile, men have been able to guarantee their own survival, thanks to their innate resilience power and to the exploitation of mountain natural resources. In the current cultural landscape of the Alps, it is clear the effects of the human presence, which is also visible in the new human-wildlife relationship, caused by the return of large carnivores in many areas and expanding. In the ALPINE SPACE project ALPBIONET2030, having the final aim of enhancing the ecological connectivity in the Alps, Eurac has analysed the current main human-wildlife conflicts following a social approach in order to identify the different impacts of the conflicts and the current resolution techniques applied in each pilot area of the project. A part of this conflict analysis is located also in South Tyrol, an alpine province in the northeastern Italian Alps, where the wolf is naturally returning. This has caused conflicts with human economic activities and the raise of ancestral fears. The province is characterized by a traditional land use, where livestock farming on alpine pastures is a key activity to maintain the typical landscape image. Livestock losses due to wolf predation is a new conflict in this area and it is causing emotional responses and strong discussions on the need for management measures to protect human health and activities. The Province administration of Bolzano and Eurac Research started a collaboration in 2017 working on technical and social aspects of wolf return based on empiric and statistical data. Experts of the Bolzano Province are studying the best way for the implementation of different prevention systems on selected alpine pastures in the provincial territory, including fences and the merging of herds to reduce the risk of predation. In addition, the applied monitoring system guarantees a reliable overview of current wolf presence on the territory. Eurac Research will point to the collection and analysis of social aspects related to the presence of this predator in South Tyrol, providing, at the same time, the scientific background to sustain the strategic management choices developed at provincial level. The methodology foresees quantitative questionnaires for the large public and qualitative interviews for local stakeholder and representatives of interest groups. The on-going study wants to fill the lack of information about the general knowledge on this species and analyse the concrete problems related to the return of the wolf trying to satisfy the management expectations, demonstrate the potentials for a positive coexistence and reply to the personal consternation of the economic operators and of the large public of South Tyrol. The current contribution wants to highlight the new challenges facing the human-wildlife coexistence in the Alps, which is finding policy makers, technicians and large public mainly unprepared. Eurac is working to provide opportunities for positive confrontation and dialogue of the different interested parts, bringing scientific knowledge, best practices from other mountain areas and new ideas to re-shape the Alpine communities and move from a perceived crisis to new socioeconomic opportunities.

Introduction to 3 Lynx project

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The Eurasian lynx is a highly endangered species and protected under the EU Habitat Directive. The main threats for the lynx survival are poaching, happening due to lack of acceptance by key stakeholders and habitat fragmentation. In addition, non-harmonised monitoring and management among neighbouring states hamper a coordinated approach.

That´s why a project CEE1001 3Lynx started to be implemented and supported by the Interreg CENTRAL EUROPE programme (2017-2020). Project is led by the Ministry of the Environment of the Czech Republic. Project partners include five countries - CZ: Nature Conservation Agency of the Czech Republic, Šumava National park Administration, Alka Wildlife o.p.s; D: Bavarian Environmental Agency, World Wide Fund for Nature Germany; A: Government of Upper Austria, Green Heart of Europe, Research Institute of Wildlife Ecology, University of Veterinary Medicine, Vienna; SLO: Slovenia Forest Service; IT: Italian Lynx Project. University of Zagreb, Faculty of Veterinary Medicine from Croatia is involved as associated strategic partner.

The project is focused on three European lynx populations: Bohemian-Bavarian-Austrian population, Dinaric and SE Alpine population. The main objectives of the project are: a) to improve lynx conservation capacities by responsible stakeholders through experience, data and tool sharing (common database for data sharing will be implemented); b) to jointly analyse gained data from monitoring on transnational levels; c) to implement a harmonised Pilot lynx monitoring system on population level, based on several approaches (camera trapping, snow tracking, DNA samples collecting and analysing), also as an instrument to achieve active involvement of key stakeholders (hunters and foresters) into lynx conservation issues (aimed to improve acceptance); d) to increase problem awareness among other stakeholder groups (regional training schemes for different stakeholder groups such as hunters, foresters, schools, veterinarians, etc.) and connect the activities and acquired knowledge to macroregional/multinational strategies. Also a Regional Action Plans will be developed and signed by implementing partners. Lynx monitoring report containing current distribution and status of populations will be drafted each year. This report will provide detailed information on data and experience obtained within each "lynx year" (1.5. - 30.4. of the following year, based on the lynx life cycle) on whole population(s) level.

The main output and the biggest challenge will be to integrate all available knowledge from several types of lynx monitoring, conservation and management practices into a transnational lynx conservation strategy for the Bohemian-Bavarian-Austrian population, endorsed by Memorandum of Understandings and a sound acknowledgement of the approach by EUSALP, EUSDR, Alpine and Carpathian Conventions.

Education of Romani students in Lesser Poland Voivodeship

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The Romani are the largest ethnic minority in Poland (about 20.750 people) with largest population called "Carpathian Roma" in Lesser Poland Voivodeship (3.500). The issue of Roma education analyzed in the study is important from social and economic point of view, because it has a decisive influence on the standard of living of this minority in Poland (Świętek, 2016). The aim of the study was to define the condition of education of Romani students in Lesser Poland Voivodeship. Using diagnostic survey and interviews as well as analysis of the available data, this study attempted to answer the following research questions: (i) what is the current organization of education on Romani children in Poland and is it effective in Lesser Poland Voivodeship? (ii) What is the level of education of Romani children in Lesser Poland Voivodeship? (iii) What irregularities occur in Romani children education? The survey was conducted in 2013 on Polish and Romani students in integration classes in 12 towns of Lesser Poland Voivodeship: Andrychów, Czarna Góra, Czarny Dunajec, Kraków, Krośnica, Limanowa, Maruszyna, Maszkowice, Nowy Sącz, Nowy Targ, Ochotnica Dolna, and Tarnów. Students finishing the primary school or students beginning the middle school of both Polish and Roma origin attending integration classes together were all participants of the reseach. The respondent group consisted of 528 students (including 43 Romani students). The author interviewed the staff (headmasters, teachers, Roma education assistants), Małopolska Provincial Office workers responsible for implementation of the "Program for the Roma minority in Poland" and Romani activists (e.g. workers of the Ethnographic Museum in Tarnów). Based on the collected data, organization of education of Romani children, their level of integration and educational difficulties were analyzed.

The analysis of organization of education of Romani children in Poland showed that Romani children attend integration (Polish- Romani) classes in Polish public schools. Their education is aided by teachers, Roma assistants, as well as by support from the governmental program ("Program for the Roma minority in Poland"). This analysis, however, also pointed to a number of flaws. The lack of textbooks and other didactic materials hinders proper education od Romani children. Additionally, few publications are available to students and teachers. There is still no system of educating teachers working with Romani students. Those teachers lack background in culture, customs and the Romani language.

The condition of education of Romani children in Lesser Poland Voivodeship was analyzed using indicators devised on the basis of available data of Ministry of the Interior and Administration. Five indicators were chosen: realization of the duty of schooling, attendance, GPA among the Romani children, the number of said teachers and Roma assistants, participation in compensatory classes. The values of these important indicators among the Romani children in Lesser Poland Voivodeship are unsatisfactory, but higher than in remaining voivodeships. The most interesting and more detailed conclusions the author obtained from the results of diagnostic survey among students. Romani children in Lesser Poland Voivodeship have significant difficulties studying which stem from their not being prepared for school and preschool work. The most serious of the identified difficulties included insufficient command of the Polish language and gaps in general knowledge,l which resulted in difficulties in studying. Apart from didactic difficulties, in realization of education of Romani children the author also identified difficulties in upbringing resulting from the adopted model of educating the Romani in Poland. The Romani students in majority of integration classes are rejected by their peers. The reason is in the intolerance of most Polish students, the stereotype

of the Romani and financial problems of Romani families. However, Romani students tackling those adversities receive various forms of help from Romani assistants and teachers. Romani parents are generally in favour of education, yet they do not support their children sufficiently. Low level of professional ambition reflect the low self-esteem of Romani students and strong influence of parents. On the other hand, Romani students take active part in school life and various forms of pastime activities mostly due to governmental programs realized by teachers and assistants. Empirical studies have shown that in spite of providing the Romani with proper environment for education in reality many of them still struggle in this sphere.

Finally, actions are proposed that would eliminate the irregularities in educating Romani children.

Eco-schools in the Hungarian Carpathians – good practices and challenges

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Eco-schools are the realization of the holistic approach of education for sustainable development which has been significantly reinforced by United Nations with adoption of the 17 Sustainable Development Goals (SDGs) in September 2015 (UN, 2015), and among them Quality Education. The SDGs not just declared sustainability as the most important common and global goal for humanity, but considered education as a significant tool to reach every and each SDG goals.. The 2017-2019 work plan for implementation of the UNECE Strategy for ESD invited all UNECE member states to encourage whole-institution approaches by establishing "ESD school plans" for every school by 2019. (UNECE, 2016)

In Hungary approximately 25% of schools has established ESD plans based on the wholes school approach of ESD by applying for the Eco-School title. The work of the Eco-schools are monitored yearly by a compulsory on-line questionnaire and monitoring visits in selected schools. (Varga, Saly, Benkő, & Könczey, 2017)

The presentation will summarize the monitoring data available about the Eco-schools operating in the Carpathian region of Hungary. The first part of the presentation will analyse the statistical data of the monitoring questionnaires of the Eco-schools in the Hungarian Carpathians and give an overview of the main characteristics of the schools and their pedagogical work. The second part of the presentation will present some cutting edge good educational practices Eco-schools in the Hungarian Carpathians, demonstrating the possibilities for citizen science, local or regional educational activities promoting protected areas, sustainable lifestyles and sustainable economy in the pedagogical work of schools.

In the three Carpathian counties concerned, 8, 28 and 38% of kindergartens are Green Kindergartens and only 7, 8 and 10% of schools are the Eco-schools. While in schools, with this value, they are in the last third, Nógrád county is far ahead of all other counties and the capital for kindergartens. In 2015-2016, 62 kindergarten teachers and 58 teachers participated in a special 'coordinating a whole institution ecopedagogy' training within which teaching with and for Natura 2000 values were focused as well.

In the 2017 year survey, all schools of the three Carpathian counties with eco-school experience of 2 to 13 years long were involved. We got answers from 85 schools, 11 schools did not answer. Within the answers concerning specifically to nature conservation and biodiversity, bird feeding and school-gardening continue to be ever-growing activities. In the public cleaning action (TeSzedd!) that covers the outskirts (for example, forests and streams), eco-schoolchildren are traditionally involved, and eco-schools are much more active at the nationally organized Sustainability Thematic Week than the non-addressees. More and more eco-schools are in contact with the state forestries in the area, especially the Egererdő. In addition, 23 schools have indicated a special nature conservation activity (stream source cleaning, cross-border nomad camps etc.) or a success story in a nature conservation or biodiversity competition from the 2017 year. Only a few primary schools are able to organize 'forest school' week programs that were more commonly used in the pedagogical program and in the work plan of the school year earlier.

The final part of the presentation will focus on the challenges Eco-schools face in the Hungarian Carpathians. A brief overview will be given about the general social challenges decreasing population, growing number of minority pupils, then the most significant pedagogical challenges will be highlighted as the lack of dedicated, earmarked resources for education for sustainable development activities, the lack of co-ordination between different initiatives and the project based development approach which makes it harder to develop and co-ordinate a long term development strategy.

References:

[1] *UN. (2015). Sutainable Development Goals. Forrás: http://www.un.org/sustainabledevelopment/sustainable-development-goals/ (16. 05. 2018)*

[2] *UNECE. (2016). Framework for the future implementation of the UNECE Strategy for Education for Sustainable Development: http://www.unece.org/fileadmin/DAM/env/documents/2016/ece/ece.batumi.conf.2016.11.e.pdf (16. 05. 2018)*

[3] *Varga, A., Saly , E., Benkő, F., & Könczey, R. (2017). Whole School Approach of ENSI Network for ESD in Hungary – Achievements and Challenges., European Educational Research Association (ECER) Conference. Copenhagen. http://www.eera-ecer.de/ecer-programmes/conference/22/contribution/40950/ (16. 05. 2018)*

Eco-Island

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Outdoor Mission Kft was founded in 2006. We were the first in Hungary to carry out researches to find out more about the voluntary practices of Hungarian companies. We base the development of our activities and the broadening of product palette on the results of these researches. In the past years, we have realized many successful communal and social projects.

From 2010, we have widened our range of activities with informative presentations about environmental consciousness and sustainability. The above mentioned directive of policy was supported even further with the establishing of our Ecological Cultural Foundation.

After numerous environmental projects, in 2015 we founded the two-day long presentation series that helps raising the environmental consciousness of elementary school students. With the active support of the municipal council of Szigetmonostor, we could organize the IV. Eco-Island event this year. At the event, the students could get to know the basic questions concerning the environment through experience based methodology learning, in a playful and fun way. We are very much on the side of experience based learning. We take a different environmental topic (eg. water, climate change, the decline of biological diversity, and consumer habits) every year, this way we can encourage the students and the teachers as well, to return to our event. To keep the elements of the Eco-Island programme, it is a crucial criterion to urge the participating students to think outside the box, not in a nowadays narrow and linear plain, but in a coherent system of the problems and their solutions. The holistic way of thinking is one of the potential ways out of the current sustainable-environmental-social problems.

We promote the Eco-Island events for the elementary schools of towns and villages in a 70-100 km radius, around Szigetmonostor, but of course any other schools who are interested in the event are welcome to get in touch with us. Around 1000 students and 60-80 accompanying teachers visit the Eco-Island every year. As closing the year's event we ask for any form of opinion or feedback from the teacher, and we would like to share some of these here:

"The event makes the children aware of the fact that we are part of nature, not its master!"

"This event collected the environmental knowledge in a neat system. It was a great experience. There was a lot of interactivity involved. Everyone could find the right topic for themselves."

"... the presentations and activities here are not just supplementary but fills a gap in environmental education as well."

Our main professional partners and presenters at the event, including but not limited to, MTA Ecological Research Centre, National Meteorological Service, Duna-Ipoly National Park, Hungarian Museum of Natural Sciences, CEEweb for Biological Diversity, Humusz Society, Small Communities Programme, NÉBIH, WWF Hungary.

Formal education about rivers and their public perception – a meandering road to sustainability

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No abstract has been submitted.

The relevance of transdisciplinary approaches in education and research for facilitating sustainable development in mountain regions

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Mountain regions have their own peculiarities in the distribution and management of natural resources, which also demands specific approaches in regional development. Tourism can be a way improving the socio-economic situation of mountain regions, especially in those located within or near protected areas [1].

An important aspect of supporting sustainable tourism development is close cooperation among various stakeholders, taking into consideration its transdisciplinary nature. Academic activities that bring together knowledge from various academic fields, as well as practical knowledge of the local communities, could play an important role in facilitating sustainable tourism development in mountain regions.

While applied research and fieldwork are part of university practices, cooperation among various university departments, as well as cooperation with local stakeholders within teaching or research projects is a less common approach in many Caucasus countries.

The goal of this paper is to discuss appropriate ways of applying transdisciplinary approaches [2; 3] in tourism development of mountain regions in order to achieve sustainability. We examine practical cases of cooperation between local communities and universities in the field of sustainable tourism development in the Caucasus Region, using examples from Armenia and Georgia.

The research is based on literature analysis, qualitative interviews with different stakeholders, field studies with university students and teachers in local communities and the authors' own experiences as a teacher and tour guide in Armenia.

References

[1] Lalayan, A. 2014. Community based tourism in Armenia: planning for sustainable deveopment. Ritsumeikan Asia Pacific University.
[2] Muhar, A., A. Posch, U. Vilsmaier, M. Glanzer, B. Freyer. 2006. Initiating transdisciplinarity in academic case study teaching. International Journal of Sustainability in Higher Education 7/3: 293-308.
[3] Pohl, C., G. H. Hadorn. 2007. Principles for designing transdisciplinary research. oekom Munich.

Stakeholders' attitudes towards green energy innovations as a prerequisite to successful implementation: international experience and lessons learned in the Ukrainian Carpathians

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Energy cooperatives, "zero non-renewables" towns and other community initiatives in renewable energy (RE) are emerging across the world, in particular, in Europe and the North America. Such social initiatives vary in size, success rates and implementation strategies. Decentralization consistently appears to be one of the most important characteristics of institutional development and generally, increases the institutional space for local (community) players (Oteman, 2014). Analysis of international cases shows that a range of systemic problems hamper the rapid development and diffusion of RE. Therefore, additional attention is needed from policy makers and other stakeholders that have an interest in speeding up the diffusion process. A study by Negro et al (2012) shows that a lack of stable institutions, and poor alignment of these institutions with practices in other sectors and across governance scales are key systemic problems.

In Ukraine, there are a growing number of social initiatives in the field of energy: community-led, civil societies and NGOs, as well as initiatives promoted by government at national, regional and local levels (Buchan and Keay, 2016). However, Ukrainian energy governance has traditionally been centralized and top-down, and the process of transition to a system which takes into account stakeholders' attitudes is ongoing. A range of indicators characterizes the implementation of RE initiatives. For example Kharlamova *et al* (2016) states that process (technological) efficiency is characterized by the interaction of physical and cost indicators related to land use availability , labour market, and the raw material resources required for the production of electricity, such as absolute growth rates and GDP; output increase of each type of alternative energy sources; and the total percentage of RE sources. Innovative solutions concerning the implementation of green energy projects depend considerably on the support of policy at the local level, development of the institutional network, individual household economic status and living conditions. Despite the positive perception of RE by local authorities and especially ENGOs, in many cases RE projects in the Ukrainian Carpathians meet substantial local opposition. While bioenergy and solar energy projects are rarely opposed, hydro- and wind energy projects, considered by business as an attractive investment, are of often not supported by stakeholders. In particular, hydropower development is associated with significant environmental risks, which need to be regulated by policies which ensure transparent planning, appropriate procedures, and compatibility with international and national environmental legislation (ELP, 2017).

This study focuses on rural communities in three Carpathian Oblasts: Transcarpathia, Lviv and Ivano-Frankivsk. The research followed a mixed-method approach (Morse 2016). Semi-structured

interviews were carried out with stakeholders associated with RE development. It assesses stakeholder' attitudes about the significance and future potential of wood energy, its efficient use for the regional economies and consumers, households, including municipalities, from an environmental, economic and social perspective (Björnsen Gurung & Seidl 2017).

It should be acknowledged that this study was conducted in the frame of the project "Identifying Energy Options for the Ukrainian Carpathians" supported by the Swiss State Secretariat for Education, Research & Innovation SERI and the "Stiftung für Wirtschaft und Umwelt" SWO, Switzerland.

References:

Björnsen Gurung A. and. I. Seidl. 2017. Identifying Green Energy Options for the Ukrainian Carpathians, 125th IUFRO Anniversary Congress - Book of Abstracts, 2017. Freiburg, p. 93.

Buchan , D. & M. Keay, 2016. EU energy policy – 4th time lucky? Oxford Energy Comment, December 2016, https://www.oxfordenergy.org/wpcms/wp-content/uploads/2016/12/EU-energy-policy-4th-time-lucky.pdf

ELP, 2017. Small Hydropower Stations, http://epl.org.ua/en/small-hydropowers-stattions/http://epl.org.ua/en/small-hydropowers-stattions/

Kharlamova G., Nate S., Chernyak O., 2016, Renewable energy and security for Ukraine: challenge or smart way? Journal of International Studies, Vol. 9, No 1, pp. 88-115. DOI: 10.14254/2071-8330.2016/9-1/7).

Oteman, M., M. Wiering and J.-K. Helderman.2014. The institutional space of community initiatives for renewable energy: a comparative case study of the Netherlands, Germany and Denmark. Energy, Sustainability and Society, 4:11

Morse, J. M. 2016. Mixed method design: Principles and procedures (Vol. 4). Routledge.

Negro, S. O., F. Alkemade, and M. P. Hekkert. 2012. Why does Renewable Energy Diffuse so Slowly? A Review of Innovation System Problems."Renewable and Sustainable Energy Reviews 16 (6): 3836-3846.

City residents' readiness to a wood energy transition (Lviv Region Case Study)

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Hypothesis of the research was that energy transition process is a quite weak in Lviv region and residents of the region cities are not ready to this transformation. To answer this question we started from the DPSIR analysis [2] to understand drivers, pressures, state and impacts of the complex causal interactions between people and nature in the realm.

Stakeholder analysis [1] let us to identify key stakeholders of the transition process and their interests in it. Stakeholders positioning according two axes – influence or influenced and win or lose – provides us information on synergies and conflicts among stakeholders and therefore their support or opposition to a wood energy transition in a residential sector of the region.

The next step of the research was SWOT analysis of the energy transition process in residential sector of the region cities conducted with an aim to get a systemic and deep insight into the wood energy transition process and develop SWOT-strategies [3] for the process development. TOWS-matrix, derived from the obtained information, enabled us to draw four strategies for the further energy transition of the residential sector, namely:

- Conservative strategy – attracting investments for wood mobilization, a wood waste processing and storage, logistic and information support, consulting on all levels of the supply chain;
- Preventive strategy – developing bioenergy and wood biofuel markets; introduction of solid biofuel certification;
- Aggressive strategy – benefiting from international programs, grants and experience to realize the potential of the region and to fulfil international obligations of Ukraine;
- Competitive strategy – subsidizing production of energy from wood waste, elimination of subsidies for fossil fuel; increase its prices to internalize externalities; introduction of efficient green tariffs.

The SWOT-strategies for a wood energy transition in the residential sector were evaluated according to sustainable development criteria using analytic hierarchy process [4], namely: environmental, economic and social. Our findings shown that the Conservative strategy (to invest in the process of collection, processing and storage of wood waste) was assessed by experts as the optimal one in modern conditions. Competitive bioenergy market is considered as an obligatory condition for the transition of the population to a woody biofuels. Respondents mentioned that a current state of this market in Ukraine needs a substantial development and improvement.

In order to ensure the energy transition, it is also important to introduce a solid biofuel certification in order to ensure the quality and transparency of the market. The next step is to introduce "green tariffs", as well as to offset subsidies for natural gas and coal. With such strategies, the urban population will receive favourable conditions and a clear market signal for changing their energy behaviour. These measures were integrated into the DPSIR model developed for the transition process as a response for current situation.

Our experts' choice corresponds to the behavioral model of the "economic man" type. This type of human behavior describes people whose behavior is aimed at maximizing the satisfaction of personal material interests and needs. This kind of behavior is known as a "rational choice". People are considered to be rational-strategic actors who seek to get as good a product as possible for as little price as possible. Accordingly, individual actors will change their behavior (for example, in relation to the method of heating) in response to political and socio-economic changes only if they can obtain certain material benefits from it and avoid significant costs. [5] But in recent economic environment of Ukraine this option is hardly possible.

As a result of the study, it can be argued that in today's institutional and economic conditions, the population of the cities of Lviv region is not yet ready for the transition to woody biofuels. Such a transition requires the corresponding value changes, institutions and investments, which are missing in the conditions of sluggish economic development. Informing the population and education for sustainable development, development and implementation of energy policy on the basis of sustainable development will promote the process of energy transition.

