

Landscape and Society in the Context of Globalisation



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Book of Abstracts

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Dr. Marta Dobrovodská
MSc. Alexandra Hladká

© Institute of Landscape Ecology,
Slovak Academy of Sciences
Štefánikova 3, 814 99 Bratislava

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Changes in land use and landscape structure significantly affecting the biodiversity and species migration in the territory

Peter Barančok

Institute of Landscape Ecology, Slovak Academy of Sciences, Štefánikova 3, 814 99 Bratislava

e-mail: peter.barancok@savba.sk

Keywords: *land use, landscape structure, animal migration, impacts on the environment, environmental impact assessment*

The development of human society is connected with the building and expansion of settlements, the construction of industrial areas, transport and other infrastructure, the use of natural resources, etc. All these activities to an extent affect the environment as a whole and also its individual components.

In connection with the preparation of strategic documents, spatial planning documentation, or during the preparation of projects of specific proposed activities, an environmental impact assessment is carried out - Strategic Environmental Assessment (SEA) or Environmental Impact Assessment (EIA). In the Slovak Republic, assessments have been carried out since 1994. Currently, Act No. 24/2006 Coll. on the assessment of environmental impacts and on the amendment of certain laws is in force, which comprehensively regulates the assessment of environmental impacts, the assessment of strategic documents and the assessment of the impacts of buildings, facilities and other activities on the environment. All projects implemented before 1994 were not assessed in terms of the aforementioned legislation.

The implementation of projects in the past and in the present is often associated with large-scale construction of sites, construction of solid barriers or significant changes to existing natural conditions. The previous use of the land is changing, the landscape structure is changing, and the conditions for the existence of plant and animal species are changing. This results in changes in the species composition of the flora and fauna of the territory, changes in the species composition and representation of habitats, changes in the behaviour of animals and changes in their migrations.

Such an example of relatively large changes in the natural environment at local to regional levels are changes and impacts on the biotic component of the natural environment in the territory of Bratislava city. Mainly the consequences of expanding urbanization, the construction of areas of grass-herbaceous or woody vegetation, the construction of large industrial complexes or the construction of line elements with the character of large barriers (highways, railways) come to the fore. A detailed evaluation of these processes was carried out in the territory of Bratislava IV district. An example of changes in the natural environment and impacts on species migration at the supra-regional level is the construction of the Ružín Water Works and the reconstruction of the railway in the Kysak – Krompachy section.

In addition to the evaluation of the effects of the proposed activities on the biotic components of the natural environment, various measures were also proposed to improve their condition.

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Natural capital assessment of the eastern part of the Slovenské rudohorie Mountains

Peter Barančok, Mária Barančoková

Institute of Landscape Ecology, Slovak Academy of Sciences, Štefánikova 3, 814 99 Bratislava
e-mail: peter.barancok@savba.sk, maria.barancokova@savba.sk

Keywords: *the natural capital, the natural potential, land use, Slovenské rudohorie Mts.*

The territory of the Slovenské rudohorie Mts. is important not only from the point of view of natural values, but also provides great opportunities for the use of its natural capital for humans. The bedrock is rich in various raw materials, the mountain massifs represent the most forested area of Slovakia, and the mountain environment with its characteristic climate also provides opportunities for recreational and tourist-sports activities. In our work, we focus on the evaluation of the natural capital of the territory and its potential in different time horizons, in different socio-economic conditions and from the point of view of the protection of the most important components of the natural environment.

In the past, the eastern part of the Slovenské rudohorie Mts. (Volovské vrchy Mts. and Čierna hora Mts.) was mainly altered by mining and ore processing. The settlement, use and overall character of the territory also depended on these activities. These activities were followed up by forestry, which used suitable conditions for forest cultivation and the production of wood needed for ore processing. In connection with the demand for wood material, the approaches in forest management procedures also changed, but throughout the entire period the monitored territory maintained the character of a forest landscape, where the forest cover did not fall below 70% and the mountain massifs and entire valley complexes were covered by continuous forests. Settlement and agricultural activity were mainly concentrated in the valleys of the main water streams. In the course of time, the conditions for agricultural activities changed significantly in the territory, which were influenced on the one hand by climatic conditions and on the other hand by the overall social situation in Slovakia.