References:

[1] *Delmas M., Toffel M. W., 2004. Stakeholders and environmental management practices: an institutional framework. Business strategy and the Environment 13(4): 209-222.*

[2] *EEA (European Environment Agency), 2005. The European environment. State & Outlook, 2005. Office for Official Publications of the European Communities, Copenhagen.*

[3] *Rauch P., 2007. SWOT analyses and SWOT strategy formulation for forest owner cooperations in Austria. European journal of forest research 126(3): 413-420.*

[4] *Saaty T.L., 1980. The analytic hierarchy process: planning, priority setting, resource allocation. McGraw-Hill, New York; London.*

[5] ***Sotirov M.,** Sallnäs O., Eriksson L.O., 2017. Forest owner behavioral models, policy changes, and forest management. An agent-based framework for studying the provision of forest ecosystem goods and services at the landscape level.* Forest Policy and Economics *(accepted, in press). https://doi.org/10.1016/j.forpol.2017.10.015*

Using participatory video as a research tool to capture local perspectives on the use of energy wood in the Ukrainian Carpathians

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Bioenergy, in particular energy wood, can play a decisive role in the transition to a new energy system [1]. In particular in forested regions, it is an obvious choice to use the re-growing resources nearby, especially as the intensified use of energy wood could also strengthen regional added values. Despite these undoubted benefits, the answer to the question "To burn or not to burn?" is not simple. Apart from the resource availability and the inherent energy potentials, also unwanted effects of intensified forest use for energy purposes should be taken into consideration. Not least, numerous less tangible factors influence the decision and capability to expand the efficient use of bioenergy at the local scale.

As an integral part of a Swiss-Ukrainian research collaboration [2] focusing on the Ukrainian Carpathians, this study addresses the above question from both, a natural science as well as socioeconomic perspective. Ukraine, one of the most energy intensive countries, relies strongly on fossil fuels and nuclear power [3]. With hydropower and emerging renewables covering only a small share, the potential to expand biomass use for energy purposes, primarily for heating, is high. The resource potential of woody biomass in Ukraine amounts to 4 Mt annually. It includes sawmill waste, wood-cutting waste (branches, crowns), firewood and some technical timber, which is currently exported. While there is additional forest potential, road transportation of the lumber is a limiting factor for heating and power generation [4].

To complement statistical data aggregated at the national level and inspired by a recent call to render research more societally relevant [5], this project used participatory video together with a set of interrelated activities to shed light on local realities. The participatory video intervention built on the outcome of a Best Practices Contest published in two districts of the Ukrainian Carpathians in early 2018 [6]. The contest aimed at eliciting visionary ideas and examples of innovative energy practices in the field of energy wood [7]. To gain a better understanding of local people's capabilities and coping strategies to cover their daily energy needs, in particular heat demand, a participatory video intervention was conducted in the town of Boryslav, Lviv Region, i.e. in the place of the prize-winning project that had been awarded by the contest evaluation committee. Six local residents representing various community voices were selected for an intensive training and practical film-shooting in June 2018.

The paper describes the process of the one-week participatory video intervention that started with a series of interactive exercises feeding in into the creation of a storyboard and film. On the background of the ongoing academic research aiming at the assessment of the sustainable potential of energy wood in rural areas of the Carpathians, this work presents the missing pieces in the big energy picture of Boryslav and other forest-dependent communities in Ukraine. In the same vein, it critically reflects the added value of participatory video as a research tool. Primarily in terms of eliciting information and the interpretation of such, but equally in terms of a joint exploration of relevant research topics by members of the local community together with scientists.

This exercise was conducted in the frame of the project "Identifying Energy Options for the Ukrainian Carpathians" supported by the Swiss State Secretariat for Education, Research & Innovation SERI and the "Stiftung für Wirtschaft und Umwelt" SWO, Switzerland.

References:

[1] *Anonymous. Declaration of Graz, January 2017: The role of bioenergy in Europe after COP 21 Paris. 5th Central European Biomass Conference 2017, 4p. www.aebiom.org/wp-content/uploads/2017/01/Declaration-of-Graz-2017.pdf*

[2] *Björnsen Gurung, A. and Seidl I. (2017). Combating Ukraine's energy crisis with wood fuel. https://www.wsl.ch/en/news/2017/03/combating-ukraines-energy-crisis-with-wood-fuel.html*

[3] *Savitsky, O. (2016). Towards the energy transition in Ukraine. Finding pathways to energy independence and carbon-neutral sector.*

[4] *IRENA (2015). Remap 2030: Renewable Energy Prospects for Ukraine. IRENA, Abu Dhabi. www.irena.org/remap*

[5] *Pohl C., Krütli, P. and Stauffacher M. (2017). Ten reflective steps for rendering research societally relevant. GAIA 26/1: 43-51.*

[6] *FORZA (2018a). Wood for energy: best practice contest for using woody biomass for energy production in Lviv and Zakarpattia Oblasts. http://www.forza.org.ua/en/identifying-green-energy-options-ukrainian-carpathians/wood-energy-best-practice-contest-using-woody*

[7] *FORZA (2018b): Кращі практики використання деревної біомаси для виробництва енергії в Карпатському регіоні. http://forza.org.ua/uk/viznachennya-mozhlivostey-zelenoyi-energiyi-v-ukrayinskih-karpatah/krashchi-praktiki-vikoristannya*

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Multidimensional analysis of indicators for maximizing the sustainability of tourist destinations: a case study of national and natural parks in the Romanian Carpathians

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The creation of sustainable tourist destinations in the Carpathian states is a priority stimulated by WTO recommendations, European policies and the Carpathian Convention. Romania, through the eco-tourism certification system, subscribes to this deed, but acquiring certification is not enough to ensure a strong and secure sustainable development (SD). In this context, the present study takes into consideration the national (II IUCN) and natural parks (V IUCN) of the Romanian Carpathians certified or not as (eco) tourist destinations to test which are driving directions that can maximize the sustainable development of tourism. With the help of the GIS and SPSS tools, multi-dimensional assessments were carried out on the basis of a set of indicators consistent with those of GSTC, EU [1; 2] and those for ecotourism destinations in Romania, with five value thresholds grouped into four sections: management, economy, communities and the environment. The results have shown that driving factors for maximizing sustainable development are management of the destination, followed by benefits to communities. Within them, management predictors for maximizing sustainable development are medical safety services, physical integrity, then smart connectivity coverage, and local communities are promoting products own and then work. In the next step, we identify and interpret the gaps by sections and driven factors of 22 destinations. Thus, it was revealed that parks can be included in only three categories, with their current status of ST: medium development, followed by good and weak. This suggests that the SD of ecotourism destinations should be accompanied by a development rating system that will maximize this process. It has to create a greater connectivity of internal management with a number of external components, a careful management of the involvement of local communities and services for tourists [3] and the environment.

References:

[1] Blancas, F.J.; Lozano-Oyola, M.; González, M. A., 2015. European Sustainable Tourism Labels proposal using a composite indicator. Environmental Impact Assessment Review, 54, 39-54.

[2] Mendola, D.; Volo, S., 2017. Building composite indicators in tourism studies: Measurements and applications in tourism destination competitiveness. Tourism Management, 59, p. 541-553.

[3] Matei, E., Vijulie, I., Manea, G., Dezi, S., 2014. Changes in the Romanian Carpathian tourism after the communism collapse and the domestic tourists'satisfaction. Acta geographica Slovenica, 54-2, 335–344.

Unique features of the Romanian Carpathians - opportunities for a sustainable tourism development

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Romanian Carpathians cover a large part of the surface of the country (about 28%) and at the same time about 50% of the surface of the Carpathian Mountains is located on the territory of Romania.

This area singles out due to its outstanding natural and cultural features. Thus, 55.5% of the forest-covered areas in Romania are located in the Carpathians, including, among others, a large part of the virgin forests in Europe (here are 12 reservations included in the UNESCO Site of *Ancient and Primeval Beech Forests of the Carpathians and Other Regions of Europe*). Moreover, in the Romanian Carpathians, there are also 22 national and natural parks including two biosphere reserves and the only geopark of the UNESCO Global Geoparks Network in the country.

At the same time most of the cultural monuments on the UNESCO World Heritage List in Romania are located in the Carpathian Mountains: all six Dacian fortresses in the Orăştie Mountains, four of the eight churches adorned with exterior frescoes in Bucovina, all eight wooden churches in Maramureş, all seven fortified churches in southern Transylvania, as well as Hurezi Monastery. In addition, several items on the UNESCO list of intangible cultural heritage, such as the Căluș Ritual («Ritualul Căluşului») and the Craftsmanship of Horezu ceramics, originate in the Carpathians.

The previous attractions are supplemented by a series of other representative cultural monuments that draw tourists a lot; many of them can be included in the European Cultural Routes – Ellie Wiesel's House in Sighetul Marmaţiei (European Route of Jewish Heritage), the Roman Catholic Church in Sanmartin, Harghita County (Saint Martin of Tours Route), the Roman churches in Alba Iulia, Densuş, Cisnădioara (TRANSROMANICA), Aiud (Iter Vitis Route), Prejmer's Evangelical Church (European Route of Cistercian Abbeys), the Merry Cemetery of Săpânţa (European Cemeteries Route), Sovata and Călimăneşti-Căciulata spa resorts (European Route of Historic Thermal Town), the locality of Marginea (European Route of Ceramics) and so on. It can be said that most of the cultural itineraries that are developed or that can be developed on the territory of Romania include tourist attractions located in the area of the Carpathian Mountains, thus bringing a comparative advantage to this area.

At the same time, the Romanian Carpathians are crossed by two of the 12 European long-distance footpaths (one covering entirely the Occidental Carpathians and the other covering the Oriental Carpathians and the Southern Carpathians) and by two of the 15 European cycling routes (both pass through the south-western extremity of the country through the counties of Caraş Severin and Mehedinţi).

The existence of this rich natural and cultural heritage in the area of the Romanian Carpathians, whose various features are included in the patrimony of UNESCO, with destinations that can be embedded in European Cultural Routes, as well as the presence of European foot and cycling routes, are comparative advantages of the tourist destinations in the Carpathians, providing prerequisites for the development of complex tourist products for the segments of tourists interested in these kinds of activities.

The opportunity for the sustainable development of tourism in the region of Carpathian Mountains was also identified in two strategic documents, one of national importance (the Strategy for Sustainable Development of the Carpathians) and the other of international importance (the Strategy for Sustainable Development for Tourism in the Carpathians), both covering cumulatively 878 territorial administrative units.

Community based tourism in Dartlo: towards a better integration of community in tourism

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Tourism has become part of development strategies aimed at revitalizing rural areas, especially mountainous areas, which are facing labor migration and destructive economic structures. Over the past decades, several concrete initiatives in mountain tourism have been promoted in Georgia, where the role of tourism is recognized as a catalyst for conservation of nature and culture, diversification of rural economy and development of strong communities [1].

We will present a case of community based tourism in the *Tusheti* mountainous region located in the north-eastern part of Georgia, with an emphasis on *Dartlo v*illage. The recently implemented projects in this village on nature conservation, revitalization the cultural heritage of a mountain village and improvement of local livelihoods encouraged locals to preserve and keep their community active and attractive [2,3,4].

The study analyzes tourism-induced changes in *Tusheti*, as a result of a well-functioning cooperation between the local community, regional municipality and international development agencies. This new approach is vastly different from the traditional tourism governance that dominated in Georgia during and after the Soviet period. The case of the *Dartlo v*illage could provide a good example for other communities in mountain regions [5].

The study is based on document analysis, qualitative interviews with different stakeholders and the authors' own project experiences.

References:

[1] Government of Georgia. Rural Development Strategy of Georgia 2017-2020 RDSG. 2017.
[2] WB. Strategic Environmental, Social and Cultural Heritage Assessment;: Executive Summary, World Bank. 2015
[3] Muhar A, Siegrist D. 10 Synergies Between Tourism, Outdoor Recreation and Landscape Stewardship. The Science and Practice of Landscape Stewardship 2017:184.
[4] Suansri, P. (2004). CBT, Community Based Tourism Retrieved 10, February, 2008, from http://www.rest.or.th/studytour/medias /chapter1eng.pdf
[5] Khelashvili.I. The Importance of Transdisciplinary Studies in Sustainable Development of Tourism. ECONOMICS AND BUSINESS, 2017, 3, pp 131-143 2017

Environmental impact of the planned ski resort SVYDOVETS: far-reaching Consequences on the ecosystems and biodiversity

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The Svydovets is a mountain range located in Western Ukraine. It is one of the highest ranges of the Eastern Carpathians, with 4 peaks higher than 1700 m a.s.l. and one peak higher than 1800 m a.s.l. More than half of all glacier lakes in the Ukrainian Carpathians (9 out of 17) are located there as well as one of the key components of the transnational composite nature UNESCO World Heritage site "Ancient and Primeval Beech Forests of the Carpathians and Other Regions of Europe."

The whole mountain range is a unique part of the Ukrainian Carpathians due to the high concentration of rare, red-listed, relict and endemic plant, animal and fungi species. The central part of the Svydovets mountain range and the upper part of the Chorna Tysa River are important for both the Ukrainian Carpathians and the entire Carpathian mountain system because they ensure the ecological stability of the region. In particular, according to the data published in "*Nature Conservation Value of the Central Svydovets Mountains (Ukrainian Carpathians)*" [1], the territory of the massif is home to 42 plant species and 51 animal species listed in the Red Data Book of Ukraine [2].

There is a number of protected areas on the territory of the Svydovets massif. In particular, the southwestern part of the massif belongs to the Carpathian Biosphere Reserve. 4 objects are nature protected areas (zakazniks) of local and national importance: Smerekovi Carpaty forest reserve, Apshynetsky hydrological reserve, Bila ta Chorna Tysa ichthyological reserve and Stanislav botanical reserve. 3 more objects are natural monuments: Vorozheska hydrological natural monument, Gerezhaska hydrological natural monument, and Andromeda botanical natural monument.

The Svydovets is also part of the Emerald Network, which is protected by international environmental treaties, including the Berne Convention [3] that is also ratified in Ukraine. The implementation of the Emerald Network principles in Ukraine will help improve the legal framework for biodiversity conservation, provide practical tools to form a national ecological network and harmonize Ukrainian environmental legislation with the standards of the EU Community, including NATURA 2000 principles. As of November 2016, the Standing Committee of the Berne Convention approved 271 objects of the Emerald Network on the territory of Ukraine. In particular, there are 2 objects on the territory of the planned resort: Skhidnyi Svydovets [4] and Marmaroski ta Chyvchyno-Hryniavski Hory [5].

Unfortunately, there are plans to build the largest ski resort in the Carpathians in this unique place. The total area of the recreational complex will cover 1430 hectares, according to the announcements

made on the planned activity [6]. 23 ropeways, 120 restaurants, 60 hotels, 390 cottages, 10 shopping centers, 17 rental equipment items, 2 bank branches, 3 fitness centers, 5 multi-storeyed parking spaces for 6000 cars, 230 km of ski tracks and 89.9 km of highways are planned to be built. Altogether, the infrastructure is designed to accommodate 22,000 people at the same time. About 800 hectares have been earmarked for housing, commercial, economic and recreational infrastructure, including the area for engineering communications. It is planned to build several reservoirs with the total volume of 1,260,000 m^3 to provide the necessary amount of water both for tourists and for the artificial snow production. Also, up to 5,800 m^3 of sewage waters will be produced by the ski resort daily and depleted directly into Bila ta Chorna Tysa ichthyological reserve, which is also a part of Marmaroski ta Chyvchyno-Hryniavski Hory Emerald site.

According to the construction plan, up to 850 ha are earmarked for deforestation in the area. More than 300 ha of the planned clearcuts are located in the water protection zone and about 330 ha is at an altitude above 1,100 meters, which should be protected by the Law of Ukraine "On the Moratoria on Clearcuts on Mountain Slopes in Juniper-Beech Forests of the Carpathian Region". Deforestation will increase the risk of soil erosion, flooding, and avalanche, land-slides, forest fires, decreased water table, inadequate water resources for domestic and commercial use, increased water pollution, decreased food production (mushrooms and berries) and loss of income due to decreased provision for natural medicine.

In general, 93 species listed in the Red Data Book of Ukraine and dozens of species of regional and international red lists will be threatened as a result of the project implementation. We insist that such large-scale anthropogenic impact on these territories that include unique habitats of rare, endemic, relict and arctic-alpine species of flora and fauna is inappropriate. Also, building Svydovets Ski Resort will violate the requirements of the national and international laws. Apshynetsky, Bila ta Chorna Tysa, Vorozheska and Gerezhaska protected areas are located directly on the territory of the potential resort, as well as Skhidnyi Svydovets and Marmaroski ta Chyvchyno-Hryniavski Hory Emerald sites. The ski resort will have a direct impact on all protected territories mentioned above.

We suggest that the territory of the Svydovets mountain range be made a protected area. There are two scenarios that we support: either create here a landscape reserve – zakaznik (IUCN category IV), as suggested by Kagalo et al (2018) [1], or include this territory into the Carpathian biosphere reserve (IUCN category II), which is preferable in our point of view. A less desirable scenario would be creating a regional landscape park on this territory. This status gives only formal or "paper" protection for the ecosystems and species, and therefore may be used by the investor as a trick to both build a ski resort and to formally comply with the request of the nature conservationists.

References:

[1] Kagalo A., Kanarsky Y., Mykitchak T., Kovtoniuk O., et al. Nature conservation value of the central Svydovets Mountains (Ukrainian Carpathians) // Bulletin of the Taras Shevchenko National University of Kyiv. Geography 1 (70). 2018. - P. 35-48.

[2] Red Data Book of Ukraine: Plant Kingdom (2009) ed. by Y. P. Didukh [in Ukrainian], Globalkonsalting, Kyiv, pp. 900

[3] Council of Europe (2014) Convention on the Conservation of European Wildlife and Natural Habitats – Resolution No. 4 (1996) listing endangered natural habitats requiring specific conservation measures (Adopted by the Standing Committee on 6 December 1996) and Revised Annex I of Resolution No. 4 (1996) (1996) (Adopted by the Standing Committee on 5 December 2014)

[4] http://natura2000.eea.europa.eu/Emerald/SDF.aspx?site=UA0000259

[5] http://natura2000.eea.europa.eu/Emerald/SDF.aspx?site=UA0000117

[6] http://eia.menr.gov.ua/places/view/288

Analysing the role of social innovation in addressing sustainability goals in the Scottish uplands and Ukrainian Carpathians

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Considerable changes have occurred in the Scottish uplands and Ukrainian Carpathians: social, including demographic (*e.g.* workers leaving); economic (renewable energy, tourism development); institutional (*e.g.* relating to new policy documents, tenure rights) and environmental (*e.g.* driven by climatic change). Some upland regions require strategies for risk prevention (*e.g.* alleviate floods, windfalls, soil erosion) and the preservation of biological, landscape and cultural diversity. For example, the decline of agriculture in some localities affects cultural landscapes via land abandonment. In other places, small private enterprises intensify wood production, *e.g.* for using biomass for energy. An expansion of small businesses (*e.g.* tourism, infrastructure or wind/hydro power), new social enterprises and social entrepreneurship (*e.g.* health care or renewable energy) and new activities (*e.g.* mountain biking) may support sustainable economic growth. However, some changes may entail environmental and social challenges to upland ecosystems and may at times threaten sustainable provision of ecosystem services.

Important research questions therefore include: How do local people residing in the Scottish uplands and Ukrainian Carpathians perceive the changes and how do they see their future? What are the pathways towards sustainability? What are the dominant attitudes to sustainable rural development and how can they be translated into policy designs and operationalised by using socially innovative tools, strategies and adaptive management practices?

The research employed a case study approach with the use of mixed methods. By addressing and comparing selected case studies in mountain areas in Scotland and Ukrainian Carpathians, it has developed a better understanding of: (i) human-environmental interactions pertaining to social-ecological systems (SES), which is considered to be crucial for the designing innovative responses to address contemporary challenges in uplands and to enhance the systems' resilience; (ii) the perception of pathways to change by relevant stakeholders to suggest tools and strategies to enhance the resilience of SES and advance the well-being outcomes derived from these; (iii) management options, policies or institutional arrangements -- responses (*e.g.* social innovations) -- to assist in overcoming the challenges and achieving the SES sustainability at a local scale.

The pilot findings indicate that deliberative governance systems can enhance the collective agreement - hierarchically, inter-sectorally and spatially - on (i) how to attain desirable trade-offs between non-marketed and provisioning ecosystem services in a locality, and across the territory and (ii) which strategies, policy instruments and management tools to use in order to promote a more sustainable delivery of ecosystem services. Participatory decision-making processes and collaborative networks, involving scientists and other relevant stakeholders, can assist in the development of a better understanding of the drivers and pathways of change, and of how these drivers may affect marginalised rural areas and local communities residing in these areas.

Pathways to change, with opportunities and challenges that local communities in the Scottish uplands and Ukrainian Carpathians are currently facing, have been uncovered. The results offered some useful insights into innovative responses to address these challenges, including through the development of a better understanding of social innovation and linked novel governance mechanisms, specifically in the context of rural development; advancing the knowledge of success factors and the subsequent enhancement of social innovations in rural areas in the uplands.

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Understanding social innovation for the well-being of rural communities: a preliminary theoretical framework

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The debate on social innovation has rapidly expanded over the last decade. There are considerable expectations of the potential of social innovation for addressing urgent societal challenges in rural communities living in mountain regions. Forests provide a long list of benefits to people and are vital to communities. Sustainable use of forest ecosystem services can provide a substantial contribution to the wellbeing of those communities. In spite of the importance of forest in climate change mitigation highlighted since Rio Earth Summit in 1992, potential of rural communities living in mountain regions has been overlooked in a long term.

We follow approach developed in the Horizon2020 project SIMRA (Social Innovation in Marginalised Rural Areas) and explore social innovation in rural communities as *"reconfiguration of social practices, in response to societal challenges, which seeks to enhance outcomes on societal well-being and necessarily includes the engagement of civil society actors"*. Informed by innovation theory the principal concern of the paper is to determine the types of SIs, which are likely to occur in marginalized rural areas (MRAs), and what can be done to enhance the innovation potential across different types of MRAs. Emergence of social innovations is seen as the collective action, which is comforted or distracted by its surroundings and societal challenges that are affecting dynamics of changes. A key questions to be addressed are: *Why communities in some MRAs respond to societal problems? How to integrate experience and local knowledge on forest ecosystem services,* self-organization and shared responsibility *into the forest governance to enhance wellbeing?* In particular the aim is to i) identify the patterns that enable and constrain (lock-ins, path-dependencies) efforts for social innovations in rural communities living in mountain regions to emerge, nurture and develop, ii) present framework for understanding relationships, variables and trajectories of SI in marginalized regions and apply them for rural communities.

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Social innovations in the mountain region environment: conversion of secondary Norway spruce stands in a focus

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Nowadays, when humanity operates at the edge of the planetary boundaries [2], the adequate solutions to tackle the challenges have to be developed. In recent approaches a complex nature of the real-world problems is described as a nexus of interrelated non-linear processes. Ability of co-evolving social and ecological systems to self-organization and emergent behavior, as well as to converge towards an own attractor(s) reveals the necessity to act on a higher level and to apply a transdisciplinary approaches to activate and mobilize stakeholders' knowledge, willingness and ability to solve the problems in a systemic way.