Currently, the impact of man and his activities on the components of the natural environment are very often evaluated. This assessment also has its legislative justification and is based on the overall protection of the environment and its components against the adverse effects of human activity in the territory.

At the same time, in the monitored area, the effects of the natural features on its use by humans and the associated changes in the landscape structure can also be very clearly evaluated. These changes can be evaluated in the course of a certain longer historical period, or with regard to the current relatively rapidly changing environmental conditions and needs, or human approaches to the use of the natural capital of the territory.

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Quantitative assessment of geodiversity in the Slovenské rudohorie region

Mária Barančoková¹, Daniela Hutárová¹, Maroš Nikolaj²

¹Institute of Landscape Ecology, Slovak Academy of Sciences, Bratislava, Slovakia

²Esprit spol. s r.o., Banská Štiavnica, Slovakia

e-mail: maria.barancokova@savba.sk, daniela.hutarova@savba.sk, nikolaj@iesprit.sk

Keywords: *geoheritage, geodiversity index, grid analysis, GIS, landscape management*

Geodiversity assessment is one of the basic steps in the development of geoprotection activities. It is important to establish parameters that quantify the elements and locations of abiotic nature. Here the focus is on those who are richer than the average. In doing so, it is possible to manage areas for the protection of important geoheritage and develop sustainable activities, e.g. geotourism. Geodiversity as a natural range of geological rocks, minerals, fossils, geomorphological forms, relationships and processes, and soil features, is seen to be a complementary resource to natural heritage. Planners and managers for the better conservation of abiotic values of the territory may use a quantitative approach to the assessment of geodiversity together with cultural, ethnographic and biological assessments.

The monitored territory (Slovenské rudohorie region – Slovak Ore Mountains) lies in the southeast Slovakia and occupies an area of 4986 km². In the past, the whole territory was an important mining area.

The geodiversity assessment is based on overlaying the grid with different maps at a scale of 1:500 000, where the final geodiversity index is the sum of six indices calculated on a 5 x 5 km grid. These indices represent the main components of geodiversity. They consist of a geological index, a geomorphological index (composed of two sub-indices: geomorphological subdivision and morphological-morphometric types), a hydrological index (composed of three sub-indices: type of aquifer, density of the river network and occurrence of springs and mineral waters), a soil index, a tectonic index and a mineral resources index (composed of sub-indices: occurrence of ore, non-ore, construction and energy resources). The geodiversity index takes the form of an isoline map that can be used as a tool for spatial planning, in particular for identifying priority areas for the conservation, management and use of natural resources at national level. The resulting geodiversity index map is presented in the form of five isoline classes: very high (10% of the monitored area), high (28%), medium (32%), low (23%) and very low (7%). The geodiversity map together with the indices creates a useful tool for management, conservation, sustainability programs and education.

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Hayloft meadows of Slovakia and drivers of their development

Zuzana Baránková¹, Jana Špulerová¹, Juraj Lieskovský²

¹ Institute of Landscape Ecology, Slovak Academy of Sciences, Štefánikova 3, Bratislava, Slovakia

² Institute of Landscape Ecology, Slovak Academy of Sciences, branch Nitra, Slovakia

e-mail: zuzana.barankova@savba.sk¹, juraj.lieskovsky@savba.sk², jana.spulerova@savba.sk³

Key words: *land abandonment, biocultural heritage, grasslands, agricultural history*

In the past, agriculture in the mountain and submountain villages in Slovakia was mainly focused on livestock production, especially sheep and cattle breeding, which was linked to the development of pasture and meadow farming. In many areas of Slovakia, hay meadows with haylofts have been developed. In addition to haylofts, the hay meadows were characterized by solitary trees, whose lower branches were cut off. In this way, typical hay meadows were created with a significant representation of woody vegetation, and together with the haylofts, they created the traditional landscape scenery and the colour of the region.