Conversion of even-aged Norway spruce stands in the Ukrainian Carpathians is one of such challenges [4]. Quality of mountain forest ecosystems determines local people wellbeing. Complexity of stakeholders' interests should be analyzed with an aim to get an insight into the role and interest of each stakeholder of the process and to present it in a comprehensive way. Stakeholder analysis [1] enables a decision-maker to identify winners and losers, initiators and impacted stakeholders and, therefore, understand support and opposition groups to the process. Stakeholders networking, interacting and knowledge exchange will significantly increase bilateral trust and help to enhance the conversion process. As literature on social innovations shows, participatory approaches and networking stimulate stakeholders to develop own innovative instruments for payment or compensating the forest ecosystem services providers and, as a result, to improve environmental quality and human wellbeing.

We tested a hypothesis on impact of social interactions on a diffusion of innovative activities with an agent-based model of a forest cluster activity greening [3; 5] and revealed that number of links among agents significantly impacts a speed of the process, especially on the initial stage.

Acknowledgement: *The agent-based model of eco-innovations diffusion in a forest cluster activity was developed under the framework of Fulbright Scholarship Program at the Portland State University, Oregon, USA in 2016-2017.*

References:

[1] *Pelyukh O., Zahvoyska L, Maksymiv L., 2018. Analysis of stakeholders' interaction in the context of secondary Norway spruce stands conversion in the Ukrainian Carpathians. In: Sustainable forest management for the future – the role of managerial economics and accounting. IUFRO Research unit(s): 4.05.00, 4.05.01, 4.05.02, 4.05.03. Book of abstracts. Book of abstracts. May 10-12, 2018, CFI, Zagreb: 22-24.*

[2] *Rockström J., Steffen W., Noone K., Persson Å., Chapin II, F. S., Lambin E., ... & Nykvis B., 2009. Planetary boundaries: exploring the safe operating space for humanity. Ecology and society 14(2).*

[3] *Sotnik G. G., 2015. Theoretical and Methodological Foundations of the Social Human Extension (SHE) for LANDIS-II. In International Scientific Conference" Problems of Information Economy Formation in Ukraine. Lviv National University, Lviv: 106-112.*

[4] *Spiecker H., Hanse, J., Klimo E., Skovsgaard J.P., Sterba H., von Teuffel K., 2004. Norway spruce conversion - options and consequences. European Forest Institute Research Report 18: 25-62.*

[5] *Zahvoyska L., 2018. An agent-based simulation of internalization of externalities with a focus on a forest cluster. In: 3rd International Scientific and Expert Conference "Natural resources, Green Technology and Sustainable Development", Zagreb, 2018. (In press).*

What are the attitudes of local stakeholders towards multi-functional changes in woodlands of the Ukrainian Carpathians?

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In this research stakeholder attitudes towards ecosystem-based forest strategies and management practices in marginalized mountain areas of the Ukrainian Carpathians were analysed. The focus was on multi-functional changes in upland woodlands, as those were viewed by relevant stakeholders. A final goal was to assist decision-makers in evaluation (e.g. through stakeholder evaluation using the suggested method) and implementation (through stakeholder engagement) of sustainable forest policy and management decisions. The Q-method, with the sequential application of its correlation and factor analytical tools, was applied to elucidate a range of existing attitudes (e.g. towards the expansion of woodlands under climate change and other drivers) and the spectrum of sustainability (its ecological, economic and social components) to which they relate. Dominant attitudes of representatives of relevant stakeholder groups towards multi-functional changes in forestry in the Carpathian Mountains were revealed and explained, along with key factors influencing the attitudinal diversity. The results improve our understanding of stakeholder priorities and of commonalities and differences in existing attitudes/perceptions, providing some indication of how the diversity of attitudes towards forestry changes (e.g. integration of woodlands in mountain landscapes) could potentially influence sustainable forestry decisions, including those promoting participation and enhancing social innovation. At times, entirely opposite attitudes (e.g. of the so-called Conservationists and Productivists attitudinal groups) towards forestry practices and key objectives of forestry in the Carpathian uplands were revealed. However, it was found out that overall people put strong emphasis on multi-functional forestry and stakeholder engagement in decision making processes.

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The impact of agrotourism as a function of women's professional activation

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Since 1990s rural communities in Poland have undergone significant economic transformations. These have particularly affected the residents of the Carpathian Mountains. Decline in traditional branches of economy has prompted the region to seek new pathways for local development with a view to enhance the well-being of rural communities and bring them towards the goal of sustainability. Service sector industries, such as agrotourism, are seen as means to facilitate entrepreneurship and improve employment opportunities. Agrotourism helps residents of rural communities utilise environmental capacity of the region for the purpose of socio-economic development. It enables effective combination of traditional agricultural activities and tourist services provision. Women have the primary responsibility for running, maintaining and managing the agrotourism business, due to its close affinity with hospitality - traditionally a woman's territory.

This paper aims to better understand women's participation in the development of agrotourism in the Polish Carpathian Mountains. It demonstrates how engagement in agrotourism activities may enhance women's social empowerment in rural communities.

In order to address these research aims a multistage and qualitative methodology was developed. The materials collected during interviews with the managers of purposefully selected agrotourism farms were fundamental for solving the research problem. I conducted seventy in-depth interviews (between 2012-2014) with women - managers of purposefully selected agrotourism farms, using a previously verified questionnaire (19.5% of the agrotourism farms in the area of the Polish Carpathians within Małopolskie voivodship borders).

The study shows the key role played by women in the development of agrotourism activities in the region. This has transformed traditional family relationships with the function of household head now attributed to women. Agrotourism develops familial forms of entrepreneurship. Women mostly engage in guest service, combining it with family responsibilities and farm work. As managers, they are responsible for organizing the accommodation, nourishment and other services provided to guests. Women make business decisions, represent their own family vis-à-vis visitors, solve problem situations. They accept the necessity of reconciling this with their numerous other duties because such reconciliation is closely related to the traditional perception of the way of life in the countryside, where one's own duties should be performed rather than relegated to family members. Obtaining income and the development of professional activity provided women with a subjective sense of satisfaction, "comfort" and independence. Women saw it as their own contribution to the livelihood of the household.

The development of agrotourism does not lead to the creation of new jobs, but to the multiplication and intensification of the duties already performed by members of the household. Organizational changes of a household as a result of tourism are progressive and with the acceptance of family members do not lead to conflict and do not destroy the family order. Together family members shape the system of relationships in their division of duties. In the managers' threefold sphere of duties, work for the benefit of tourists is perceived by them as a professional activity, unlike running a farm and a household, which are not classified as a profession.

The manner in which female managers run their own homes determines the success of their agrotourism activity. The managers' individual predispositions for building interpersonal relationships related to female personality traits, such as empathy, care, intuition or patience. The success of running an agrotourism farm is also determined by their attitudes and managerial skills, such as the ability to organize work, coordinate duties, make independent decision and take independent actions. All personal qualities, competences and interpersonal contacts are defined by the individual social capital of the managers, which creates the economic value of an agrotourism farm. Developing their own qualities and abilities, women build an "agrotourism product" on their farm. The personal involvement of women managers and the development of their individual social capital is reflected in the process of their empowerment. The development of agrotourism allows women in rural areas of the Polish Carpathians to overcome their social isolation.

The lack of institutional support towards women empowerment hampers collaboration between individual agrotourism businesses, hinders networking opportunities and restricts formation of collaborative partnerships. In the absence of institutional support, informal contacts with neighbours represent the only opportunity for women to share experiences and 'best practices'. Women's engagement in agrotourism has enhanced their societal role and facilitated better involvement in community activities in the region.

Disturbance-based management for old-growth characteristics and late-successional functions in mesic temperate forests

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Introduction

Sustainable forestry practices contribute to watershed functioning, carbon sequestration, and biodiversity conservation as well as the provision of harvestable resources. A challenge lies in determining the mix of management approaches – including type, timing, intensity, and spatial configuration of silvicultural treatments – necessary to achieve sustainable forest management objectives. One possibility is to focus on the architecture of individual forest stands and their spatial arrangement, with the goal of increasing the complexity of stand development conditions and habitat representation at landscape scales (1). Patch and forest development dynamics associated with natural disturbance regimes provide a useful guide for designing this type of disturbance-based approach (2). In North America as in Europe, there is growing interest in disturbance-based silviculture as a way to restore under-represented habitats and elements of biodiversity as well as other ecosystem functions in temperate landscapes. Restoration of old-growth forest characteristics to a portion of the secondary temperate forests that predominate in some mesic temperate landscapes, including the eastern United States and parts of the Carpathian Mountain region, is one such example (3).

This study tests the hypothesis that an approach called "Structural Complexity Enhancement" (SCE) can accelerate rates of late-successional/old-growth structural development and sustain a broader array of biodiversity in northern hardwood-conifer forests compared to conventional selection systems. Additional research associated with this project has examined carbon fluxes and storage in aboveground pools as well as economic tradeoffs.

Methods

The on-going, long-term project employs a Before-After-Control-Impact experimental design to compare SCE against two modified uneven-aged treatments, single-tree and group selection. Manipulations and controls were applied to 2 ha experimental units and replicated four times at two research areas in the Green Mountains of Vermont, USA. The selection treatments and controls were replicated two additional times at a study area in the Adirondack Mountains of New York, USA. Structural objectives for SCE include vertically differentiated canopies, elevated standing dead and downed coarse woody debris (CWD) densities, small canopy gaps, and re-allocation of basal area to larger diameter classes. The latter objective is achieved using an unconventional marking guide based on a rotated sigmoid target diameter distribution. The marking guide is also derived from a target basal area (34 m^2/ha.) and maximum diameter at breast height (90 cm) indicative of old-growth structure. Accelerated growth in larger trees is further promoted through crown release. Prescriptions for enhancing snag and downed woody debris densities are based on stand potential. On some units downed CWD is created by pulling trees over to create pits and exposed root wads. Variable density horizontal structure, including small gaps (0.02 ha mean), is an explicit objective of SCE, whereas the group selection openings average 0.05 ha in size and are intended to emulate the reported scale of canopy gaps in the region (4). Legacy (or residual) trees are retained within gaps to further approximate natural disturbance effects.

Data on aboveground carbon pools, soils, vegetation, herpetofauna, and fungi were collected over two years pre-treatment and ten years post-treatment. Operational expenses and revenue, sorted by treatment unit and product grade, were tracked during and after logging operations, as was information on market conditions. Analyses consisted of a variety of univariate and multivariate statistical approaches. These examined both empirical response data as well as stand development projections made using the Forest Vegetation Simulator (FVS).

Results and Discussion

There will be significant differences in stand development based on FVS simulation modeling. Late-successional structural characteristics will develop to a greater degree under SCE. Large tree recruitment rates were related primarily to the form of residual diameter distributions and, possibly, to maximum diameter limits. Ten years after harvest, measured aboveground biomass in SCE units was 15.9% less than simulated no-harvest baselines, compared to 44.9% less in conventionally treated areas (5). While passive management yields the greatest carbon storage when accounting for both in-situ pools and wood products (6), SCE achieves values significantly closer to this baseline relative to conventional management (P=0.006).

All treatments were successful in maintaining overall richness and/or abundance of understory plants, terrestrial salamanders, and fungi. Statistical model results show that over time, understory plant responses were strongly affected by overstory treatment and less influenced by soil chemistry and drought stress. However, diversity for sensitive, late-successional herbaceous plants increased significantly in SCE units and decreased significantly in the semi-open canopied conditions within group selection units (7). Fungi and salamander responses were strongly associated with microsite characteristics, particularly CWD, and increased significantly ($P < 0.05$) under SCE, but showed no statistically significant decrease in gaps created by group selection in comparison to controls (8, 9). Tree regeneration responses for SCE were sufficient to sustain merchantable growth and yield as well as a diversity of species, though competition with beech sprouts was a limitation under all the treatments tested (10). The results suggest that a variety of silvicultural techniques can help maintain late-successional biodiversity in managed forests, so long as they promote structurally complex stand conditions.

SCE is economically profitable or breaks even under the right site and market conditions, but does not maximize timber revenue. Potential applications include old-growth restoration, riparian restoration, carbon management, and low intensity commercial forest management. Silviculture for old-growth forest structure can contribute to biodiversity conservation and terrestrial carbon storage on temperate forested landscapes while providing both timber and non-timber economic opportunities.

References

[1] Fahey, R.T., B. C. Alvesherea, J.I. Burton, A.W. D'Amato, Y.L. Dickinson, W.S. Keeton, C.C. Kerne, A.J. Larson, B.J. Palik, K.J. Puettmann, M.R. Saunders, C.R. Webster, J.W. Atkins, C.M. Gough, and B.S. Hardimani. 2018. Shifting conceptions of complexity in forest management and silviculture. 421: 59-71

[2] North, M.P. and W.S. Keeton. 2008. Emulating natural disturbance regimes: an emerging approach for sustainable forest management. Pages 341-372 in: R. Lafortezza, J. Chen, G. Sanesi, and T. R. Crow (eds.). Patterns and Processes in Forest Landscapes - Multiple Use and Sustainable Management. Springer, The Netherlands.

[3] Keeton, W.S. 2006. Managing for late-successional/old-growth characteristics in northern hardwood-conifer forests. Forest Ecology and Management 235: 129-142.

[4] Kern, C. C., J. Burton, P. Raymond, A. D'Amato, W.S. Keeton, A.A. Royo, M.B. Walters, C.R. Webster, and J.L. Willis. 2016. Challenges facing gap-based silviculture and possible solutions for mesic northern forests in North America. Forestry 90: 4-17.

[5] Ford, S.E. and W.S. Keeton. 2017. Enhanced carbon storage through management for old-growth characteristics in northern hardwoods. Ecosphere 8:1-20.
[6] Nunery, J.S. and W.S. Keeton. 2010. Forest carbon storage in the northeastern United States: net effects of harvesting frequency, post-harvest retention, and wood products. Forest Ecology and Management 259:1363-1375.
[7] Smith, K.J., W.S. Keeton, M. Twery, and D. Tobi. 2008. Understory plant response to alternative forestry practices in northern hardwood-conifer forests. Canadian Journal of Forest Research 38:1303-1318.
[8] Dove, N.C and W.S. Keeton. 2015. Structural complexity enhancement increases fungi diversity in northern hardwood forests. Fungal Ecology 13: 181-192.
[9] McKenny, H.C., W.S. Keeton, and T.M. Donovan. 2006. Effects of structural complexity enhancement on eastern red-backed salamander (Plethodon cinereus) populations in northern hardwood forests. Forest Ecology and Management 230: 186-196.
[10] Gottesman, A. and W.S. Keeton. 2017. Regeneration responses to management for old-growth characteristics in northern hardwood-conifer forests. Forests 8 (45): 1-21.

Forest management and future dynamics of the Carpathian forest landscape

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Carbon accumulation and timber provision are two important services provided by Carpathian forest ecosystems. However, continued provisioning of these services is uncertain due to climate warming and intensification of natural disturbances. These are likely to cause pronounced changes in the spatial distribution of tree species and forest types and an associated reduction in carbon stocking. Therefore, the goal of this study is twofold: (1) to explore how climate change may affect timber resources in the region; and (2) to find out how forest management options can mitigate climate change effects on services associated with Carpathian forest ecosystems.

The study is a continuation of previous research simulating stand and landscape dynamics in Carpathian forests under scenarios of climate change and disturbances [1]. The study area of 1340 km^2 is located in the Tysa (Tisza) headwater basin of Ukraine. These are predominantly medium and low mountains as well as some hills spanning elevations of 265 – 1600 m. The area encompasses the main natural forest types of Central Europe (including *Carpinion betuli*, *Dentario glandulosae – Fagenion*, *Luzulo – Fagenion*, and *Piceion excelsae*) as well as intensively managed forests dominated by Norway spruce. Strictly protected, predominantly mature and old-growth, forests in core and buffer zones of the Carpathian Biosphere Reserve occupy 13% of the area.

We are using a model of forest landscape change, LANDIS-II [2], to simulate the effects of alternative management regimes on spatiotemporal trajectories of forest succession under scenarios of climate change and natural disturbance. We selected the six most common tree species in the region (Norway spruce, European beech, silver fir, sessile and pedunculated oaks, sycamore maple, and common hornbeam) to trace the development of their aboveground live carbon (ALC) as well as the amount of timber extracted by harvesting. The climate scenarios encompass four Representative Concentrations Pathways (RCP2.6, RCP4.5, RCP6.0, RCP8.5) and a baseline scenario as reference. Natural disturbances are represented by the two most common agents of the region: wind and spruce bark beetle. Forest management scenarios include (1) business as usual (BAU) harvesting based on clearcutting, and (2) adaptive harvesting differentiated along site conditions and forest types with foresighted planting of oak, beech, and fir. We will simulate forest management for 100 years and then continue running the model for another 200 years without management to trace long-lasting legacy effects of management on forest composition and carbon stocks.

The LANDIS-II model requires parameters describing tree species' life history attributes and landscape conditions. The main life history attributes are: longevity, sexual maturity, seed dispersal capacity, and shade tolerance. This information was derived from the literature. The landscape conditions are represented by four raster geodatasets of: (1) initial communities as combinations of the species' age groups (cohorts) within forestry compartments, (2) ecotopes as ecologically homogeneous landscape units representing site conditions, (3) stands as elementary management units coinciding with forestry compartments/initial communities, and (4) management areas as collections of stands to which specific management prescriptions are applied. The geodatsets of initial communities and stands containing 22,624 records were obtained from official large-scale

forestry maps linked to the database management system. The 108 classes of ecotopes were derived via processing of the Shuttle Radar Topography Mission data considering altitude, proximity to the watershed outlet, topographic position, and slope. We attributed ecotopes with values describing each species' probability of establishment, maximum aboveground annual net primary production, and maximum possible aboveground biomass. Additional parameters characterized the exposure of ecotopes to the natural disturbances. The necessary information was interpreted mainly from the forestry database. We delineated 12 management areas considering natural forest altitudinal zones and roughness of the terrain. Strictly protected areas were excluded from management simulations.

To date, we have simulated the development of carbon stocks under BAU harvesting for baseline and RCP6.0 climate scenarios. Parametrization for these scenarios is based on the Ukrainian official regulations and historic logging data, which provide for clearcutting in stands of 50 years and older with an average extent of 0.34% of all managed forested area per year. Also, BAU management did not provide for active changes in spruce forest composition (e.g., increasing proportion of fir and beech) relying on natural regeneration instead. BAU harvesting was sustainable during the first 50-80 years of the simulation period allowing ALC to increase. Afterwards, this trend reversed and carbon stocks and harvest volume declined. Our simulations revealed that climate change may initially accelerate productivity of the ecosystems, and hence contribute to a moderate increase of ALC and harvest volume. For example, by year 60, ALC stocks on the landscape were by 4.5% (4.7 Mg ha^{-1}) higher under the RCP6.0 scenario as compared to current climatic conditions. The harvested biomass was also 3.9% higher. However, climate warming shortened the duration of the initial "sustainable" period of accelerated productivity and higher harvesting rates. For example, under the baseline climate scenario, the duration of the initial "sustainable" period was 80 years, while under the RCP6.0 it was 60 years. Climate change also accelerated the decline of ALC following the "sustainable" period. For example, by year 100 (the final year of simulated harvesting), ALC stocks on the landscape were only by 2.7% (2.9 Mg ha^{-1}) higher under the RCP6.0 scenario than under the baseline. The harvested biomass was higher only by 1.0%. The reduction of potential future carbon stocks was caused by the decline of even-aged spruce plantations at low and medium elevations, which was observed even under the baseline climate scenario, and was significantly amplified under climate change scenarios. This also affected volumes of harvested spruce. For example, by year 100, 7.9% less spruce was harvested under the RCP6.0 scenario than under the baseline. The effects of BAU harvesting on the ALC trajectories were traced for another 80-110 years after the end of harvesting simulations. These effects resemble natural disturbances, which predominantly affected even-aged spruce plantations and thus smoothed ALC oscillations caused by fast initial growth and subsequent decline of these productive, but unstable, forests. In the same way, BAU management, which is oriented on spruce as a priority species, facilitated reduction of spruce-dominated stands via harvesting. We conclude that BAU management is not a sufficient strategy to continuously provide ecosystems services in the Ukrainian Carpathians. We will also explore alternative management strategies in this study.

References:

[1] Kruhlov, I., Thom, D., Chaskovskyy, O., Keeton, W.S., Scheller, R.M., 2018. Future forest landscapes of the Carpathians: vegetation and carbon dynamics under climate change. Reg. Environ. Change 18: 1555–1567.

[2] Scheller, R.M., Domingo, J.B., Sturtevant, B.R., Williams, J.S., Rudy, A., Gustafson, E.J., Mladenoff, D.J., 2007. Design, development, and application of LANDIS-II, a spatial landscape simulation model with flexible temporal and spatial resolution. Ecol. Model. 201: 409–419.

Quantification of natural disturbances in the European mountain spruce forests as a guideline for management

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As unsuitable forest management is causing significant threats in many areas of the world, many foresters believe that using natural disturbance patterns of primary forests as a guideline for management will guarantee the long-term sustainability of forest ecosystem structure, composition and functions.

Here we quantify the historical natural disturbances on the large network of sample plots in the primary mountain spruce forests of Central and Eastern Europe. We did the tree-ring disturbance reconstruction and calculated severity, patch size and proportion of stand affected for each disturbance event during last two centuries.

We described large variation in disturbance characteristics with smaller scale events being more frequent that agrees with the mixed-severity disturbance regime concept. Third quartile of the disturbance severities, patch sizes and proportion of stand affected was 39%, 8 ha and 40%. Moderate size and severity disturbance events were important in these forests. The obtained variations in natural disturbance events can serve as a guideline for managing commercial forests in similar conditions particularly for harvest rotation, size and intensity.

(www.remoteforests.org)

Disturbance history and present structure of primary mountain Norway spruce forests in Slovakia, lesson from the past development

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Forest ecosystems are substantially shaped by various disturbance regimes. It is highly important to get knowledge about history of forest disturbances for understanding recent processes and their influence on forest structure. In Europe most of the forest ecosystems are under heavy influence of forest management and it makes very difficult to disantangle natural processes against antropogenic influence. For observing forest dynamics and structure, primary forests with minimum anthropogenic influence are crucial. Such preserved ecosystems within Europe are found in Carpathian Mountains. Further, in perspective of increasing climate change effect on the ecosystems, the importance of such studies is nowadays even more urgent. Following the recent large-scale disturbances in spruce forests in Slovakia, there was much debate among forest managers regarding the future forest development and integrity of these recently disturbed mountain forest ecosystems. Knowledge about these ecosystems is therefore a keystone for science-based forest management decisions. Our main aim was to study disturbance regimes and their influence on the present forest structure of primary mountain spruce forests in Slovakia.

To study such a complex question of forest dynamics and structure, we established 184 plots (1000 m2) using a stratified random design in 14 localities in the primary mountain Norway spruce forests in Slovakia. On each plot we surveyed the living and dead trees, CWD, and regeneration, and cored around 25 random canopy trees. Disturbance history was reconstructed by examining individual tree growth trends, which we represented by rapid early growth or release after suppression. Afterwards, tree level disturbance chronologies were transformed to the percent of the canopy area disturbed. Further, study plots were aggregated into groups based on the disturbance history (severity and timing) to evaluate and explain its influence on the forest structure.