The haylofts were mainly localised in the more remote parts of the villages. They were log buildings, approximately 4 by 4 meters in size, with shingle roofs and usually without doors. Their representation in the mountain and submountain areas was mainly linked to three historical regions: Upper Liptov region, parts of the Lower Liptov and adjacent areas of Turiec and some parts of the Zvolen region. Other smaller areas of occurrence were, for example, in the Orava and Spiš regions.

On the basis of Czechoslovakian military topographic maps from 1952–1957 at a scale of 1:25 000, a map of the occurrence of haylofts in the whole of Slovakia was digitized. The data were processed using the ArcMap 10.3 software. Altogether, 9,742 haylofts were recorded, which were localized in the cadastres of 161 municipalities and 26 districts. They were mostly built on soils with low soil quality - almost 46 percent of haylofts were located on soils classified in the ninth class, which represents the lowest soil quality. Most of them were built at higher altitudes, ranging from 600-1000 m above sea level, on flat or moderate slopes up to 7 degrees.

Almost none of the former hay meadows with haylofts and solitary trees have been preserved to date, but 50% of them have been preserved as grasslands of different intensities of use. Another 27% of the sites are already covered by forest, and about 12% are subject to various stages of succession with shrubs. To a lesser extent, these areas have been converted into arable land or recreational areas. Only a few haylofts have survived to this day. Apart from a few positive cases where they have been restored, those that have survived continue to decay.

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Different landscape, different perception?

Magdaléna Bezáková¹, Peter Bezák¹, Marta Dobrovodská², Milena Moyzeová²,
František Petrovič³

¹ Institute of Landscape Ecology, Slovak Academy of Sciences, Bratislava, Slovakia

² Institute of Landscape Ecology, Slovak Academy of Sciences, branch Nitra, Slovakia

³ Faculty of Natural Science, Constantine the Philosopher University in Nitra

e-mail: magdalena.bezakova@savba.sk, peter.bezak@savba.sk, marta.dobrovodska@savba.sk,
milena.moyzeova@savba.sk, fpetrovic@ukf.sk

Key words: *agriculture, landscape, stakeholders, perception*

The presented contribution aims to analyse and interpret partial results of conducted complex research on socio-ecological changes in selected agricultural landscapes in Slovakia. In particular, it focuses on input received from key stakeholders from 7 case studies, while case studies represent different landscapes from ecological and socio-economic point of view. The main research question is based on assumption that different site-specific features of landscape structure and socio-economic context play crucial role in stakeholders' perception of past, present and future agricultural landscapes. Furthermore, insights from the questionnaire survey can serve to improve local and national rural policies, especially Common Agricultural Policy (CAP). In our investigation we applied semi-structure interviews with 5-8 key stakeholders in 7 rural areas throughout Slovakia. We found that despite divergence in landscape structure and livelihood there are quite many common signs that are perceived by key local stakeholders, e.g. radical loss of small-scale landscape features, abandonment of remote parcels and expansion of forest in peripheral areas, missing extensive grazing, dominant management by large farms, expected continuation of urbanisation trends, wished tourism development. Strong effects of the political and socio-economic changes since the 1990s and too generic and inflexible national schemes under the CAP seem to be still dominant in agricultural landscape development. Above mentioned trends in farming also correlate with changes in agricultural parcels registered for the CAP support, which lead to less area for the farming, increase of parcel size and decrease in number of parcels. However, there are certain perceived differences that mainly come from local social capital, economic vitality, geographical location or quality of environment that should be better reflected in landscape planning and decision-making, either in local or national scale.