Reconstructed disturbance history spanned from the late 18th century to the end of the 20th century. Broad landscape peaks of disturbances were evident in 1810 – 1820 and 1840 – 1880, further less pronounced peaks were detected in 1910 – 1930, and 1950 – 1970. A complex mixed disturbance regime dominated by low and moderate severity disturbances was observed, however, broad spatiotemporal synchronicity of disturbances and tree recruitments were present at the landscape level in the 19th century (about 60 % of trees established). Stand structural parameters like DBH and age stand structure were strongly influenced by long-term disturbance regimes. In contrast, the effect of disturbances on parameters like amount of CWD and regeneration was not significant. High mean densities of regeneration with the height >50 cm (about 1400 individuals per ha) were observed, but a variability of regeneration density was rather high on individual plots. It is in accordance with natural regeneration patterns leading to more heterogeneous structure in future.

Disturbance history of mountain forests was shaped by heterogeneous disturbance regimes with different severity, temporal and spatial scale. Although the disturbance history was temporally and spatially diverse, synchronicity in the stand development was found. We found some evidences for predispositions for recent severe disturbance events observed in Slovakia and found these events as a part of the range of natural variability. The effect of disturbance history on forest structure was rather variable. Surprisingly, the effect of disturbance history on parameters like amount of CWD and regeneration was not significant. In the study area rather high amount of regeneration coupled with the high amount of CWD under all different disturbance regimes was detected. It seems that these ecosystems were adapted to be severely damaged in every time of their development and after that naturally regenerate by already existing young trees. Our study highlights the role of natural disturbance patterns and related structure as important information for forest management authorities.

Are forests getting younger? A case study of environmental changes impact on growth dynamics of old-growth forests of Carpathians

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From the beginning of 21st century, throughout Europe a lot invaluable data has been produced from dendo-ecological studies of primary forests, trying to connect the pieces of the growth-age-size relationship puzzle [1-6]. In forest ecology today, one of the pivotal research interests is how forests respond and adapt to recent varying environmental changes through a response in growth. As trees age, they undergo complexed physiological and morphological changes, mostly visible as low photosynthetic rates, reduced growth, leaf size reduction as well as metabolic changes due to changes in tree size and structural complexity [7-9]. Maximum longevity of the species is *a priori* considered achievable through reduced growth, describing tree longevity as a factor of genetic differences as well as environmental influences, thusly emphasizing size and environment as main constraints to achieving old-age. Tree and stand development are driven by various factors, rather than mere age [10], and due to increased resource availability, as well as the impact of climate [11] and stand development history [12, 13], both are starting to age faster than was noted in the past [14, 15]. On the other hand, growing average temperatures have been empirically proven to benefit forest growth of mountainous spruce stands [16, 17], causing faster growth rates and earlier canopy ascension, which may lead to higher mortality with age.

Based on tree-ring analysis, growth rates of approx. 5500 individual Norway spruce trees from 11 *Picea abies* stands in the Slovakian Carpathians were classified into 30-year age classes. Growth rates were calculated as basial area increment (i.e. BAI) for all individual Norway spruce trees and averaged for each site. In order to fully realize the trade-off relationship between age and growth on different sites, repeated-measure of variance (ANOVA) was used. As a result, we found that most trees in all age classes exhibit an increasing BAI throughout their lives. A positive correlation was found between growth rates and size, but negative with age, which is attributed to the fact that young trees show substantially faster growth at the same age as slow-growing trees, but have shorter lifespan in comparison. The slowly increasing BAI in the oldest trees, in recent decades, is a continuation of their growth pattern established in previous centuries.

Furthermore, growth rates of individual trees in the last 30 years (since the theoretically accepted beginning of climate change) will be compared to the past growth trends, life history of individual trees (e.g. release vs suppressed; [13]), disturbance histories on different spatial scales (plot/stand), N-deposition and changes of environmental factors (temperature, precipitation, N of sunny days). Linear mixed-effect model will be applied to correlate and differentiate impact of driving growth-factors and age of developing spruce stands. Our results should be able to contribute to the hypothesis of stimulatory effects of global change phenomenon (both climate and land-use history) on forest development.

References:

[1] *Black, B.A., Gillespie, D., Maclellan, S.E., Hand, C.M. (2008b) Establishing highly accurate production-age data using the tree-ring technique of crossdating: a case study for Pacific geoduck (Panopea abrupta). Canadian Journal of Fisheries and Aquatic Sciences, 65, 2572–2578*

[2] *Bigler, C., Veblen, T. A., (2009) Increased early growth rates decrease longevities of conifers in subalpine forests. Oikos 118(8):1130 – 1138*

[3] *Bowman, D.J.S.M., Brienen, R.J.W., Gloor, E., Phillips, O.L., Prior, L.D. (2013) Detecting trends in tree growth: not so simple. Trends in Plant Science, January 2013, Vol. 18, No. 1*

[4] *Di Filippo, A., Pederson, N., Baliva, M., et al. (2015) The longevity of broadleaf deciduous trees in Northern Hemisphere temperate forests: insights from tree-ring series. Frontiers in Ecology and Evolution, 3, 46.*

[5] *Latte, N., Lebourgeois, F., Classen, H. (2015) Increased tree-growth synchronization of beech (Fagus sylvatica L.) in response to climate change in northwestern Europe. Dendrochronologia 33 (2015) 69–77*

[6] *Bigler, C. (2016) Trade-Offs between Growth Rate, Tree Size and Lifespan of Mountain Pine (Pinus montana) in the Swiss National Park. PLoS ONE 11(3): e0150402. doi:10.1371/journal. pone.0150402*

[7] *Carrer, M. and C. Urbinati. 2004. Age-dependent tree-ring growth responses to climate in Larix deciduas and Pinus cembra. Ecology 85:730–740O'Neil R.V., 1989. Perspectives in hierarchy and scale. In: Roughgarden J, May RM, Levin SA (Eds.), Perspectives in Ecological Theory. Princeton University Press, Princeton, NJ, USA, pp.140–156.*

[8] *Martınez-Vilalta, J., D. Vanderklein and M. Mencuccini. 2007. Tree height and age-related decline in growth in Scots pine (Pinus sylvestris L.). Oecologia 150:529–544*

[9] *Johnson, S.E., Abrams, M.D. (2009) Age class, longevity and growth rate relationships: protracted growth increases in old trees in the eastern United States. Tree Physiology 29, 1317–1328*

[10] *Popa, I., Nechita, C., Hofgaard, A. (2017) Stand structure, recruitment and growth dynamics in mixed subalpine spruce and Swiss stone pine forests in the Eastern Carpathians. Science of the Total Environment 598 (2017) 1050–1057*

[11] *Primicia, I., Camarero, J. J., Janda, P., Čada, V., Morrissey, R. C., Trotsiuk, V., Bače, R., Teodosiu, M., Svoboda, M. (2015) Age, competition, disturbance and elevation effects on tree and stand growth response of primary Picea abies forest to climate. Forest Ecology and Management 354, 77–86*

[12] *Trotsiuk, V., Svoboda, M., Janda, P., Mikolas, M., Bace, R., et al. (2014) A mixed severity disturbance regime in the primary Picea abies (L.) Karst. forests of the Ukrainian Carpathians. For. Ecol. Manage. 334, 144–153*

[13] *Svoboda, M., Janda, P., Bače, R., Fraver, S., Nagel, T.A., Rejzek, J., Mikolaš, M., Douda, J., et al. (2014) Landscape-level variability in historical disturbance in primary Picea abies mountain forests of the Eastern Carpathians, Romania. Journal of Vegetation Science 25 (2014) 386–401*

[14] *Jactel, H.G., Gritti ES, Drossler, L., Forrester, D.I., Mason, W.L., Morin, X., Pretzsch, H., Castagneyrol, B. (2018) Positive biodiversity– productivity relationships in forests: climate matters. Biol. Lett. 14: 20170747*

[15] *Pretzsch, H., Dieler, J., (2011) The dependency of the size-growth relationship of Norway spruce (Picea abies [L.] Karst.) and European beech (Fagus sylvatica [L.]) in forest stands on long-term site conditions, drought events, and ozone stress. Trees 25, 355–369.*

[16] *Cienciala, E., Altman, J., Doležal, J., Kopaček, J., Štepanek, P., Stahl, G., Tumajer, J. (2017) Increased spruce tree growth in Central Europe since 1960s. Science of the Total Environment xxx (2017) xxx–xxx*

[17] *Ponocna, T., Spyt, B., Kaczka, R., Buntgen, U., Treml, V. (2016) Growth trends and climate responses of Norway spruce along elevational gradients in East-Central Europe. Trees, October 2016, Volume 30, Issue 5, pp 1633–1646*

The role of outdoor exploration in the evolution of ecological identity

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As part of environmental education we principally aim at organizing educational events to increase public awareness about an environmental issue, we are, however, less familiar with the effect free-choice outdoor exploration has on environmentally conscious behaviour. This poster gives you an insight into the research I conducted in my thesis within the frame of the MSc Program at the Department of Human Ecology at Eötvös Loránd University on the impact of free exploration on the development of ecological identity. Based on my hypothesis, the impact of free exploration on the formation of ecological identity is more significant than that of other factors. In order to examine this hypothesis I made narrative interviews with twelve Environmental Studies and twelve Engineering students in order to map the factors determining professional interests (Palmer & Neal, 1988) and the strong emotional experience related to nature (Piskóti, 2015), as these two factors can considerably affect the formation of ecological identity. The novelty of my findings is demonstrating that significant amount of experience related to free exploration mentioned in the interviews and the appearance of negative emotions related to the organized environmental educational events, both are significantly connected to students' ecological identity.

References

Palmer, J. & Neal, P. (1994). The Handbook of Environmental Education, Routhledge, New York, (1998, Hungarian Translation, Körlánc Association, Budapest)

Piskóti, M. (2015). The Role of Environmental Identity in the Formation of Environmentally Conscious Behaviour, Doctoral dissertation, Doctoral Scool of Management Studies, Corvinus University, Budapest.

Denzicam

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DenziCam is an android application which will act as a digital densiometer, a tool used by field biologists to determine different data about the analysed vegetation, by analysing the coverage of plants. The application initially would concentrate on data gathered by analysing the foliage of a forest. For example, it can provide us approximate data about the average amount of carbon dioxide bound and oxygen released in the proximate area of the observation.

After the user starts the app he/she can start the analysis right away, by taking a photo with his/her phone of the forest's foliage above. Then the user can tap on the leaves and hit the scan button. The application will highlight the foliage with a striking colour leaving the open skies untouched. The User can alter the scan's result by tweaking tolerance level, what determines the range of colour that the scan highlights. If the highlight covers the whole foliage the user can press the analyse button to see the ordinary results.

The user can make the estimations more accurate by adding additional information for the application like the types of trees in the area form the provedid list of 30 species, or the perimeters of the trees. Of course in the end of the process the User can name and save the results, which consists of the approximate age of the forest, the average amount of bound carbon dioxide, released oxygen and the GPS coordinates of the 100 square meter area.

Long-term habitat area changes and effects of nature protection - a countrywide study of Natura 2000 habitats in Hungary

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Biodiversity loss necessitates a broader assessment of habitats loss. Most studies on long-term changes apply land-cover or land-use categories as cartographical and remotely sensed data-sources support this approach. Division of land-cover categories into habitat types offers an opportunity to reconstruct long-term habitat area changes. Habitat specific data could help increase effectiveness of conservation and communicate changes to policy makers and the public.

We estimated long-term habitat changes for the whole of Hungary from 1783 for 7 time periods in 5000 randomly selected localities. We used different sources, historical maps, archival and recent aerial photos and satellite imagery, botanical and other descriptions, recent thematic layers and field data. ArcGIS10.1.ESRI software was used for managing the database and exporting relative frequency data based on estimation probability by Python scripts. For identification of past habitat types a point-based method was developed using iterative habitat identification and information transfer between historical and recent sources.

Almost every natural habitat types decreased in extent during the studied 230-year period meanwhile trends of secondary habitats were increasing. Just before and during the communist period loss of several habitats increased, but the loss is slower in the last decades. Our data show that nature conservation had a measurable effect on habitat loss in the end of the 20th century: habitat loss ceased, but only in areas under national protection. On the basis of IUCN threshold for Critically Endangered status (which is 90% loss from approx. 1750) more habitats were classified as critically endangered when calculated with long-term data (230y) compared with short-term data. We found that longer-term datasets helped recent changes in habitat loss to be better understood and interpreted.

The method could be applied effectively in many countries in Central Europe to better understand long-term habitat trends and recognize targets in habitat conservation and management especially in case of priority habitats of the European Union (Natura 2000). The research has been supported by the project “Sustainable Conservation on Hungarian Natura 2000 Sites” within the framework of the Swiss Contribution Program (SH/4/8) and the GINOP-2.3.2-15-2016-00019 project.

The dynamics of viticultural landscape changes and its drivers (example Selestany, Slovak Republic)

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A large part of the vineyard landscape in Slovakia has undergone significant changes during the past 100-150 years. An example of the extreme change of the vineyard landscape is the model area (MA) of Selešťany in the southern part of the Banskobystrický region, close to the border with Hungary (an area of 56.7 hectares).

The main objective is to evaluate the dynamics of changes in the vineyard landscape through changes in landscape cover (LC) and landscape diversity (LD) in three time horizons (1867, 1949 and 2015) with emphasis on the construction of terraced vineyards and the creation of a modernized production vineyard during the collectivization period 1975-1978. We classified the LC to the 4th hierarchical level of the CORINE Land Cover. Landscape changes in the periods 1867-1949 (1st period) and 1949-2015 (2nd period) were quantified in the contingency table and subsequently classified through nine types of change. LD changes were analyzed by using the Shannon Diversity Index (SHDI) in the network of 1007 squares 25 x 25 m.

We identified the main drivers influencing the development of the vineyard landscape in the MA. In the 1st period, there were the phylloxera epidemic in the second half of the 19th century, the land reform and partial change of ownership after the constitution of the 1st Czechoslovak Republic in the year 1918, the annexation of the territory to Hungary during the Second World War (significant decline of the vineyard area, extensification of the vineyard landscape). In the 2nd period, there were the land levelling and bench terraces construction in the period of collectivization (intensification of the vineyard landscape) post socialist restitution, agriculture transformation (1990–2000) and influence of the Slovakia entrance in the EU in 2004 and EU Common Agricultural Policy on Slovak agriculture, which influenced keeping intensity of vine growing in MA.

In the 1st period, the vineyards transformed into mainly heterogeneous agricultural areas of small-area fields and meadows without non-forest woody vegetation, which represented a considerable degree of extensification of the vineyard landscape. In the 2nd period, the traditional predominantly non-terraced vineyards completely disappeared, and 80% of the area transformed into terraced vineyards.

We can confirm the expectation of relatively small changes of the LD in the 1st period, mainly due to ralatively stable ownership status of prevailingly small vine growers. The significant growth of LD during the 2nd period determined the construction of new terraced vineyards during the collectivization and successful post-socialist continuation of vineyard cultivation under the new owner – Chateau Selešťany. Apart from terracing, the extensification of LC can contribute to the rise of LD of vineyard landscape as well.

The assessment of tree heights based on active and passive remote sensing sensors – a case study for Romanian Southern Carpathians

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The assessment of modern methodologies based on passive and active remote sensing data involve the use of new technologies for accurate information acquisition in order to investigate the structural characteristics of the trees (height, diameter at breast height, crown diameter). In this regard, a study was conducted in South West Romania within a mixed forest stand consists of Norway spruce (*Picea abies*) and beech (*Fagus sylvatica*) trees.

The aim of the study was to compare two methods of estimating tree heights using different remote sensing data – Airborne Laser Scanning (ALS) data, respectively Unmanned Aerial Vehicle (UAV) imagery. The reference ground data was collected from one-hectare (100 x 100 m) plot located within the mixed stand using a computer-assisted field inventory system (Field Map) together with high an accuracy GNSS receiver and a Vertex inclinometer. The ALS data were collected using a Light Detection and Ranging (LiDAR) Riegl device. Very high spatial resolution images were captured using an UAV device (eBee real time kinematic-RTK) equipped with a CanonS110 NIR camera.

The first method used for estimating the heights of Norway spruce and beech trees is based on the canopy height model (CHM) extracted from ALS data, the areas covered with Norway spruce and beech trees respectively (i.e. as resulted from Object Based Image Analysis - OBIA classification) and a local maximum filtering algorithm. As a second method, in order to estimate the tree heights of the two species we used the CHM extracted from UAV point cloud. Similar to the first method, a local maximum filtering algorithm was separately applied for each of the areas covered with Norway spruce and beech trees respectively.

The correlation coefficients calculated between each set of the estimated spruce tree heights and the corresponding spruce tree heights measured in the field remains roughly at the same value ($r \approx 0.9$), with the same level of significance ($p<5\%$). The root mean square error (RMSE) computed between field measured Norway spruce tree heights and their corresponding heights estimated based on the ALS data was 0.91 m. In case of the estimated spruce tree heights based on UAV point cloud, the RMSE computed between field measured tree heights and the corresponding estimated ones was 1.79m. The difference between the two RMSE values can be explained by the fact that the DTM based on the UAV point cloud is usually biased above the ground level compared to the one based on ALS data, which alters the accuracy of the resulted CHM and subsequently the estimated heights of the trees.

Both remote sensing sensors are more and more used in order to estimate tree heights, reducing in this way the field work. The active remote sensing sensors have the advantage of providing fine detailed samples of DTM and DSM making thus possible the estimation of tree heights with higher accuracy than in the case of using UAV data. However the costs of collecting and processing ALS data are relatively high and time consuming. On the other hand, the UAV provides orthorectified aerial color-infrared (CIR) images, high precision DSM and point cloud data, being faster, easier to use and a more affordable technology also suitable for the estimation of tree heights.

Analysis of the settlement distribution in the Polish Carpathians in 19th and 21st century – changes in principal drivers

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The Polish Carpathians, like many mountain areas in Europe, were the subject to dynamic landscape changes in 19th and 20th century (Munteanu et al., 2014)

Dynamic socio-economic changes in this area triggered migrations and urbanization process, which caused changes in the settlement distribution. However, historical settlement distribution in this area were not quantitatively investigated up to this date, because lack of the spatially explicit settlement data for the past.

We collected the building locations (points of individual buildings) from the Austrian II military survey maps from the mid-19th century and compared it to the building locations from the contemporary topographic geodatabase. We collected those two data sets for the entire Polish Carpathians (~20 000 km^2).

Location of mid-19th century and contemporary buildings were subsequently subject to the statistical analysis, where number of buildings in spatial units was an dependent variable and the independent variables were various biophysical and landscape characteristics (like elevation, distance to roads, slope etc). Such analysis was conducted for several different sizes of aggregation units, with different sets of aggregation units for different variables in order to find the statistical model which explain those phenomena best.

Results showed that there were changes in the principal drivers of the number of buildings in spatial units between those two periods as well as there were changes in size of the aggregation units that was explaining the most of the variance.

The main conclusion is that the size of the spatial unit best for the statistical analysis of the settlement location for most of the explanatory variables have increased during the 150 years, showing that it is impossible to choose uniform spatial units to analyze changes in this phenomenon in time. This conclusion refers and goes beyond the classical modifiable areal unit problem (Openshaw, 1984).

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References:

Munteanu, C., Kuemmerle, T., Boltiziar, M., Butsic, V., Gimmi, U., Halada, L., ... Radeloff, V. C. (2014). Forest and agricultural land change in the Carpathian region—A meta-analysis of long-term patterns and drivers of change. Land Use Policy.

Openshaw, S. (1984). The modifiable area unit problem. Concepts and Techniques in Modern Geography, 38.

Wildland-urban interface in the Polish Carpathians in mid-19th and 21st century

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The Wildland-Urban Interface (WUI) is the area, where houses and wildland vegetation meet or intermingle, which causes many environmental problems [1]. Although WUI is a topic of many analyses currently, i.e, due to wildfires, but also in relation to other environmental processes [2], little is known, about it in long-term perspective. In this work we want to compare mid-19th century WUI extent in the Polish Carpahians with the current extent in order to analyse WUI change, as well as persistance over 150 years. Mid-19th century was a time, when on the one hand the forest extent was minimal in many regions within the Polish Carpathians [3] and on the other hand, due to difficult socio-economical situations, settlements were reaching high elevations [4]. Currently, by contrast, forest cover is occupying much more areas, and the settlements are also more widespread, what drives new WUI formation. Our results show that WUI increased substantially in the Polish Carpathias, however the changes among regions were visible. WUI areas were remarkably stable over time. This means that most of the areas occupied by WUI in 1860 were still in WUI in 2013. It may have important implications for many environmental processes taking place in the Polish Carpathians in future.

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References: *(example)*

[1] *Radeloff V. C., Hammer R. B., Stewart S. I., Fried J. S., Holcomb S. S., McKeefry J. F.,2005. The Wildland–Urban Interface in the United States. Ecological Applications 15: 799–805.*
[2] *Bar-Massada A., Radeloff V. C., Stewart S. I., 2014. Biotic and Abiotic Effects of Human Settlements in the Wildland-Urban Interface. Bioscience 64: 429–437.*
[3] *Kozak J., Ziółkowska E., Vogt P., Dobosz M., Kaim D., Kolecka N., Ostafin K., 2018. Forest-Cover Increase Does Not Trigger Forest-Fragmentation Decrease: Case Study from the Polish Carpathians. Sustainability 10: 1472.*
[4] *Kaim D., 2017.* Land Cover Changes in the Polish Carpathians Based on Repeat Photography. *Carpathian Journal of Earth and Environmental Sciences 12: 485-498.*

Effects of forestry treatments on forest site, biodiversity and regeneration

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In large part of the Hungarian native forests the aims of timber production and nature conservation should be harmonized, which enhance the importance of the exploration of the relationships between forest management and biodiversity. There are various forestry treatments used in Hungary, in the framework of rotation and continuous cover forestry systems. Many treatments were introduced in the recent past, therefore their effects on forest site, biodiversity and regeneration are still not well known.

The effects of four forestry treatments (clear-cutting, retention tree group within the clear-cut, preparation cutting, gap-cutting) were investigated in a 80 years old sessile oak-hornbeam dominated forest stand in Pilis Mountains, Hungary. The interventions were carried in the winter of 2014-2015.The experiment has a complete block design with 6 blocks as replicates and five treatments (four treatments plus uncut stand as control). All measured variables were recorded before the interventions. The following variables were studied in the period between 2014 and 2017: forest site (microclimate, litter and soil conditions); community of understory plants, spiders, ground beetles and enchytraeid worms; growth of planted seedlings and herbs; the effect of game browsing and treatments on natural regeneration within fenced and unfenced plots; survival of planted epixylic and epiphytic bryophytes.

The treatments strongly influenced the microclimate of the plots. The relative diffuse light was 2% in control, 80% in clear-cutting, 35% in gap-cutting and circa 20% in preparation cutting and retention tree group. The mean temperature increased and air humidity decreased mainly in clear-cutting and retention tree group in the growing season, the daily range of these variables were the highest in clear-cutting. The soil moisture increased in clear-cutting and mainly in gap-cutting, because of the reduced transpiration and crown interception. Because of the high soil humidity, soil temperature in the gap was similar as in the control, while it increased in other treatments. The treatments did not modify the soil conditions in the studied period, but litter characteristics slightly differed between the treatments.

The cover and species richness of the understory increased in clear-cutting and gap-cutting, following the changes of light conditions. Clear-cutting was characterised by non-forest annual

plants, in gap-cutting the proportion of light-flexible tall herbs increased. In general, the composition of the vegetation only slightly changed, because of the survival of the dominant perennial forest species. Enchytreaeid worms were very sensitive to the treatment-induced changes of soil humidity and temperature; in the clear-cutting and retention tree group they practically disappeared from the upper soil. For spiders, species richness and abundance was not influenced by the treatments, but the species composition considerably changed. Ground beetles were influenced only slightly by the treatments; their species richness increased slightly in retention tree-group. The effects of treatments were buffered by the survival of perennial species for plants, by the high mobility of individuals for arthropods, but immobile soil organisms were very sensitive to these effects.

The browsing effect of ungulates decreased the growth of natural regeneration mainly in clear-cutting and gap-cutting. Hornbeam and sessile oak were sensitive to this effect, manna ash was not influenced, the strongest browsing effect was observed on shrub species. Annual growth of the planted saplings was the highest in gap-cutting and clear-cutting, but the responses were species-specific: the growth was the lowest for sessile oak, while highest for European ash. The planted epixylic bryophyte was very sensitive to the vapour pressure deficit induced by the treatments, it extinct in clear-cutting and retention tree group, survived in control, and showed a continuous regeneration in gap-cutting and preparation-cutting. The planted epiphytic bryophyte was less sensitive to the treatments.

In general, we can conclude that gap-cutting as the main treatment of continuous cover forestry is favourable both for timber production and conservation. The increased light and soil humidity enhance tree regeneration processes. The cover of the understory increases, but it is dominated by forest species, the buffered air temperature conditions provide the survival of forest assemblages. The clear-cutting resulted the most drastic changes in site conditions and biodiversity that could be only partly compensated by retention tree group. The preparation cutting differed only slightly from control, but it is a transitional stage in the framework of shelterwood forestry system.

The study was supported by the Hungarian Research Found (OTKA 111887) and by the National Research Development and Innovation Office (GINOP-2.3.2-15-2016-00019, PD 123811),.This research is a collaboration between MTA Centre for Ecological Research and the forestry company Pilisi Parkerdő Ltd. The website of the Pilis Experiment project is http://piliskiserlet.okologia.mta.hu/en.

Disturbance driven niche availability governs lichen diversity in Slovakia's natural spruce forests

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The availability of resources and niches change in space and time in dynamic natural ecosystems. In mountain spruce forests of central Europe natural disturbances like windthrows and barkbeetle outbreaks are main driver of forest dynamics. Natural disturbances alter plot structure and create and destroy substrates for epiphytic organisms like lichens. These substrates, alive or dead, undergo a succession and diversification of microhabitats as they age. To test the influence of natural disturbances through substrate availability and stand structure alterations on lichen diversity, we sampled 60 0,1ha plots in 10 stands in Western Carparthian natural spruce forests in 2017/18.On each plot,presence and relative abundance of all epiphytic and epixylic lichens on selected objects were recorded by an experienced lichenologist (Joseph Halda), within a radius of 8 m (200 m 2) and up to a height of 2 m around a choosen centre inside the 0.1ha forest structure plot. We selected up to nine objects on each subplot stratified by tree species and substrate type(living tree, standing dead tree, snag of different decay stages, logs of different decaystages). Lichens growing on the ground, on rocks or on fallen twiggs are not recorded. Localities were distributed between five mountain ranges – High Tatra mts, Low Tatra mts., Great Fatra mts, Oravske beskydy and Poľana.We investigate patterns of diversity within a 200 years long disturbance history gradient, reconstructed with dendrochronological methods and covering different severities and frequencies occouring in this forest ecosystem. We want to unravel community composition driven by species traits and disturbance governed niche availability. Preliminary results point into the direction, that diameter at brest hight as well as tree age were significant predictors of species richness on alive trees. Species richness of deadwood was influenced by its decay status. In general lichen communities an alive trees were more species rich than on deadwood. While freshly dead objects were more species rich than objects in advanced stages of decay, turnover between alive and dead communities occoured later during wood decay. Therefore higher richness of fresh dead trees is due to the ramaining bark dwekling lichen community in transition..Within our study area red-listed species were frequently recorded as part of the natural lichen community, hence primary forests play unreplaceble role in the Western Carpathian forest landscape Our study underpins the importance of natural disturbances as the driving force of substrate creation suitable for rare and endangered epiphytic lichens.

Effect of active restoration of coppicing management on biodiversity of spiders in protected lowland oak forest

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Traditional woodland management created a dynamic mosaic of differently aged patches providing favorable conditions for a variety of arthropods. After the abandonment of historical ownership patterns providing traditional management and deliberate transformation to high forest after the World War II, large areas of forest became darker and more homogeneous. This had significant negative consequences for biodiversity [1-4]. Recently introduced coppicing interventions that could open otherwise homogeneous and dark forest stand are reintroduced in some protected locations around southern Moravia of the Czech Republic. An important question is whether newly introduced active interventions maintained by selective logging and coppicing may constitute conditions suitable for overall biodiversity of spiders including forest as well as open habitat specialists.

The objective of the present study was to investigate the impact of active logging interventions on spiders in formerly coppiced oak-hornbeam forests in the Děvín National Nature Reserve (SE Czech Republic), which were conserved for overal 80 years without any active management. In particular, we studied the effect of canopy thinning on species richness, abundance, functional diversity and its evenness, conservation value, degree of rareness and community composition of spiders. Sampling was based on 15 vegetation plots distributed equally among three thinning intensities (Fig. 1): strong thinning, moderate thinning and control (no management). The spiders were collected using pitfall traps during vegetation season of 2016. We used three pitfall traps per plot, placed five meters from each other across the diagonal of each research plot.

Altogether, we collected 3,683 adult spiders representing 21 families, 70 genera, and 116 species. Of these, 38 species were classified as having a preference for forest habitats and 65 species were classified as having a preference for open habitats including forests with a higher level of canopy openness. The records contained a total of 23 species (20%) listed in the Red List of Threatened Species of spiders in the Czech Republic [5]. In general, we discovered a substantially diversified spider assemblage with a large presence of rare species characteristic for endangered open and xeric habitats as well as species of well preserved forest ecosystems. The species richness and conservation indicators increased with canopy openness. The species richness was also positively correlated with diversity of undergrowth vegetation. The abundance of spiders had the highest values in the moderate thinning plots. However, this was mainly caused by several eudominant representatives of common forest species such as *Pardosa lugubris* and *Trochosa terricola*. Functional diversity was significantly higher in open habitats with strong canopy thinning, however, the functional traits (e.g. spider hunting strategies and body size) were equally dispersed in all canopy thinning variants. Moreover, the evenness of the functional diversity negatively depended on the coverage and density of herb vegetation.

The presented research showed that return to active management can be an appropriate strategy for biodiversity conservation in oak woodlands. However, the logging activities should not be applied by large scale clearings. The strong community changes of spiders highlight the importance of complexity of lowland forests maintained by active interventions and various traditional managements as shown also in other studies [6,7]. We propose an active forest management in oak forest reserves as suitable conservation tool to prevent the generally observed decline of woodland biodiversity in the landscapes of Central Europe.

The study was financially supported by the Specific University Research Fund of the Faculty of Forestry and Wood Technology, Mendel University in Brno (LDF_PSV_2017004) and by the Grant Agency of the Czech Republic, project 17-09283S.

References:

[1] Bengtsson J., Nilsson S.G., Franc A., Menozzi P., 2000. Biodiversity, disturbances, ecosystem function and management of European forests. Forest Ecology and Management 132: 39–50.
[2] Hédl R., Kopecký M., Komárek J., 2010. Half a century of succession in a temperate oakwood: from species-rich community to mesic forest. Diversity and Distribution 16: 267–276.
[3] Müllerová J., Szabó P., Hédl R., 2014. The rise and fall of traditional forest management in southern Moravia: A history of the past 700 years. Forest Ecology and Management 331: 104–115.
[4] Kopecký M., Hédl R., Szabó P., 2013. Non-random extinctions dominate plant community changes in abandoned coppices. Journal of Applied Ecology 50: 79–87.
[5] Řezáč M., Kůrka A., Růžička V., Heneberg P., 2015. Red List of Czech spiders: 3rd edition, adjusted according to evidence-based national conservation priorities. Biologia 70: 645–666.
[6] Košulič O., Michalko R., Hula V., 2016: Impact of Canopy Openness on Spider Communities: Implications for Conservation Management of Formerly Coppiced Oak Forests. PLoS ONE 11 (2): e0148585.
[7] Šipoš J., Hédl R., Hula V., Chudomelová M., Košulič O., Niedobová J., Riedl V., 2017. Patterns of functional diversity of two trophic groups after canopy thinning in an abandoned coppice. Folia Geobotanica: 45-58.

Fig. 1: Examples of experimental plots located in Děvín National Nature Reserve, SE Czech Republic: (A-B) strong canopy thinning; (C-D) moderate thinning; (E-F) control plots (no active management for over 80 years).

Impact of forest structure on bird communities in primary spruce forest in Western Carpathians

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Mountain spruce forests in Western Carpathians were heavily impacted by human use in history and only small fragments of primary forests with immense value remained until today. They provide us opportunity to study the ecological functioning of this ecosystem. Forest structure, changing in time and space constantly due to the various disturbances, was identified as a key factor in the life of major part of biodiversity, especially birds (Aves). Improved understading of relationships between structural parameters of forest and bird communities on multiple spatial levels in primeval forests seems to be important step to develop forest management strategies, which will sustain biodiversity and provision of ecosystem services.

In our study we established 58 plots in 10 stands on disturbance gradient in primary spruce forest fragments in Slovakia. Structual parameters on 0,1 ha plots were measured. Bird communities were counted with the specialised method of circular plots three times during the spring season. By using linear models we showed significant relationship between the parameters „number of trees per hectar“, „mean DBH“, „basal area of dead trees“ with alpha diversity of bird community on stand level. More diverse bird communities were present in stands, where the average values showed lower density of trees and bigger average DBH. On the other hand alpha diversity was negatively correlated with number of deadtrees and basal area of dead trees.

Keywords: *birds, spruce, virgin spruce forest, forest structure, diversity*

Old-growth and virgin forest in Ukrainian Carpathians: full and comprehensive database

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Identification and protection of natural and especially virgin forests (VF) is defined as one of the specific measures to be undertaken by parties of Carpathian Convention. Based on adopted by Conference of parties of Carpathian Convention criteria and indicators for virgin forests Ukrainian office of WWF and national scientific institution in the field of forestry developed the Methodology for virgin and old-growth forests identification [1]. The methodology has been used for identification VF and OGF in the field with further creation of geo-database of all plots of such forest and making this information available online via special geo-portal (http://gis-wwf.com.ua/). Identification works last in Ukrainian Carpathian (UC) since 2006 and is led by WWF while within 2016–2018 the work was done in the frame of joint project of Michael Succow Foundation (Greifswald, Germany) and Ukrainian office of WWF, which was financially supported by The Federal Ministry of the Environment, Nature Conservation and Nuclear Safety. This allowed to cover with field surveys all unchecked potential sites of VF and OGF and to create a comprehensive database of identified natural forests across entire Ukrainian Carpathians.

The database contains geo-referenced information for each of ca. 8900 forest plots on forestry management unit, protection status, area, age, species composition, forest type, volume of deadwood, forest regeneration and decay, presence of any kind of anthropogenic utilization etc. Our data show that the total area of natural forests in the region is ca. 95,000 ha, 53 % of which is virgin forests. Natural forests with the domination of beech (*Fagus sylvatica*) comprise over 55 %, followed by spruce (*Picea abies*) stands with the share of 21 %. Shares of forests composed mainly of dwarf pine (*Pinus mugo*) and fir (*Abies alba*) were 5 and 3 % of total area respectively. Specie composition of VF and OGF differs considerably on different macroslopes of the mountains. Within northeastern macroslope of UC on foothill areas beech forests dominate, whilst in mountains vast majority is represented by spruce and mixed forest often with the presence of fir. In contrast, southwestern macroslope is covered mainly by beech stands, which is well much better preserved and protected in UNESCO World Heritage Site „Ancient and Primeval Beech Forests of the Carpathians and Other Regions of Europe". Spruce forests on northeastern macroslope of UC are less protected and, thus, might be easily harvested until recently adopted Law of Ukraine on virgin forest protection will be fully implemented. Also a small remnant of unique floodplain old-growth forest of pedunculate oak (*Quercus robur*) was found in the Borzhava river valley on the nutrient-rich alluvial soil. But the poor habitat conditions often are attributed to bare rock and extreme slopes within sub-alpine bioclimatic belts and hence occupied mainly by dwarf pine.

We found that in general virgin forests are preserved in more remote from both settlements and paved roads places that remnants of old-growth forests, while variation in slope doesn't manifests explicitly between these two categories and beech and spruce stands as well. Underlying drivers, such as land use history and especially former and present natural protection management, can give a clue to the present spatial pattern of natural forest in Ukrainian Carpathians. Identified virgin and old-growth forests can be the essential for modeling of potential natural vegetation across various tree habitats as well as being a crucial component for understanding the influence of recent climate change on indigenous plant communities.

References:

[1] Volosyanchuk R., Prots B., Kagalo A. (Eds.), 2017. Criteria and methodology for virgin and old-growth (quasi-virgin) forests identification. Liga-Press, Lviv, pp.1–36. (in Ukrainian).

Can top-down land management policies sustain working wood-pasture systems? The Carpathian 'oakscape' evidence

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Objectives and methods
Wood-pastures (WP) have been developed with the silvopastoral system, the oldest form of agroforestry [1]. Being dependent on local environmental conditions (biogeographical region, topography, hydrology, regional/local flora) and socio-economic cricumstances (pasturing tradition, livestock size and structure, land ownership and pasture availability), diverse WP types have emerged [2]. However, there are numerous studies indicating that WP diversity and sustainability risk serious drawback while faced with central policies disrupting systems of local dynamics and patterns. In Central and Eastern Europe, including the Carpathian region, such collision particularly pertains to the communist collectivisation and, more recently, to the EU Common Agricultural Policy [3].

Our study concentrates on the Carpathian foothills and lower mountain elevations where oak (Quercus robur and Q. petraea) is a major contributor to the woody fabric of traditional pastoral landscapes, addressed here as the 'oakscape' [4]. A set of 22 silvopastoral oak woods representing three Carpathian locations (Carpathian foothills in SE Poland, W Ukrainian Prykarpattya, and E Transylvania in Central Romania) were subject to dendrochronological scrutiny and set in the context of the landscape changes during the last 200 years. Can the dynamics of oaks recruitment to viable oakscape trees be explained by the historic processes pertaining to the land use system? We hypothesize: yes. The results may provide an important insight into the impact of the modern changes in land use, with particular respect to forestry and farming, on wooded rural landscapes of the Carpathian region.

Results and discussion
Tree ring data of mature and ancient *Quercus robur* and *Q. petraea* studied woods point at two distinct patterns of recruitment dynamics, differing in duration and intensity: relatively short (shorter than 20 years) recruitment 'wave', characteristic for unconstrained succession of woody vegetation, and prolonged, lasting several decades, recruitment, affected by natural or anthropogenic succession retardants (e.g. wildlife or cattle grazing, dense grassy turf or undergrowth burning). The differences and similarities between particular woods indicate that the recruitment pattern depends on the local disturbance regime, rather than on more static environmental factors. Most of the studied woods should be considered relics of working rural landscapes, with habitats and processes fostering the Europe's 'oakscape'.

In the studied WPs of E Transylvania most of oak woods have emerged by 1940s i.e., prior the communist collectivisation programme. Even though the free-range cattle grazing has been retained, with missing systematic care after tree regeneration and recruitment in WP, contemporary landscapes reveal a long recruitment gap extending to the present. This corresponds with commonly

reported livestock overpopulation, excessing WP carrying capacity, driven by the EU direct 'headage' payments [5].

Unlike in Romania, in the Polish Carpathian foothills, most of the present marginal oak woods emerged in times of the livestock pressure on woods margins. That factor have played a crucial ecological role until the dramatic socio-economic changes in the aftermath of World War II, when much of the countryside along the Polish-Ukrainian border was abandoned or subject to afforestation and land acquisition by the state forest holding. While the abandonment results in spontaneous development of the dense woody undergrowth leading to oaks suppression, modern forestry intentionally transforms the inherited marginal oak understocked groves to high timber production stands. Oaks have little chance for successful regeneration in typical 'oakscape' habitats i.e., in grasslands neighbouring with woods [4]. Their regeneration is efficiently prevented by regular mowing in connection with agri-environmental payments.

The UA Prykarpattya woods are on average much younger than their Polish and Romanian counterparts. Disregard the calendar years, they developed in the local context of conspicuous changes of landscape structure, in particular substantial increase of forest, accompanied by the fall in share of treed grassland. This is in accordance with local people accounts, according to which, the woods have developed from treed meadows. Despite the declining number of livestock, such marginal oak woods are still being occasionally grazed, what, unlike in most of European forests, remains legal in Ukraine. Apparently the most important factor sustaining low density of the canopy trees and allowing the slow-pace, though continuous, oaks recruitment is, however, the common practice of early spring dry grass burning [6].

Conclusions

Our study provides a strong evidence that the Europe's land management contemporary systems of universal rules and mechanisms may become the major culprit behind the loss of local traditional routines necessary to sustain diverse and dynamic WP landscapes. Specialisation and sharp division between forest and agricultural land leads to disappearance of fuzzy, transitional (ecotonal) zones - the most favourable habitats for oak recruitment. Inside forest areas, strict silvicultural regulations (such as immediate re-stocking of gaps, ban on livestock grazing) entirely disrespect intrinsic oak life strategy and in most cases make their natural recruitment impossible. Grasslands outside forest areas, are either used as tree-less highly productive meadows supporting intensive animal production, or they are over-grazed because of the headage direct payments. Ironically, in Natura 2000 sites, where there is no economic justification for intensive grass production, the same effect of tree-less grasslands is often reached through EU agri-environmental incentives aimed at sustaining permanent grasslands.

Following the the Rzeszów-Eger Resolution on traditional rural landscapes of the Carpathian region [7], we advise that empowerment of small-scale farming and silvopastoral systems, based on local traditions, supported with state-of-the art scientific and technological assets, should be adapted as a basic way of restoring and preserving the WP cultural and natural heritage. Any top-down policies should be aimed at supporting, subsidizing the existing traditional (bottom-up) systems, not at interfering with them.

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References

[1] *Lungren B.O. 1982. What is Agroforestry? Agroforestry Systems 1: 7-12.*
[2] *Bergmeier E., Petermann J., Schröder E. 2010. Geobotanical survey of wood-pasture habitats in Europe: diversity, threats and conservation. Biodiversity and Conservation 19: 2995–3014.*
[3] *Hartel T., Plieninger T. (eds.) 2014. European wood-pastures in transition. A social-ecological approach. Routledge Taylor & Francis Group, London - New York.*
[4] *Bobiec, A., A. Reif, and K. Öllerer. 2018. Seeing the oakscape beyond the forest: a landscape approach to the oak regeneration in Europe. Land. Ecol. 33: 513–528.*
[5] *Beaufoy G. 2014. Wood-pastures and the Common Agricultural Policy. Rhetoric and reality. [In] Hartel T., Plieninger T. (eds.) European wood-pastures in transition. A social-ecological approach. Routledge Taylor & Francis Group, London - New York, p. 274-281.*
[6] *Ziobro J., Koziarz M., Havryliuk S., Korol M., Ortyl B., Wolański P., Bobiec A. 2016. Spring grass burning: an alleged driver of successful oak regeneration in Sub-Carpathian marginal woods. A case study. Prace Geogr. 146: 67–88.*
[7] *Bobiec A., Mázsa K. (eds.). 2017. Rzeszów-Eger Resolution on traditional rural landscapes of the Carpathian region. Wooded Rural Landscapes in CE Europe: biodiversity, cultural legacy and conservation. International scientific conference 20-25 September 2017. Rzeszów-Eger. http://www.woodscapes.ur.edu.pl/sites/default/files/Rzeszow-Eger_Resolution_EN.pdf*

Seminatural grasslands of Carpathians under pressures

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The semi-natural grasslands generally contribute significantly to the biodiversity of rural landscape. In Carpathians, this contribution is even more substantial than in other parts of Europe because of long-term continuity of low-intensity grassland management that is considered to be a typical feature of most valuable habitats of agricultural landscape. The variety of natural settings and variety of management practices created many grassland types, usually hosting species-rich communities. Because developed and maintained by human activities, they now enshrine not only natural, but also cultural heritage [1]. There are at least 4 reasons why to protect and maintain whole spectrum of Carpathian grassland types: their high biodiversity, productivity with low inputs; they represent the cultural heritage and form important part of the landscape character.

The agriculture in Central Europe underwent significant transformation during the second half of the 20th century. Extensive agriculture and the use of grasslands for hay-making and grazing of domestic animals were typical for the first half of the 20th century. After the World War II, a strong intensification of agriculture started. It was accompanied by broad land use changes leading to homogenisation of landscape and fragmentation of natural and semi-natural habitats, changes in their structure and loss of their conservation value. In addition, the intensification was in most of the Central and Eastern European Countries connected with the breakdown of traditional farming and the replacement of small- and medium-sized private farms with larger-scale state or collective farms. The environmental consequences of intensification included the increased use of fertilizers and biocides, land draining, irrigation, and the loss of many biodiversity-rich landscape features. The political change from socialism to democracy in countries of Central and Eastern Europe at the end of the 20th century instigated wide institutional, economic and land ownership transformation. The land ownership changes and strong reduction of subsidies to agriculture resulted in agricultural decline, including grassland abandonment, which influenced grassland biodiversity and conservation. Secondary succession commenced with grassland abandonment was accompanied by changes in plant and animal species and ecosystem structure, with significant consequences to ecosystem functions and biodiversity. The accession to the EU (2004 and 2007) increased foreign investments, initiated adoption of new legislation in nature conservation and increased agricultural subsities provided through instruments of the Common Agricultural Policy (CAP). During last few decades many grasslands lost their economic importance (provision of forage and/or fodder to livestock) and their management becomes more environmentally oriented. Currently we can record trend to polarisation of grassland use (intensive use of productive grasslands vs. abandonment of less productive or remote ones) and regional marginalisation of some rural areas.

We are living in the period of increasing environmental pressures to world ecosystems, in time that is sometimes characterised as biodiversity crisis. Terrestrial ecosystems are subjected to unprecedented rates of human-induced environmental change. The European Environmental Agency identified eleven global megatrends impacting European resource systems [2]. Two of them - growing pressures on ecosystems and increasing environmental pollution – are of high relevance for grasslands. As main reasons for the current loss of grassland habitats in Europe were identified urban sprawl and development, conversion of pastures and (semi-natural) grasslands to arable land (in areas where agriculture is profitable), and land abandonment, causing grassland to revert to shrub land or forest (in areas where socio-economic conditions are unfavourable for farming). For territory of European Union, the European Topic Centre on Urban, Land and Soil (ETC ULS) produced maps

of pressures to main ecosystems types, including grasslands. Following pressures were mapped: intensive agriculture, grassland abandonment, land take, habitat loss, nitrogen input, and nitrogen deposition. We analysed where hotspots of these pressures to grassland habitats of European importance are located in the European Union, Carpathians, and in Slovakia.