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Long-term development trend of the historical cultural landscape of the UNESCO monument: Vlkolínec (Slovakia)

Martin Boltížiar^{1,2}, František Petrovič³, Iveta Rakytová⁴, Ivana Tomčíková⁴, Eva Pauditšová⁵

¹Institute of Landscape Ecology SAS Bratislava, branch Nitra, Nitra, Slovakia,

²Department of Geography and Regional Development, Constantine the Philosopher University in Nitra, Nitra, Slovakia,

³Department of Ecology and Environmental Sciences, Constantine the Philosopher University in Nitra, Nitra, Slovakia,

⁴Department of Geography, Catholic University in Ružomberok, Ružomberok, Slovakia

⁵Department of Environmental Ecology and Landscape Management, Comenius University in Bratislava, Bratislava, Slovakia

e-mail: martin.boltiziar@savba.sk, fpetrovic@ukf.sk, ivana.tomcikova@ku.sk, iveta.rakytova@ku.sk
epaudits@gmail.com

Keywords: *Vlkolínec, UNESCO, Slovakia, historical structures, land use changes*

The presented paper focuses on the United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site of Vlkolínec (Slovakia), changes in its cultural landscape and the possibilities of its preservation for future generations. However, it is also a living settlement with residents who have demands for their standard of living. To analyze the development of changes in the landscape of the Vlkolínec protection zone, we used available relevant data such as historical maps and aerial photographs from selected time horizons 1769, 1823, 1949, 2007 and 2022. Overall, we interpreted a total of 13 landscape elements, paying special attention to historical landscape structures. For the land use elements, we focused mainly on determining their area and percentage of the landscape in relation to their changes in the period under review in the context of natural and socio-economic conditions. In order to gain a realistic view of the future development and use of the Vlkolínec area in the context of direct users of the area, we decided to apply a questionnaire survey in 2017. The questionnaire is a written form of a structured interview. We determined a target group of respondents - residents of Vlkolínec and users of this area (holiday cottage owners, foresters, farmers), i.e., we processed the opinions of people directly influencing Vlkolínec and its immediate surroundings—the landscape. The interviews were focused on identifying problems and proposing solutions so as not to disturb the uniqueness of this site, but at the same time to also attract tourism participants. Based on the results of the survey, we evaluated the identified phenomena, structures and values and compared them with the desired state of protection of the landmark. Subsequently, we prepared plans for the preservation and sustainable development of this important site.

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**The interdisciplinary research of the current state and further development of
alpine lake ecosystems as an indicator of changing climate trends
(High Tatra Mts.)**

Silvia Čajková, Kristína Hrivnáková, Juraj Hreško, Gabriel Bugár

Department of Ecology and Environmental Sciences, Faculty of Natural Sciences and Informatics,
University of Constantine the Philosopher

e-mail: silvia.cajkova@ukf.sk, kristina.hrivnakova@ukf.sk, jhresko@ukf.sk, gbugar@ukf.sk

Keywords: *characteristics of the micro-catchment, geomorphological processes, climatic factors, sub- and alpine lakes, physical-chemical state*

These specific aquatic ecosystems are excellent indicators of natural and human-made changes. The High Tatra mountain range formed by glaciers has a typical exposed relief, elements, and dynamism. The current climate trends change significantly contribute to the intensification of morphodynamic activity in this alpine environment. An increase in extreme precipitation activity is shown to result in more substantial movement of unstable rocks and their weathering, a change in the length of the snow cover to insulate the rocks, and an increase in air temperature and its fluctuation around zero to defrost them. Mainly the higher lakes are gradually silted up by water-gravity processes from their micro-catchments, which affect their existence and the sensitive composition of the lake water column. With this contribution, we want to point out the interdisciplinary connection, appropriateness, and topicality of our research on the given issue, which is supported by data obtained directly in the field, on a large number of investigated lake ecosystems of the High Tatras, in the sub-alpine and alpine zone. The identification of land cover and the analysis of morphodynamic processes in micro-catchments, together with an analysis of the physico-chemical composition of water samples from these lakes, will assess the current state and future development of these ecosystems, pointing out the importance of the impacts of a changing climate.