On the regional level, we demonstrate the long-term grassland changes and assess impact of and recent pressures to grassland habitats in the Liptov basin (N Slovakia and Poloniny National Park (NE Slovakia). The agricultural land in the upper Liptov basin was changed substantially in period 1949-1973 – the main processes included drainage, grassland conversion to arable land and establishment of intensive grasslands. In the next period (1973-1997) followed destruction of wet meadows by grassland abandonment leading to overgrowing of grasslands by scrub and trees and this process continues till now. During period 1973-2004 we recorded significant changes in structure of wetland plant community Trollio-Cirsietum. While in 1973 dominated species typical for wet and cold conditions belonging to alliances Calthion, Caricion davallianae, Molinion, and Polygono-Trisetion, in 2004 played more important role species typical for more dry and warm conditions, typical for classes Molinio-Arrhenatheretea and Festuco-Brometea. The species composition changes indicated besides decrease of the soil moisture also increase of soil nutrients. We consider these changes as consequences of the grassland drainage and abandonment, the climate change can play certain role as well.

In the Poloniny National Park, we recorded grassland changes between 1999 and 2015. We identified remarkable increase of proportion of managed grasslands from only 8% in 1999 to 40% in 2012–2015; other 7% of sampled grasslands were recently restored and prepared for future management. The average species richness in grasslands managed in 2012–2015 increased from 47.5 species per record in 1999 to 54.2 species in 2012–2015, the increase was found statistically significant. In 2012–2015, we observed statistically significant difference in the average species richness between managed (54.2) and abandoned grasslands (46.3). We found that the nature conservation importance of grasslands is maintained – we recorded persistence of threatened and rare species during studied period. While in managed grasslands highly dominated typical grassland species, species of forest and forest margins played an important role in the structure of abandoned grasslands. We identified altitude and soil properties as the main environmental factors driving grassland structure in the studied area: altitude determines climate gradient and probably also management intensity gradient and soil properties express soil fertility via A-horizon depth.

The agricultural management is crucial for long-term persistence of grasslands and maintenance of their biodiversity. The agricultural subsidies of the CAP drive the grassland management in the study area, therefore we conclude that CAP enabled grassland biodiversity maintenance in the Poloniny National Park after 2004. Despite clear contribution to grassland maintenance, also side effect of CAP was recorded – landscape homogenisation. In addition, the conservation of mountain meadows remains a challenge because of their poor accessibility.

References:

[1] Batáry, P., Dicks, L.V., Kleijn, D., Sutherland, W.J., 2015. The role of agri-environment schemes in conservation and environmental management. Conserv. Biol. 29 (4), 1006–1016.

[2] EEA, 2015: European environment — state and outlook 2015: Assessment of global megatrends. – European Environmental Agency, Copenhagen, 134 pp.

Traditional agricultural landscapes in the framework of green infrastructure

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Traditional agricultura landscapes are characterized by a distinct and recognisable structure which reflects clear relations between the composing elements evolving during several centuries [1]. They represent preserved pre-industrial landscapes which have been managed by traditional means in contrast to intensive, usually large-scale, management. Nowadays they face abandonment and disappearance despite the fact that they provide cultural and social values [2] and can be considered as hotspots of biodiversity, especially in the context of agricultural landscape [3].

There are many frameworks/concepts how to try to preserve traditional landscapes, be it their protection under e.g. Convention on Biological Diversity, UNESCO's Man and Biosphere programme, RAMSAR or [4], using agri-environmental schemes [5]. Another option could be using the framework of green infrastructure since traditional agricultural landscapes with their multifunctionality fulfill many of its objectives.

On the example of Kyjovsko region in the Czech Republic that has been characterized by a mosaic of traditional agricultural landscapes we will focus on how incorporation of this type of landscape into green infrastructure can enhance its presence and connectivity. We will also have a look at the changes of occurence of traditional agricultural landscapes during the past 200 years.

Our results show that if we incorporate traditional agricultural landscapes that are defined as a mosaic of small vineyards, arable fields, orchards, meadows, gardens and scattered woody vegetation, the percentage of green infrastructure in the Kyjovsko region increases for nearly 8 %. Connectivity calculated in terms of morphological spatial pattern analysis (MSPA) also show increases, namely in the presece of cores, islets, loops and branches. We can say that traditional agricultural landscapes can serve as bridges connecting more valuable parts of the landscapes.

Further analyses of changes in the occurrence of traditional agricultural landscapes revelead astonishing results – in a representative sample, the area of this type of landscape decreased from 1820s till present for 45 %. This fact confirms findings from other countries, especially from Central Europe [3; 5] and can be largely attributed to collectivisation of agriculture during the socialist period of 1950s-1990s [7].

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References:

[1] Antrop, M., 1997. The concept of traditional landscapes as a base for landscape evaluation and planning. The example of Flanders Region. Landscape and Urban Planning 38: 105-117.
[2] Špulerová, J., Bezák, P., Dobrovodská, M. Lieskovský, J., Štefunková, D., 2017. Traditional agricultural landscapes in Slovakia: why should we preserve them? Landscape Research 42: 891-903.
[3] Špulerová, J., Piscová, V., Gerhátová, K., Bača, A., Kalivoda, H., Kanka, R., 2015. Orchards as traces of traditional agricultural landscape in Slovakia. Agricultura, Ecosystems and Environment 199: 67-76.
[4] Harrop, S.R., 2007: Traditional agricultural landscapes as protected areas in international law and policy. Agriculture, Ecosystems and Environment 121: 296-307.
[5] Baran-Zglobicka, B., Zglobicki, W., 2012: Mosaic landscapes of SE Poland: should we preserve them? Agroforestry Systems 85: 351-365.

[6] Fischer, J., Hartel, T., Kuemmerle, T., 2012: Conservation policy in traditional farming landcapes. Conservation letters 5: https://doi.org/10.1111/j.1755-263X.2012.00227.x.

[7] Lieskovský, J., Bezák, P., Špulerová, J., Lieskovský, T., Koleda, P., Dobrovodská, M., Bürgi, M., Gimmi, U., 2015: The abandonment of traditional agricultural landscape in Slovakia – Analysis of extent and driving forces. Journal of Rural Studies 37: 75-84.

Economic and environmental impact of silvopastoral farms in the Carpathians – case studies of cattle farms from Poland and Romania

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Sustainable grazing land management on partly wooded permanent grasslands that presently are not in compliance with Good Agricultural and Environmental Conditions is considered as an important alternative income source for small and medium-sized farms in mountain areas. Agroforestry and silvopastoral systems have gained renewed interest and support in last years by the reform of the Common Agricultural Policy (Mosquera-Losada et al. 2016). Trees offers animals protection against sun, wind, snow and rain, making them healthier and delivers woody biomass at the same time (Novak, Emile 2015; USDA 2013). Apart from wood for renewable energy or timber, high-quality cheese or meat can be considered as a specific product coming from the traditional silvopastoral system. Moreover, the grazing in a sustainable way is usually increasing biodiversity of grassland. To resume, the system is considered as an effective way for revitalizing rural areas with non-used or abandoned lands, hence they might constitute an important source of income for farmers working on the Carpathian land. There is need to assess potential of silvopastoral systems in the region in terms of agronomic productivity and environmental performance and to design optimal spatial scenarios in order to balance food and non-food components of integrated systems with state-of-the-art tools and models.

Traditional silvopastoral systems with pastures, haymeadows, well individualized trees, forest strips and grazing animals are the most encountered form of land management in the mountain and hilly areas of Romania. Mihalca farm, located in Petrova municipality (Maramus county) is 94 ha organic farm. Grasslands are grazed extensively by dairy cows based on rotation of field use. The woody vegetation, often spontaneous, is managed by pruning and pollarding and used as firewood in the farm.

Silvopastoral systems in Polish Carpathians are often present due to fragmented land use structure. In remote hilly areas, large silvopastoral farms breeding sheep or cattle may be found. Livestock farm in Beskid Mountains is 200 ha organic farm in Sękowa municipality and situated in very diversified ladscape, consisting of open and wooded grasslands and forest of different age. Grasslands are planted partly with hedgerows and fruit trees. Beef cattle is kept in rotational system of field use, involving grazing and mowing. Wood is harvested for heating of farm buildings as well as for sale to local buyers.

The adaptation of locally relevant silvopastoral systems is explored by analysis to examine resource use efficiency and cost effectiveness. Two spatial regional scenarios are assessed in aspect of their environmental and economical influence in the farms. GIS tools are used to carry out analysis. Cost-effectiveness of farms is simulated with the FarmSAFE model to assess the long-term flow of income from the annuals and perennials. For environmental assessment spatial indicators of erosion risk, soil hydrology, landscape diversity and micro-climate were applied. Scenarios are adjusted to reflect

two thresholds of agroforestry share in the region the farm is located: 10% and 50%. Sensitivity analysis of silvopastoral system impacts on crop productivity and environmental performance under current and future climatic scenarios is performed.

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References:

[1] Mosquera-Losada, M.R., Santiago Freijanes, J.J., Pisanelli, A., Rois, M., Smith, J., den Herder, M., Moreno, G., Malignier, N., Mirazo, J.R., Lamersdorf, N., Ferreiro Domínguez, N., Balaguer, F., Pantera, A., Rigueiro-Rodríguez, A., Gonzalez-Hernández, P., Fernández-Lorenzo J.L., Romero-Franco, R., Chalmin, A., Garcia de Jalon, S., Garnett, K., Graves, A., Burgess, P.J. (2016). Extent and success of current policy measures to promote agroforestry across Europe. Deliverable 8.23 for EU FP7 Research Project: AGFORWARD 613520. 95 pp.

[2] Novak S., Emile J-C. (2015). Agroforestry for ruminants in France. Deliverable 5.13 (5.1): Detailed system description of a case study system23 for EU FP7 Research Project: AGFORWARD 613520. Available at:

[3] https://www.agforward.eu/index.php/en/agroforestry-with-ruminants-in-france.html Access: 20.06.2018. 13 pp.

[4] USDA 2013. Working trees for livestock. Available at: https://www.fs.usda.gov/nac/practices/silvopasture.shtml. Access: 20.06.2018.

Is there a landslide? Visual interpretation of DEM and its geophysical verification on flysh landslides. Case study, Gorce mountains, Poland

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There are numerous landslides in the flysh part of the Carpathians. Their mapping has become easier since precise terrain models are available. Readability and clearness of models caused LIDAR based DEMs to become one of the most often used information sources in geomorphology nowadays. DEM interpretation seems to be straightforward and unequivocal, but the results of previous analyses show that one can make several grave mistakes during an apparently simple interpretation process. The geophysical and the GIS analysis combined bring possibilities of verification and of validation of the GIS results. They also offer an opportunity for methodological development.

The first stage in the present research project consisted in the mapping of landslides on LIDAR based DEM at Gorczanski National Park area. For this stage, hillshade (45°, 135°, 270°, 315°), slope, TPI, TWI and SVF rasters were used. As the second stage, three ERT profiles were made. The first of them was conducted at a shallow landslide, which had not been recognized at DEM, but was mapped on the field. The second profile was realized on a deep-seated landslide. The third profile was measured through the area initially incorrectly mapped on DEM as a landslide, but later, during the field mapping and the geophysical research, it was designated as a non-landslide area.

The geophysical method has provided an answer to the following question: ”Is there a landslide?“ in the spots for which an interpretation of the terrain model was incorrect or ambiguous. The comparison of the results of the visual interpretation of DEM and those of the ERT has confirmed the following conclusions: 1) Visual interpretation of DEM should not be the only method used in landslide mapping as there are landslides not recognizable on DEM. Also, not all ”landslides“ mapped on DEM are real landslides. 2) Geophysical ERT survey is a remarkable method for verification of those areas where GIS analysis does not provide decisive results. Research was funded by National Science Center grant no. 370834.

Shear strength of silty soil of the Wieliczka foothills reinforced with root system of deciduous trees

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Landslides are one of the geodynamic processes that significantly shape the contemporary relief of the Polish Flysch Carpathianst. It is estimated that there are more than 60000 landslides in this area with quite diverse surface area and activity level. The formation of landslides is closely related to the terrain and the geological structure of the ground, whereas the main factor initiating their occurrence is rainfall, which causes a change in the state of stresses in the ground. Additionally, an increase in the moisture content reduces the geotechnical properties of the soil, in particular their shear strength.

The aim of the research was to determine the parameters characterizing the shear strength of soils reinforced by the root system from the landslide area in Winiary (Wieliczka Foothills) created in 2010. The landslide in question is located in a forest area represented mainly by deciduous species. The tests were carried out in a three-axial compression apparatus on samples with a diameter of 10 cm and a height of 20 cm taken from a depth of 0.5 and 1.0 m at a distance of 1.0 m from black locust, european hornbeam, comon birch and hazel.

The test results showed that there are hard plastic and plastic silty and silty-sandy soils in the landslide area. The obtained shear strength parameters indicate an ambiguous effect of root systems on the values of internal friction angle and cohesion. The angle of internal friction of the rootless soil was about 24°, with roots from 5 to 12°. In case of cohesion, an increase in its value from 16 kPa was observed for ground with no roots up to 33 kPa for samples with roots. The research also showed that the root mass, their length and diameter contained in individual samples were in a significant range and they were small in relation to the mass of the soil skeleton.

Landslide analysis using multi-temporal inSAR techniques in Prahova Valley, Romania

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The current study presents the effort made at the moment in order to analyse and monitor landslide evolution in one of the most landslide-prone regions in Romania, Prahova Valley, using modern remote sensing techniques. The Prahova Valley has been considered a very important study site for landslide vulnerability and risk mitigation mainly due to its geomorphologic and anthropic particularities [1]. The high instability of the valley slopes is given by a composition of sandstone fragments and limestone cemented by a clay-silt matrix and also by the influence of the area with the most active subcrustal earthquake activity in Europe, the Vrancea Seismic Region [2]. The number of inhabitants in the study area is the highest in comparison to any other region from the Romanian Carpathians and subCarpathians. In the last century, the region was affected by continuous negative human intervention that amplified the slope instability mainly by deforestation, which sustained the urbanization process.

Launching of the C-band European Space Agency satellite, Sentinel-1A in April 2014, has made it possible for us to monitor the surface deformation in the Prahova valley over the last 4 years. The study area has been imagined in both ascending and descending orbit. A number of 70 images in each orbit have been processed using the Permanent Scatterers (PS) [3] and the Small BAseline Subset (SBAS) [4] multi-temporal interferometric techniques. The results consist of deformation maps that show millimetre displacements derived for man-made microwave coherent features (PS) or coherent areas (SBAS). The main challenge of our study was identifying displacement associated to slow developing landslides on the vegetated slopes that are usually affected. The obtained deformation maps are mainly describing the movement of the coherent targets, which are found in built-up areas.

References:

[1] Armaş, I., Nistoran, D. E. G., Osaci-Costache, G., & Braşoveanu, L., 2013. Morpho-dynamic evolution patterns of subCarpathian Prahova River (Romania). Catena 100:83-99.

[2] Radulian, M., Panza, G. F., Popa, M., & Grecu, B., 2006. Seismic wave attenuation for Vrancea events revisited. Journal of Earthquake Engineering, 10(03): 411-427.

[3] Ferretti, A., Prati, C., & Rocca, F., 1999. Permanent scatterers in SAR interferometry. In Geoscience and Remote Sensing Symposium, 1999. IGARSS'99 Proceedings. IEEE 1999 International (Vol. 3, pp. 1528-1530). IEEE.

[4] Berardino, P., Fornaro, G., Lanari, R., & Sansosti, E., 2002. A new algorithm for surface deformation monitoring based on small baseline differential SAR interferograms. IEEE Transactions on Geoscience and Remote Sensing, 40(11): 2375-2383.

Poster abstracts

P-1

Validation of the IBA method of bankfull discharge determination in gravel-bed rivers of the Carpathian region

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Bankfull discharge is the most important characteristic discharge of river regime. It is defined as a flow which fills the channel to the top of river banks. There are, however, many definitions of this parameter and many attempts have been undertaken to estimate it using hydrological, geomorphological or biotic approaches [1]. Invertebrate Bankfull Assessment Method (IBA method) applies riverine invertebrate community of ground beetles as a biotic indicator of bankfull variation in a dynamic river [2]. The IBA index is calculated as a proportion of individuals with the size of 1–6 mm/number of individuals 18–24 mm in size and reflects the proportion of individuals of minimum size species to maximum size species in the community of ground beetles in a temperate region [3].

The aim of the study is to validate the IBA bankfull discharge method with 135 carabid assemblages collected in gravel-bed rivers of the Polish Carpathian region that were subjected to various modifications of channel morphology. The distribution of 123 species showed strong selection of species to a particular terrace (NMDS, Anosim, $p<0.001$). Constrained CCA showed that biotic factors such as the IBA index, plant cover and plant height described most of the variation of small-sized and big-sized species. GLM indicated that the IBA index confirms further expectation of the mean IBA values. Mean value of the index for the lowest terrace is about 5, for the middle terrace about 2 and for the highest terrace it never exceeds 1. There are, however, disturbances appearing in river channels that slightly modify the IBA values. Values of the IBA for the lowest terrace depend significantly on channel incision and modifications of vegetation affect the values for the highest terrace. In spite of such disturbances, however, mean values of the IBA are congruent with those expected on the basis of former IBA calculations.

References:

[1] Radecki-Pawlik A. 2002. Bankfull discharge in mountain streams: Theory and practice. Earth Surface Processes and Landforms. John Wiley&Sons Ltd. 27: 115-123.
[2] Radecki-Pawlik A., Skalski T. 2008. Bankfull discharge Determination using the new invertebrate bankfull assessment Method. Journal of water and land development. No. 12 p. 145–154.
[3] Church M. 2015. Channel Stability : Morphodynamics and the Morphology of Rivers. In: Rowiński P., Radecki Pawlik A. (Eds.), Rivers- Physical, Fluvial and Environmental Processes. GeoPlanet: Earth and Planetary Science. Springer, Cham, pp.281-321.

P-2

Rivers' hydromorphological features and their perception – a premise for geoconservation in the Carpathian curvature region

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In the context of dramatic alterations suffered by rivers during the last century, the geoconservation of fluvial processes should be better integrated into nature conservation [1]. To set guidelines towards enhancing geoconservation of valuable fluvial processes at regional scale, the aim of our study is to analyze rivers' hydromorphological features and their perception by actors susceptible to propose protected areas. The case study refers to rivers draining watersheds located in the Carpathian curvature region (including both mountainous area and neighboring lowlands – hills and plains) in Romania, with high suspended sediment loads, which were forming several types of channel patterns a century ago and were dramatically transformed since [2].

The study is focused on protected areas in the analyzed region and has two main parts. First, rivers in protected areas are inventoried by their hydromorphological features, including channel pattern, analyzed based on recent aerial photos and field investigations. Then, the perception of valuable hydromorphological features for nature conservation is assessed based on a photo-questionnaire applied to both local communities and experts.

In the studied area, mostly a meandering channel pattern is found in protected areas (especially Natura 2000) to the detriment of the braided pattern, despite the decline of the latter in this region over the last century and its well-known ecological value. This finding suggests the necessity to better correlate the hydromorphological value of rivers with the aims of geoconservation at regional scale. Concerning the perception of valuable hydromorphological features for nature conservation, the results of the survey show a high variety of opinions (e.g. concerning bars), reflecting the interests and objectives of the groups of participants. Similar to other regions [3], for the Carpathian Curvature region, our study identifies a disparity between scientific findings and public perception, and we discuss the importance of environmental education in understanding the necessity for a river's geoconservation.

References:

[1] Gordon J.E., Crofts R., Díaz-Martínez E., Sik Woo K., 2017. Enhancing the role of geoconservation in protected area management and nature conservation. Geoheritage, 1–13.
[2] Ioana-Toroimac G., 2016. Inventory of long-term braiding activity at a regional scale as a tool for detecting alterations to a rivers' hydromorphological state: a case study for Romania's South-Eastern Subcarpathians. Environmental Management 58(1): 93–106.
[3] Le Lay Y.F., Piégay H., Rivière-Honegger A., 2013. Perception of braided river landscapes: implications for public participation and sustainable management. Journal of Environmental Management 119: 1–12.

P-3

Tree-ring record of the impact of channelization-caused incision of a mountain river on the growth of grey alder in riparian forest

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Incised rivers are characterised by excessive flow capacity and lower vertical position of water stages associated with given discharges than vertically stable rivers [1]. Such a river condition may result from progressive bed degradation or the formation of excessively deep channel in the course of channelization works. Channelization works conducted in the mid-1970s in the middle course of the Czarny Dunajec, Polish Carpathians, caused replacement of the wide and shallow, multi-thread channel with a deep, single-thread channel and this study aims to determine the impact of this change on the growth of grey alder (*Alnus incana*) in the riparian forest near the village of Długopole. One-dimensional hydraulic modelling with the HEC-RAS software was used to determine the vertical position of water stages associated with given discharges in the pre-regulation and regulated channel. A dendrochronological method was used to analyse tree-ring widths (TRW) as a proxy of year-to-year changes of grey alder growth. The TRW chronology was compared with climatic (air temperature, precipitation, Palmer Drought Severity Index and Standardised Precipitation-Evapotranspiration Index) as well as hydrological (minimum and mean monthly discharges recorded at the nearby gauging station) data. The hydraulic modelling indicated that the channelization lowered minimum annual stage of the river by 2.2 m and average maximum annual stage by 1.9 m. These changes caused a sudden substantial lowering of groundwater table and a cessation of deposition of overbank sediments in the riparian forest. Correlation analysis with a significance level selected at $p = 0.01$ indicated that the strongest influence on grey alder growth was exerted by minimum monthly discharges of the river, with the highest correlation coefficients found for the lowest discharge in February of previous year ($r = 0.46$) and in March–April of a given year ($r = 0.45$). Other important factors were the precipitation during June–July ($r = 0.44$), the temperature in March–May ($r = 0.37$) and SPEI ($r = 0.36$ for July of a given year and for December of previous year). The established chronology is characterised by two positive and six negative pointer years (1983, 2010 and 1974, 1976, 1987, 1992, 2006, 2007, respectively). Most of them can be explained by the combination of atypical minimal discharge in early spring (March–April) and/or precipitation in June–July. The analyses of running correlation between the tree-ring chronology and these hydroclimatic factors indicate that the grey alder growth in an early part of the post-channelization period mainly depended on the discharge during early spring, determining the position of groundwater table in the riparian area. In the later part of the period, the secondary growth of the trees has been mainly related to the amount of precipitation in summer. This study shows that the channelization-caused lowering of water stages in the river resulted in the worsening of growth

conditions for grey alder in the riparian forest, which was most apparent in years with particularly low minimum flows in the river or/and particularly low precipitation.

References:

[1] Wyżga B., Zawiejska J., Radecki-Pawli A., 2013. Impact of channel incision on the hydraulics of flood flows: Examples from Polish Carpathian rivers. Geomorphology 272: 10–20.

P-4

Influence of flow regime on macroinvertebrate community structure in rivers of Southern Poland

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Flow variability determines conditions of a river ecosystem and river ecological functioning. The ecological functions of river ecosystems gradually decrease. Predicting the environmental flow allowing to keep diversity of river biota and river health developed as a response to the degradation of aquatic ecosystems overexploited by humans [1]. The goal of the study is to construct a model of instream environmental flow with hydraulic parameters such as water depth, flow velocity and substrate. Twelve rivers in southern Poland varying in bed substrate and the amplitude of discharge were surveyed. We performed the survey of 240 sampling points, where 24763 macroinvertebrates belonging to 81 families were found. The similarity of invertebrate communities reflects the typological division of the rivers into three classes: mountain Tatra streams, mountain rivers draining flysch catchments and upland rivers draining catchments with carbonate and silicate bedrock (NMDS, Anosim, $p<0.001$). , Total number of taxa, number of EPT taxa and score of BMWP_PL index were chosen as response variables related to the environmental variation characterizing river flow in the second type of rivers (gravel-bed river draining flysch catchment). Generalized Additive Model indicated that for flysch rivers optimal parameters maintaining high values of biotic parameters reflecting ecological state oscillated around the depth of 0.5 m and the velocity higher than 0.8–1.2 m/s. Hydraulichabitat 2D model of a section of the Raba River was applied to estimate habitat prediction in terms of Weighed Usable Area. The relationship between modelled discharge and WUA for benthic macroinvertebrates indicated that the flow that maintains high diversity of macroinvertebrates should oscillate in the range between 11.5 and 15 m^3/s. Such flow is in the range of mean annual discharge and a decrease in discharge below this value rapidly causes unfavourable conditions for macroinvertebrates. This research suggests that high diversity of macroinvertebrates occurs at higher flows than excellent discharge value for aquatic organisms [2].

References:

[1] Poff N.L., Allan J.D., Bain M.B., Karr J.R., Prestegaard K.L., Richter B.D., Sparks R.E., Stromberg J.C., 1997. The natural flow regime. Bioscience. 47(11): 769–784.
[2] Tennant D.L., 1976. Instream Flow Regimens for Fish, Wildlife, Recreation and Related Environmental Resources. Fisheries 1: 6–10.

P-5

Recent vertebrate and invertebrate burrows in lowland and mountain fluvial environments – similarities and differences

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The riverine environment is characterized by large energy gradients occurring in relatively short time, which forces special adaptations of burrowing animals recorded in bioturbational structures. Predators mainly produce shelter burrows (interpreted as domichnia), while saprofags, especially earthworms, produce locomotion and feeding structures (pascichnia). Diversity and abundance of burrowing animals are mainly controlled by water-level fluctuations, especially these causing floods or droughts. The time of fauna activity also depends on large fluctuations of sediment temperature what is especially important in mountain rivers.

Recent domichnial and fodinichnial burrows of several tracemakers were investigated in sandy to silty overbank deposits of two rivers in southern Poland: the lower reach of the Dunajec (lowland river with a meandering channel pattern) in the Sandomierz Basin and the Wielki Rogoźnik (mountain river with a braided to meandering channel pattern) in the Orawa–Nowy Targ Basin. Burrows occurring in sediments of the lowland meandering river have a more extensive network of corridors and chambers than their counterparts from sediments of the mountain river. Vertical distribution of the studied burrows reflects a response of particular tracemakers to disturbances and the position of water table. Generally, frequent disturbances (erosion, deposition) and water-level fluctuations lead to a decrease in the diversity and abundance of burrows. Long, horizontally oriented domichnial burrows of birds (e.g., *Riparia riparia*, *Alcedo atthis*) and ground beetles (*Bembidion stephensii*) are present exclusively in the scarps actively eroded by a river. The scarcity of bioturbation structures in coarse-grained sediments of the mountain river does not reflect a lower abundance of tracemakers but rather their special environmental adaptation (small chambers in mud under pebbles instead of typical shafts with terminal chambers as in the lowland river banks). Sediments covering abandoned channels (mountain river) and oxbow lakes (lowland river), both inactive since at least the 1990s, exhibit similar sediment maturity and bioturbation structures.

The ground beetle burrows show a characteristic morphology, with a shaft and a terminal chamber. Their inclination changes from more or less oblique on horizontal surfaces to horizontal in steep scarps of the mountain river. The abundance and species structure of ground beetles are similar in both studied river reaches. In the lowland river environment, more or less evenly distributed burrows prevail in the fertile sediments of natural levees. On the contrary, in gravel sediments of the mountain river, the beetle population is concentrated close to the water table at the toe of scarps. The scarps provide access to food and enable quick escape during rapid water-level fluctuations. The frequency of burrows ranges from 5/m^2 (in the undercut banks of the Wielki Rogoźnik) up to 100/m^2 near the Dunajec River outlet.

P-6

Corridor *versus* barrier – on the ambiguous role of a river channel in the dispersal of a frog *Bombina variegata*

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The understanding of population dynamics must be based on a spatial approach since buffer, metapopulation or sink–source concepts have been proposed. The analyses of spatial patterns of dispersal resulted in the ecological corridor concept. For a wide spectrum of species, rivers are believed to be such ecological corridors. However, particularly for small animals, they may also play a role of effective migration barriers.

We analyzed the role of a river as a corridor for dispersal of the yellow bellied toad (*Bombina variegata*) in southern Poland. The study was conducted in the Biała River, Polish Carpathians, which flows in a seminatural channel and valley, with patches of riparian forest adjacent to farmland. The field study was conducted in the years 2011–2013, including a survey of the yellow bellied toad breeding sites (natural and anthropogenic), tracking adult individuals using telemetry as well as the analysis of dispersion of the freshly transformed juveniles around artificial breeding sites.

The breeding sites were located significantly closer to the river than points randomly located at the study area. Adult toads, equipped with radiotransmitters, migrated mainly towards the river channel. Individuals which attained the river bank remained there in a narrow zone of muddy, usually shallow water edge. The individuals detected far from the water spent days buried in mulch, soil or in burrows of small mammals. The riverbank was also the main migration destination for a significant proportion of freshly transformed juveniles. Adults and especially juveniles were spreading along the river bank. Despite the general migration direction towards the river, there was no case of reaching the opposite bank, which suggests the isolating role of the main river channel. Moreover, cases of predation suggest that at deeper water toads were predated by fish.

P-7

Deciphering the biogeomorphology of a gravel-bed stream in fluctuating backwater zone of a dam reservoir

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In the years 2007-2016 about 8,000 new large dams were constructed all over the world. It is widely known that dams disturb abiotic and biotic components of the fluvial systems, but to date the knowledge of their impacts has been mainly derived from observations of downstream river reaches. In contrast, little is known on the biogeomorphological adjustments of rivers upstream from dam reservoir, in so called backwater zone.

We analyse sedimentology, riparian vegetation, morphology and flow characteristics of a gravel-bed stream in the Polish Carpathians, which has been influenced by backwater inundation since 1942. The rate of fine sediments deposition in this zone was mainly controlled by past river morphology and the backwater magnitude, with the highest value (9.5 cm/year) found in a part of former multi-thread channel near reservoir. Overall vegetation cover area in the backwater zone did not change significantly over the post-dam period. However, the area of woody vegetation increased significantly in that period. This increase was positively related to the initial area of unvegetated bars and negatively related to the initial woody vegetation cover. Plant diversity of riparian forest was lower on low elevations near the reservoir, which may reflect elimination of riparian plant species non-resistant to water stress. We also document distinct river morphology in backwater (with deeper and more sinuous channel), which is interpreted as the effect of the abovementioned sedimentological and riparian vegetation adjustments. Numerical modelling of river hydrodynamics in the backwater zone shows that these adjustments significantly influence river flow characteristics even without a direct influence of backwater inundation. This suggests that backwater effects may promote the development of specific channel hydromorphology and riparian vegetation mosaic, contrasting with those occurring in free-flowing gravel-bed rivers in the temperate climatic zone.

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P-8

Does climate changes affect biotic factors of deep dam reservoirs? A case study of the Dobczyce dam reservoir (Southern Poland)

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Natural lakes and artificial dam reservoirs are important water ecosystems from economic and environmental points of view. Although both of them are often treated in the same way, in fact lakes and dam reservoirs differ in their functioning. While lakes that have existed for thousands of years have been studied from the dawn of freshwater science, the majority of dam reservoirs were built during the last century and remain relatively new ecosystems whose functioning is still being explored. The number of existing dam reservoirs in the world exceeds 500 thousand, and it is predicted that until 2035 about 90% of river courses will be disrupted with at least one dam. It is estimated that the surface occupied by dam reservoirs worldwide will increase from about 400 thousand km^2 to nearly 1 million km^2 by 2050. Therefore, the understanding of the effect of climate changes on the biotic elements of dam reservoirs is very important.

Eutrophication and global warming are ones of the biggest threats to water ecosystems and especially dam reservoirs. Both are recognized as the most important factors increasing primary production in waters and promoting proliferation of harmful algal blooms. Based on a long-term monitoring programme (30 years) established on the deep Dobczyce dam reservoir in the Polish Carpathians, we found that water temperature in the epilimnetic zone has increased as a total average and also in particular months, but primary production measured as chlorophyll a decreased. We observed more often violent high waves (river inflow) which destroy algal community and lead to development of small celled type of algae. Based on the results, we conclude that global warming will lead to changes in the algal community promoting development of small specimens and, as a consequence, to unpredicted changes of the entire food network of dam reservoir.

P-9

Loss of wetland areas in the Sandomierz basin as a result of increasing human impact – spatial changes observed between the 19th and 21st centuries on cartographic materials

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The Sandomierz Basin is a northern part of the Subcarpathian region. It is a large, mostly flat depression with triangular shape in south-east Poland between the towns of Kraków, Przemyśl and Sandomierz in the corners (14 100 km^2). The basin encompasses the Vistula River valley, low parts of the catchments of Polish Carpathian rivers (Raba, Dunajec, Wisłoka and San) and their alluvial plains as well as high plains and foothills between them. The geological structure and hydrological conditions related to the Carpathian rivers (impermeable, flat ground and large water supply by the rivers) resulted in the large density of wetlands in the basin. However, in the 19th and 20th centuries many wetland areas declined because of land development works (river engineering, irrigation and drainage). Nowadays negative effects of the works are periodical problems with drought risk, water pollution and decrease of biodiversity.

The purpose of this study is description of the scale of these changes. Research of spatial distribution of wetlands is nowadays possible with cartographic or remote sensing data and Geographical Information System (GIS) technology. Long-term changes of the environment of the Sandomierz Basin can be studied on archival maps published since the second half of the 19th century. It is impossible to work in GIS with previous cartographic works because of no reliable reference points on them. In the study, data from three maps were used: (1) third military survey of the Austrian-Hungarian Empire (from the second part of the 19th century), (2) map of Polish Military Geographical Institute (from the first part of the 20th century) and (3) military topographic map of Poland (from the end of the 20th century). Relevant to the study were the following aspects of these cartographic data sources: all of them have a similar scale (~1:100 000) and the degree of generalization, and the period between each pair of maps was about 50 years. On the basis of map scans, a database was established in GIS and used to determine historical and contemporary condition of wetlands and related parameters in the basin.

Chosen impacts of wetlands' loss in the basin, especially spatial changes of hydrographic network and land cover, were analysed and discussed in the study. Wetland areas have declined to less than 20% of their extent from the 19th century. The biggest change occurred between the second half of the 19th century and the first part of the 20th century (74% of the wetlands loss). Some parts of the basin have been almost completely devoid of any wetland areas, e.g. the low part of the Dunajec valley or areas in the vicinity of the Carpathian Foothills. The loss was significantly correlated with an increase of drainage density (expressed as the length of streams as well as distance from watercourse). The decrease of forest areas and increase of arable lands, grasslands and development areas was also a statistically significant factor of wetland changes. However, the areas of recorded afforestation or other signs of reclamation did not cause statistically significant restoration or growth of wetland areas. The wetland areas that have survived are mainly located in the north-east part of the basin and in big Sandomierz and Niepołomice forest ecosystems. Some parts of them have been placed under conservation in landscape parks, nature reserves or Natura 2000 European nature conservation network.

In view of the different aspects noted above, the following conclusions can be drawn. Wetland areas in the Sandomierz Basin have shown a large decrease (to less than 20% of the area from the second half of the 19th century). Archival maps are useful and reliable data source in examination of changes of wetland areas. The spatial distribution of observed changes is correlated with increasing human impact: channelization of Carpathian rivers and irrigation works, deforestation and increase of development areas.

P-10

Evaluation of the biodiversity value by CZ-GLOBIO in highland landscape of the most western part of Carpathians in the Czech Republic

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The naturalness and biodiversity value of habitats have decreased by intensive using of landscape last hundreds years in the central Europe as well as in the Czech Republic. We used modified model GLOBIO v3.0 for the conditions of the Czech Republic (CZ-GLOBIO) to evaluate the current state of habitat naturalness and their vulnerability. The model CZ-GLOBIO operates with five drivers - land use change, landscape fragmentation, infrastructure influence, atmospheric NOx deposition and change of climate parameters. For evaluation of each driver, the indicator MSA (mean species abundance per unit surface, reaching values from 0 to 1 – highest naturalness) was applied. In CZ-GLOBIO, the naturalness rate per unit surface instead of the native species abundance was used. For drivers land use change, landscape fragmentation and infrastructure influence the "Combined Layer" was used as a background. This layer consists of Habitat Mapping 2014, provided by Nature Conservation Agency of the CZ and set up in relation with the establishment of the Natura 2000 network (138 natural and close to nature habitats) and Corine LC (53 more anthropically influenced habitats). For drivers "atmospheric NOx deposition" and "change of climate parameters", CORINE LC 2012 data were used, regarding to the coarse grid data for these two drivers. The output of CZ-GLOBIO modelling is a joined layer (total MSA) identifying areas with a high biodiversity vulnerability, especially with regard to land use change, landscape fragmentation and infrastructure influence. We applied the CZ-GLOBIO in three different types of highland landscape organization units of the most western part of Carpathians, near the border with Slovak Republic. First type of area was the Landscape Protected Area Beskydy (LPA Beskydy), second type was the municipality with extended competence Valašské Klobouky (MEC Valašské Klobouky) and the last area was middle catchment of the Dřevnice river. The mean values of total MSA were similar; 0.72 for LPA Beskydy, 0.73 for MEC Valašské Klobouky and 0.68 for catchment of Dřevnice. These small differences among different areas were caused by combination of all five drivers of MSA together, because drivers "atmospheric NOx deposition" and "change of climate parameters" provided similar values for whole Czech Republic. The detailed role of all five MSA drivers in biodiversity vulnerability will be discussed on the poster.

P-11

A study case on effect of fire on ground-living spider fauna in dry grassland of the Zoborská lesostep National Nature Reserve (Slovakia)

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The issue of the impact of fire on individual ecosystems and their use for landscape management is frequently discussed in the professional as well as lay public, whether in the short term or long term aspects. However, there are relatively few professional and scientific papers dealing with this issue. The changes induced by an extensive fire in the ground-living spider fauna were examined for two years starting six months after the fire and later from long term aspect after 16 years at the dry calcareous grassland of the Zoborská Lesostep National Nature Reserve which is located the southernmost part of the Western Carpathians in Slovakia. The study area represents the plant phytocoenosis *Festuco-Brometea*. Epigeic spider communities, examined by pitfall traps during 2000-2001 and in 2016, were studied on unburned and burned sites in adjascent areas of the reserve. Epigeic communities spider spiders were screened by ground formalin traps immediately after the fire in the growing season (March to end of October) 2000 and 2001 and after 15 years in 2016. One line of traps was located on the unburned part of the area, and the second line of traps on the burned part of the area with the same type of habitat. Over the three years of research, we have captured 1440 specimens of 80 spider species and 18 families in total on two compared surfaces. Most species were also represented by families of Lycosidae and Gnaphosidae. Epigeic spider communities have been evaluated and compared as part of their composition on a burned-down and unburned part of the Reserve from a short-term, but especially a long-term aspect. The communities are also compared based on time periods and the impact of the fire has been analyzed. The research leading to these results received funding from the grant agency VEGA, project No. 02/0171/16.

P-12

Genotype/phenotype interaction and its relevance to climate change in Scots pine (*Pinus sylvestris* L.) populations

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The abstract has been withdrawn.

P-13

Influence of artificial light at night (ALAN) on plants: current state and perspectives for researches

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The last scientific investigations show significant influence of artificial light at night (ALAN) on majority of living organisms including plants with the next cascading effects for ecosystems. At present the different mechanisms of this impact are unclear, but data accumulation and its analysis continue. Besides, negative effects of ALAN for protected areas have been described generally, and, as a result, recommendations have been prepared for avoiding them. Also there are data about phenology of plants, changing fruit maturing, increase in phytomass, decreasing seed productivity and dynamics of other indicators of plants under influence of ALAN. However, no country or region has a full list of plants pollinated at night still. It is very important to make estimation of risks because it seems that it can be potentional danger for plant diversity. Therefore, we have started to make a preparation of the list of species for Hungary using both literature data and data of our field investigations. More details will give during our presentation. Furthermore, understanding that the problem of light pollution has exclusively anthropogenic origin, as well as its solution (most likely - partial) can be found only in direct work with society, we have decided to estimate the level of awareness about the topic of light pollution and plant pollination to collect the knowledge level of people in countries with different economic development. Questionnaire has been prepared.. It helps the identification of benefits which people see in ALAN during using it and also their opinion an experiences about the negative effect of ALAN for themselves as well as for other groups of living organisms. We are going to cover two countries (Hungary and Ukraine) by this research then we are looking for wider cooperation. Obtained results will be a basis for the next development of educational strategy, which must increase society awareness and has indirect influence for the efficiency of biodiversity conservation.

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References:

MacGregor, C. J., Pocock, M. J. O., Fox, R., & Evans, D. M. (2015). Pollination by nocturnal Lepidoptera, and the effects of light pollution: a review. Ecological Entomology, 40(3), 187–198. http://doi.org/10.1111/een.12174

Carvalheiro LG, Kunin WE, Keil P, Aguirre-Gutiérrez J, Ellis WN, Fox R, et al. Species richness declines and biotic homogenisation have slowed down for NW-European pollinators and plants. Ecology Letters. 2013;16:870–878.

P-14

Climatic exposure of natural upland forest stands: What impact will be expected by the end of 21th century?

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More and more research aims to forecast the consequences of global warming, for instance to focusing on the shifts of the geographic range limit of climate-sensitive species or openings of stands due to draught induced tree mortality. Our hypothesis is that the effect of climate change will be demonstrated on the population and forest structural changes studied in the core areas of strict forest reserves since forest stands has developed with no human interventions here for decades.

One of the main target areas is the Vár-hegy Strict Forest Reserve in Felsőtárkány (Bükk mts., Hungary) where standard field survey was completed ten years ago in the Permanent Sampling Points (PSP) of the Stand Dynamic and Ecological Observation Network. The forest reserve is in the possession of diverse terrain and soil, where, depending on altitude, exposures, steepness and site charachteristics beech dominated, sessile oak – hornbeam, sessile oak – turkey oak or downy oak forest types can occur. In order to get an insight into the degree and spatial pattern of prospective climate changes (the climatic exposure), the FORESEE (1951-2100) gridded database of observed and projected daily meteorology and the Mountain Microclimate Simulation Model (MTCLIM) was applied. The prognosed and downscaled climate exposure calculations show that by the end of the 21st century, the microclimate of all PSP sites will have increase and become much more severe. The Forest Aridity Index (FAI) as a useful climate indicator of forest zones will go over the value of 7.25 which will indicate the development of an almost unbelieveable forest-steppe climate here by the end of the 21th century.

The changes of the forest dynamic processes will be examined by comparative analysis of re-survey and former field survey data. It will be performed in selected PSPs according to the standard sampling protocols of stand structure, regeneration/shrub layer, and ground layer. The re-survey and comparative assessment will be accomplished in the main zonal forest types of the Carpathian Region of Hungary then we are looking for evidences of climate change impacts on forest stand and population changes.

P-15

Biotic and abiotic changeability of a small river with sandy bottom along a regulated and close to nature stretch

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The Nida is a river flowing in southern Poland. As a whole it is situated in the area of Świętokrzyskie province. It is a typically lowland tributary to the Vistula river. Along the most of its length its course is close to nature. In the early 70-ties of the 20th century the river was regulated in the vicinity of Pinczów town. Subsequent river stretches between Motkowice and Pińczów localities were regulated in the 80-ties. The activities resulted in cutting off several arms of the middle Nida river, in result of which nowadays considerable areas of the river valley have been undergoing a mucking process [1]. Still, many valuable habitats have been preserved in this area. Specific natural and landscape assets accompanying the river are: marshlands, backwaters and xerothermic turfs constituting unique areas with considerable diversity of plant and animal species. Therefore, along some of its sections the Nida is flowing in a technically regulated channel, whereas along the other it remains close to nature [2]. It is easy to spot the adjoining stretches characterized by the same hydrological regime and water quality but by a different horizontal transverse, vertical and different channel and differing with the size of alluvial material.

The paper aims to analyze, in terms of biotic an abiotic factors, the differences of two sections of the Nida river with a different degree of anthropogenic transformation, i.e. regulated stretch and close to nature section. Measurements of water velocity and flow rate were conducted, as well as the bottom shape and granular size composition. River cross sections and flow slope were measured by means of GPS RTK device. Two-dimensional models of the analyzed stretches were made using CCHE2D software in order to determine the changes of hydrodynamic parameters along the whole area of the investigated river. Samples of the bedload and macrobenthos were collected randomly along the length of the investigated river stretches [3], whereas the area and species composition of hydromacrophytes were analyzed along 100m long fragments of the two investigated river sections.

Collected data indicate a bigger biodiversity of the macrobenthos along the close to nature river stretch [4], particularly in the areas of woody debris effect increasing turbulences, but decreasing mean velocity of flowing water.

Species composition of macrohydrophytes was the same along both sections. Significant differences were observed in the bottom surface coverage, which was respectively 1.3% along the regulated stretch and 11.7% along the close to nature section.

References:

[1] Strużyński A., Książek L., Bartnik W., Radecki-Pawlik A., Plesiński K., Florek J., Wyrębek M., Strutyński M., 2015. Wetlands in river valleys as an effect of fluvial processes and anthropopression. S. Ignar, M. Grygoruk (eds.), Wetlands and Water Framework Directive. Protection, Management and Climate Change. GeoPlanet: Earth and Planetary Sciences, Springer-Verlag Berlin Heidelberg, pp.69–90.

[2] Strużyński A., 2011. Flood protection in high valued river ecosystem – Middle Delta system of the Nida River. Electronic Journal of Polish Agricultural Universities 14/2.

[3] Szczerkowska-Majchrzak E., Woziwoda B., 2014. Benthofauna of the Pichna Szadkowicka river's section from the river's headwater area to its outlet from the Wojsławice forest complex. Bulletin of Szadek 14 pp.189–20. (in Polish).

[4] Verdonschot R.C.M., Kail J., McKie B.G., Verdonschot P.F.M., 2015. The role of benthic microhabitats in determining the effects of hydromorphological river restoration on macroinvertebrates. Hydrobiologia 769 pp.55–66.

P-16

Relationship beetwen hydric potential and predictability of maximum flow for different catchments in Poland and Slovakia

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Raised water flow is a complex event caused by variable climatic and physiographic characteristics of a catchment. Climatic and hydrological phenomena also cause cyclic variability and renewability of water resources. The knowledge about relationships between factors that influence on hydrological regime is essentially in the context of predictability of maximum flow and thus flood hazard. The aim of this work is to study relationships between a hydric potential of catchments (LHP) and predictability of maximum flow in rivers in the Upper Vistula basin and Slovakia. The LHP method is a new concept of practical application of Geographic Information System (GIS) analysis and tools in water management. The method refers to the ability of catchments to slow down and retain precipitation and the capability of the water to infiltrate into ground. The predictability (P) of river is one of the Colwell's indices that describe seasonality of hydrological regime [1]. The constancy (C) and contingency (M) are components of P. The P value represents a measure of confidence with regard to the state of an event at a given point. Predictability is a measure of regularity of occurrence of the analyzed event. When P exceeds 50%, the regularity of occurrence of the event is above average; when it is less than 50%, the regularity of the event is below average.

All calculations are performed for 35 catchments located in the Upper Vistula basin and Slovakia. The LHP was calculated according to the method described in [2, 3]. The P was calculated according to the method described in [1]. To determine links between the LHP and P, a cluster analysis was used with a Ward method of agglomeration.

The mean LHP varied between 1.2 for the Skawa River and 20.1 for the Vistula River. Only the Vistula River has excellent LHP. The rest of the rivers have average or limited LHP. The mean predictability for all rivers is high (0.54), but the highest was for the Wisłok (0.69) and Raba (0.68) rivers and the lowest for Białka (0.40) and Wapienica (0.43) rivers. The cluster analysis showed that the study catchments may be aggregated into four homogeneity clusters: first – catchments with high P and limited LHP, second with mean P and limited LHP, third with low P and average LHP, and the last one with very high P and average and excellent LHP.

References:

[1] Wałęga A., Młyński D., 2017. Seasonality of median monthly discharge in selected Carpathian rivers of the upper Vistula basin. Carpathian Journal of Earth and Environmental Sciences, 12 (2): 617–628

[2] Lepeška T., 2010. Hydric potential of landscape and integrated river basin management in mountain and submontane regions. Ecohydrology & Hydrobiology 10 (1): 13–24

[3] Lepeška T., Radecki-Pawlik A., Wojkowski J., Wałęga A. 2017. Hydric potential of the river basin: Prądnik, Polish Highlands. Acta Geophysica 65 (6): 1253–1267

P-17

Effect of anthropogenic and natural factors on the location of underground water outflows in forested region in the Western Carpathians

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The dynamic of the locations of underground water outflows in the Western Carpathians is still insufficiently recognized [1], although the changes of outflows altitude or their drying out are common phenomena in the flysch mountains [1]. In order to at least partially fulfill this gap, the occurrence and location of outflows within the Skrzyczne Range were investigated in the years 2009, 2011 and 2012 during different weather conditions. 172 outflows were mapped on the 28.2 km2 area, which gives spring density index of 6.10 outflows/km2, and the highest outflow altitude was 1160 m, while that of the Skrzyczne peak is 1257 m. Seven outflows were located along the edges of the Godula Sandstone layers, 87 within landslides area, 13 directly on forest roads or in the roadside slopes, and 57 in close proximity of roads and their landforms (sharp channel head [2]) implied road influence on their location. There is a big difference between the number of outflows on the western slope of the mountain massif (17 outflows) and on the eastern one (58 outflows), which is related to mostly consequent dip of sandstone beds on the western slope and obsequent one on the eastern slope. The snowmelt has stronger capacity of supplying outflows with water than rainfall – after snowmelt periods all investigated outflows were present and about half of them changed position to higher altitude. After rainfall periods 6 outflows were found dry. In the period of the smallest precipitation (lower than 44.4 mm of total rainfall in 2 weeks before fieldwork), a quarter of outflows dried up. The research is going to be repeated this year.

References:

[1] Jokiel P., Moniewski P., Ziułkiewicz M., 2007. Źródła Polski. Wybrane problemy krenologiczne. Wydz. Nauk Geor. Uniw. Łódzkiego, Łódź, pp. 351 (in Polish).

[2] Wrońska-Wałach D., Żelazny M., Małek S., Krakowian K., Dąbek N., 2018. Channel heads in mountain catchments subject to human impact – The Skrzyczne range in Southern Poland, Geomorphology, Vol. 308, p. 190-203.

P-18

Effect of deforestation triggered by different factors on seasonal and short-term changes in water chemistry in the Carpathians – Beskid Śląski and Western Tatra case studies

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The Beskid Śląski Range was subject to intense human impact in the form of severe air pollution originating in the adjacent region of Silesia in the 1980s and 1990s, which led to severe damage to tree stands. Different types of deforestation continue to occur in the Polish Tatras, where tree stands are subject to gradual decline caused by the European bark beetle or were rapidly damaged by strong wind gusts.

The purpose of the study was to determine the effects of deforestation caused by a set of different factors on water chemistry on a seasonal and short-term basis. The study occurred in several catchments in the Beskid Śląski Range (anthropogenic impact) and in the Kościeliska Valley in the Western Tatras (windfall in December 2013, contemporary bark beetle gradation).

Seasonal changes were assessed using 250 water samples collected on a monthly basis, while short-term changes such as high water stages or base-flow periods were assessed using ISCO autosamplers. In the latter case, the sampling rate varied from 1 to 12 hours (n = 4,250) depending on the rate of flood wave formation. Water samples were collected in the field and water levels, pH, SEC and temperature of water were assessed. A DIONEX 2000 ion chromatograph was used to determine the presence of 14 ions: Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, NH_4^{+}, Li^{+}, HCO_3^{-}, SO_4^{2-}, Cl^{-}, NO_2^{-}, NO_3^{-}, PO_4^{3-}, Br^{-}, F^{-}.

Hillslope deforestation caused a change in water chemistry, especially in the content of anions. The NO_3^{-} content (4.4% mval·L^{-1}) increased markedly in the anion total, as expected, across Tatra catchments affected by deforestation. A marked increase in SO_4^{2-} (31.6% mval·L^{-1}) content and marked decrease in HCO_3^{-} (5.2% mval·L^{-1}) content occurred in the anion total in the deforested catchments of the Beskid Śląski. Water chemistry at high water stages was quite variable and the variances strongly depended on the degree of deforestation. These main findings show the exceptionally strong role of woodland areas in hillslope water chemistry. In a spatial sense, the observed atypical pattern is that of hydrochemical mosaics in the form of different proportions between anions, especially bicarbonate, sulfate and nitrate.

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P-19

Effect of deforestation on stream water chemistry response to rainfall in small Carpathian catchments (Tatra Mts., Poland)

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Hurricane-force winds noted in the Polish Tatras on 25-26 December 2013 caused substantial damage in the spruce and fir stands in this area. This event served as a once in a lifetime opportunity to perform experimental research on the effects of deforestation on stream water chemistry response to rainfall. Two small catchments (<1 km^2) characterized by a different degree of deforestation and located in the northern part of the Tatra Mountains were selected for the study: Wściekły Żleb catchment (66.1% deforested) and Kończysta Turnia catchment (19.9% deforested). Fieldwork was conducted in 2017 and included continuous measurement of water levels and specific electrical conductivity (SEC) in the two streams. Stream water samples were collected for laboratory analysis during seven rainfall events. The concentration of main ions (Ca^{2+}, Mg^{2+}, Na^+, K^+, HCO_3^-, SO_4^{2-}, Cl^- and NO_3^-) was analyzed.

In both catchments, SEC and the concentrations of most main ions except K^+ and Cl^- decreased with increasing discharge during the studied events. On the other hand, the concentration of NO_3^- increased in the course of the same events. Relationships between SEC and the concentrations of most main ions and discharge took the form of a clockwise hysteresis in both study catchments. It means higher values during the rising limb of the hydrograph versus those during the falling limb. In the mostly deforested Wściekły Żleb catchment, hysteresis loops were very wide, while in the Kończysta Turnia catchment (mostly not deforested) they were very narrow.

In the mostly deforested catchment clockwise hystereses were noted for Cl^-, K^+, and NO_3^-. This indicates a very rapid loss of these ions from the soil cover of the deforested catchment driven by infiltrating precipitation water. In the mostly not deforested catchment, the opposite was true in that the concentration of Cl^-, K^+, and NO_3^- during the falling limb was higher than during the rising limb (counterclockwise hystereses). This indicates delayed leaching of these ions from the soil cover in relation to changes in discharge in the mostly not deforested catchment.

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P-20

Natural dynamics of the temperate mountain beech dominated primary forests in the Western Carpathians

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Natural disturbances play key role in forming forest ecosystem structure. It is relatively well known how intermediate and severity disturbance regimes are forming Norway spruce forest ecosystem of west Carpathians Mountains. We reconstructed the overall regional canopy disturbance history of primary forests dominated by European beech (*Fagus sylvatica* L.) and Silver fir (*Abies alba* Miller) in Slovakia using dendrochronological analysis, on five forest stands in Low Fatra, Great Fatra, Low Tatras and Klenovsky Vepor. Our study of beech dominated forests ecosystems in west Carpathians Mountains responded on two questions: (i) Are localities forming by low severity disturbance regimes or by combination of intermediate and high severity disturbance regimes? (ii) Does exist any disturbance synchronisation on stand or landscape level? Using tree-ring width analysis we conducted disturbance history reconstruction based on two patterns of radial growth: (1) abrupt, sustained increases in growth (release - indicating mortality of a former canopy tree) (2) rapid early growth rates (gap recruitment - indicating recruitment in a former canopy gap). All detected events were converted to the percentage of the canopy area disturbed in each plot to scale the evidence of disturbance according to each tree's current crown area. To calculate the disturbance chronology, we summed up the percentage of the canopy disturbed area by decade.

Dendroecological analysis proved occurrence of beeches more than 350 years old. Further, occurrence of low and intermediate severity disturbances were found as the most important drivers. Plots with evidence of high severity disturbances (Šramkova, Low Fatra, Kornietova stand) were detected too. Reconstructed disturbance regime demonstrated spatial and temporal heterogeneity. Also evidence of synchronicity of disturbance events in the time among plots and among several stands ere found. Forest managers in the Carpathians should take into consideration these findings and reflect it in used silvicultural systems. We proposed to increase spatiotemporal complexity in forest management approaches. Management of protected areas should be changed more toward non-intervention regimes instead of commonly used sanitary logging and other type of interventions of post-disturbed stands. Supporting of hight complexity of environmental conditions will create forest ecosystem valuable from view of conservation of nature.

P-21

Tree mortality in sparsely disturbed natural Norway spruce stands

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Mortality rate is an important factor in forest dynamics, unfortunately it is usually studied in forests affected by recent high severity disturbance. Understanding the supposedly low annual mortality rates in stands with no recent severe disturbances are equally important. Here we aim to evaluate the mortality rates and the main factors causing mortality in recently sparsely disturbed mountain Norway spruce stands. A total of 5272 trees on 118 plots were resampled after five year period in primary Norway spruce (*Picea abies* (L.) Karst.) forests in four localities in eastern Carpathians. Mortality modes were used as approximation of mortality cause and recently dead trees were sorted into five categories (broken crown, broken stem, uprooted, result of competition, killed by bark beetle perhaps in combination with fungi). Only 10 % of plots display more than 2% annual mortality and only one plot exceeds 5% a year. Bark beetle infestation is the main mortality agent in all studied localities. Contribution of competition varies seriously. Abiotically caused physical damage is equally common agent in all localities however composition of its different forms varies. Observed average annual mortality rate is within the usually accepted range of background mortality. This allows assumption of no high severity disturbance taking place in the region recently. Although on a plot level moderate severity disturbances can be seen in increased variability of mortality rates within certain localities. There seems to be no universal pattern in relation of recent mortality rates to disturbance history in last 200 years. While the role of competition in the form of density-dependent mortality is clear for some localities only, the portion of recently dead trees killed by bark beetle is rather high across all stands even in plots with generally low mortality. It is very likely many tree deaths are caused by combination of factors.

P-22

Industrial changes in the municipalities from Romanian Carpathians

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Background
The Romanian Carpathians are widely known for their variety of resources that aided communities to obtain their development. Lots of researchers have written about the destruction of Europe's central and south-eastern industry but few of them are currently try understand and identify the current progress of an important part of the Carpathian territory. Currently, the paper wants to seek the real situation of the industrial evolution and how this transformation developed some of the Romanian municipalities located in Carpathian Mountains.

Methods used
The research methods used can be split in two major types: classical ones and modern ones. The research was designed to actively show how large parts of Romanian industry suffered and resurrected in Carpathians. Some rules were established:

- All cities that currently have the municipality administrative rank were included only if industry was spotted in the area
- The starting point of the study is that in the majority of cases municipalities remained without industrial facilities
- For a correct approach all municipalities from the Romanian Carpathians were included in the study
- Satellite observations were used and analyzed during couple of months
- Industrialization parameters were calculated and established
- Digital techniques for spatial analysis were involved in study

Expected results
Following the research process we are confident that the study will show the real situation that took place in Romania. The relevance of the research is underlined with the help of modern digital mapping techniques used to establish a modern web-mapping application used to keep track, manage, organize and analyze the impact of industrial facility's changes and how the population reacted and reacts.

Conclusions
We think and try to prove that industry in Romanian Carpathians revived and a major impact is currently spreading even beyond the border.

P-23

Land use changes in Jabłonka village during the years 2004-2009-2014

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The article shows land use changes in Jabłonka in the Polish Carpathians. This village is situated in Orawa region, over 600 m above the sea level. The natural conditions limited the activity of local society. It is also visible in the land use, which is very spatially varied. There are small farms with multidirectional agricultural production.

The Author researched the structure of land use and the structure of cultivations in arable land in Jabłonka village in 2004, 2009 and 2014. The paper is based on terrain research. The Author went across the village area and drew different forms of land use on a map. After that he prepared a map of land use in 1:5000 scale and later he calculated the areas in each category of land use. This way, the Author could show different forms of land use according to the degree of incline, land exposure and height zones. The Author was researching land use and referred to local natural conditions, such as: soils, microclimate and water level in ground. The Author also determined the directions of land use and the directions of cultivations in arable land. In order to do it he used the six consecutive quotients method. These results from 2004, 2009 and 2014 were compared. This way the Author could show the extent of land use changes and cultivations in arable land. The spatial diversity in the structure of land use and the structure of cultivations in arable land in Jabłonka village is shown on land use maps. The paper has practical aspects, because the Research may be used in spatial planning.

P-24

Arable land abandonment in low and medium altitude mountains from Romanian Carpathians

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The year 1990 was a time-reference for the Romanian agriculture, considering the political regime changes together with the socio-economic transformations. In this respect, many of the agricultural fields were the subject of the land ownership recovery process, passing from public administration to private property. However, this was not a general feature for the agricultural lands on mountain areas, as many of them were not included in the centralized economy of the socialist period because of the specific environmental conditions [4]. Therefore, the agricultural land use change in mountain areas was conditioned mainly by socio-economic facts instead of political events [1].

The aim of this study is to quantify the agricultural land use change occurred in low and medium altitude mountains, within two representative case studies from Southern Carpathians: Poiana Mărului platform at 900-1000 m and Fundata site at 1300-1400 m altitude. Both case studies are complementary from different points of view: altitude, topoclimate, tourist potential and valorisation, entrepreneurship and business development, regional branding.

Our approach is based on a multisource and multiscale analysis for two reference periods. In this context, there were integrated topographic maps at 1:5000 scale from the early 1970s, Landsat 5 TM, 7 ETM+ [2, 3, 5] and 8 OLI satellite multitemporal imagery, orthophotos at 1:5000 scale from 2018, together with in-situ measurements obtained from a geodetic GNSS surveying.

The first case study from Poiana Mărului integrates only satellite data at 30 m spatial resolution from 1986, 2002 and 2018, obtained at the beginning of the month of May, to the start of the agricultural season, when the spectral signature of arable plots is easy to be identified and processed. The second case study from Fundata is developed at a high resolution, after the integration of the inventoried arable plots from 1:5000 topographic maps, together with the orthophotos from 2018 and GNSS data.

After data processing, we obtained statistics showing the magnitude of agricultural land abandonment for the both case studies. These were mapped together with selected features of the driving factors of the land use transformation. The comparative approach between Poiana Mărului and Fundata sites confirms two different stages of arable land abandonment process: an initial stage related to an emergence of rural tourism developments (Poiana Mărului) and an advanced stage strongly related to a total transformation of arable land into pasture and hayfield around the remaining scattered farms and tourist pensions and hotels (Figure 1).

The driving factors are strongly correlated with the social processes like depopulation and population ageing, as well as with the economic facts like low land productivity, a decreased economic competitivity and a limited accessibility.

These changes occurred in the arable lands lead to the decrease of the landscape diversity together with the increase of the dependency of the current low and medium altitude mountain environments.

Figure 1. Fundata village, 1360 m altitude, Southern Carpathians. Land use change within the scattered built-up area, showing the replacement of arable plots with pasture and hayfield. Recent developments occur as an effect of tourist activities (Photo: B. Mihai, September 2017).

References:

[1] *Griffiths P., Müller D., Kuemmerle T., Hostert P., 2013. Agricultural land change in the Carpathian ecoregion after the breakdown of socialism and expansion of the European Union, Environmental Research Letters 8, 045024, doi: 10.1088/1748-9326/8/4/045024.*

[2] *Kuemmerle T., Hostert P., Radeloff V., van derLinden S., Perzanowski K., Kruhlov I., 2008. Cross-border Comparison of Post-socialist Farmland Abandonment in the Carpathians, 11: 614-628, doi: 10.1007/s10021-008-9146-z.*

[3] *Müller D., Kuemmerle T., Rusu M., Griffiths P., 2009. Lost in transition: determinants of post-socialist cropland abandonment in Romania, Journal of Land Use Science, 4:109-129, doi: 10.1080/17474230802645881.*

[4] *Munteanu C., Kuemmerle T., Boltiziar M., Butsic V., Gimmi U., Halada L., Kaim D., Király G., Konkoly-Gyuró É., Lieskovský J., Mojses M., Müller D., Ostafin K., Ostapowicz K., Shandra O., Štych P., Walker S., Radeloff V., 2014. Forest and agricuktural land change in the Carpathian region – A meta-analysis of long-term patterns and drivers of change, Land Use Policy, 38: 685-697, doi:10.1016/j.landusepol.2014.01.012.*

[5] *Prishchepov A., Radeloff V., Baumann M., Kuemmerle T., Müller D., 2012. Effects of institutional changes on land use: agricultural land abandonment during the transition from state-command to market-driven economies in post-Soviet Eastern Europe, 7, 024021, doi: 10.1088/1748-9326/7/2/024021.*

P-25

Moderate infection by ash dieback (*Hymenoscyphus fraxineus*) as unexpected improver of spider biodiversity in lowland forests

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The *Fraxinus excelsior* trees have been, until recently, one of the last smooth tree species that continue to grow in lowland and floodplain forests. However, in the last decades, ashes have been attacked by the invasive pathogenic fungus *Hymenoscyphus fraxineus*, which causes decline of ash trees. The intensity of the fungal attack and mortality of trees differ according to the age structure of the forest stand and the most critical situation is in the mono-aged forests younger than 40 years. Ash decline can cause significant changes in the stand structure, microhabitat conditions, and overall strong disruption of various biotic interactions at the levels of producers, detritivores, and consumers.

The objective of our study was to analyze the diversity of spiders in commercial plantations during the gradual death of ash forest stands due to the spreading of the pathogenic fungus *H. fraxineus*. In particular, we studied the effect of ash decline on species richness, abundances, conservation value, degree of rareness and number of rare and endangered species of spiders. Experiments took place on 12 locations with three levels of infection/decline: low infection, moderate infection, strong infection. Spiders were collected using pitfall traps between April and October 2017 in the floodplain area around southern Moravia, Czech Republic.

We collected 5,809 individuals belonging to 120 spider species and 21 families. The highest species diversity and individual conservation indicators were in ash stands with moderate infection. We suppose it was mainly due to the higher level of habitat heterogeneity maintained by diverse canopy coverage and more complex vegetation structure in comparison with healthy and/or strongly infected plantations. On the other hand, the lowest values of all indicators were in ash stands with strong infection by *H. fraxineus*. There was no difference in spider abundance between infected ash stands.

Surprisingly, the results showed that the invasive pathogenic fungus can have a seemingly positive effect on the diversity of particular organisms in forest plantations. However, the ultimate impact was still highly negative because a strong infestation of ash plantations greatly reduced the overall spider biodiversity.

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Effect of natural disturbance regime on saproxylic beetles diversity across primary Picea abies forests of Western Carpathians

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Primary forests are of outstanding biological value and they enable us to gain crucial insight into the complex relationships between biodiversity and the evolutionary pressures of natural disturbances. Western Carpathians host some of the very last remnants of primary Picea abies forests in Central Europe, which are under influence of certain natural disturbance agents such as bark beetle outbreaks and windthrows. Using the remaining primary spruce forests in Central Europe as a model system, we will conduct the first quantitative analysis linking taxonomic and functional diversity of saproxylic beetles assemblage to the long-term disturbance dynamics of the region. We hypothesize that natural disturbances shape forest communities by acting as a source of environmental variation; disturbances either create or destroy specific habitat substrates. After a disturbance event, ongoing successional development may also promote species and functional turnovers. We sampled 58 plots across Western Carpathinas in spruce primary forests with different natural disturbance regimes, using flight-intercept traps to assess the species and functional diversity of saproxylic beetles assemblages. In this contribution, we provide short insight into the methodology we used for our study and hypothesis we would like to answer in upcoming future.

P-27

Change in the *Myrmica* ant community on Alcon Blue sites following cessation of management

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Larvae of the protected Alcon Blue butterfly (*Maculinea alcon*) are obligate social parasites of different *Myrmica* ant species. Different populations are adapted to different *Myrmica* species, with which the caterpillars develop to the adult stage with the highest probability. For example, in the Carpathian Basin the host ant usage of the different populations proved to be variable just before 2008 [1]: While different hygrophilous *M. alcon* populations used mainly *Myrmica scabrinodis* and occasionally *M. slovaca* and *M. vandeli*; the xerophilous *M. alcon* populations were recorded mainly with *M. scabrinodis*, *M. sabuleti* and *M. schencki* and occasionally with *M. lonae* and *M. specioides*.

In the early 1990's, following developments in agricultural practise, grazing and mowing ceased at many Hungarian Alcon Blue sites. Furthermore, climate change has affected such meadows, which now have more xerophilous vegetation than ten years earlier.

We examined whether these changes have also led to changes in the *Myrmica* ant community and the patterns of host ant usage on one xerophilous Alcon Blue site in the Bükk-mountains (Hungary, Carpathian-Basin) during these 10 years.

Our preliminary results show negative changes in both the *Myrmica* community and the availability of suitable host ant species.

We are planning to give suggestions about the managements of the neglected xerophilous Alcon Blue sites.

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<u>References:</u>

[1] Tartally A., Nash D.R., Lengyel S., Varga, Z. 2008. Patterns of host ant use by sympatric populations of Maculinea alcon and M. 'rebeli' in the Carpathian Basin. Insectes Sociaux 55: 370–381.

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