Factors affecting the biodiversity of historical landscape elements: detailed analyses from three case studies in Slovakia.

¹Marta Dobrovodská, ¹Róbert Kanka, ²Peter Gajdoš, ³Anton Krištín, ¹Jozef Kollár,
⁴Slavomír Stašiov, ²Juraj Lieskovský

¹Institute of Landscape Ecology, Slovak Academy of Sciences, Štefániková 3, 814 99 Bratislava, Slovakia,

²Institute of Landscape Ecology, Slovak Academy of Sciences, Branch Nitra, Slovakia.

³Institute of Forest Ecology, Slovak Academy of Sciences, Zvolen, Slovakia,

⁴Department of Biology and General Ecology, Faculty of Ecology and Environmental Sciences, Technical University in Zvolen, Zvolen, Slovakia,

e-mail: marta.dobrovodska@savba.sk¹, robert.kanka@savba.sk¹, p.gajdos@savba.sk², kristin@ife.sk³, j.kollar@savba.sk¹, stasiov@tuzvo.sk⁴, juraj.lieskovsky@savba.sk¹

Keywords: *traditional agricultural landscape, spiders, millipedes, grasshoppers and crickets, vascular plants, species richness, landscape ecological factors*

A direct, positive correlation between biodiversity and the traditional agricultural landscape is evident on the national or regional scale. It is mostly conditioned by higher landscape diversity and less intensive farming. We have carried out research on a detailed scale at plot level (productive plots of arable lands, grasslands, vineyards, orchards, and unproductive agrarian landforms (mostly field margins) such as terraced slopes, terraced steps, heaps, mounds and unconsolidated walls in three traditional agricultural landscapes: the mountain village Liptovská Teplička, the vineyard landscape in Svätý Jur, and dispersed settlements in a submontane area in Hriňová. We determined the statistical significance of the impact of the selected landscape ecological factors (a set of factors concerning land use and management, agrarian landforms and relief properties) on the distribution of vegetation and selected invertebrate groups (spiders, millipedes, grasshoppers and crickets). We also explored whether maintaining traditional land use and traditional management helped to enhance the biodiversity. We found that the management regime is the most important factor determining the species composition the species profile of vascular plants and all studied animal groups. Also, present land use and agrarian landforms character (type, skeleton content, continuity) are significant factors. Our expectation of a positive relationship between biodiversity and the maintaining traditional land use and traditional management was, in general, not confirmed: such a relation was only found in Svätý Jur for biodiversity of spiders.

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Creating new social-ecological values through the restoration of post-mining ecosystems: the case studies from Polish Lowland

Katarzyna Fagiewicz

Department of Integrated Geography, Faculty of Human Geography and Planning, Adam Mickiewicz University in Poznan, Poland,

e-mail:kfag@amu.edu.pl

Keywords: *post-mining areas, restoration, ecosystem services, Polish Lowland*

The post-mining areas create specific anthropogenic ecosystems with high dynamics of change. For diverse post-mining ecosystem types, the ways of restoration are different and dependent on environmental factors, methods and time of exploitation, and the scope of preventive measures. These conditions offer unique opportunities for creating a specific range of social, economic and ecological value through restoring post-mining ecosystems. The structure of services depends on the mode of reclamation and the type of use of post-mining ecosystems. The post-mining ecosystems and their restoration may become a crucial element of development strategy in the region. They offer space and a wide range of opportunities to create vital ecosystems that fill deficit structures in the landscape (e.g. forest ecosystems, floral and nesting ecosystems for pollinators, and rich structured ecosystems with ruderal herbaceous vegetation).

The concept of ecosystem services supports post-mining management because it allows assessing what benefits in the regulation, provisioning, and cultural dimensions will result from decisions on the mode of reclamation and the use of post-mining ecosystems.

This work describes the different scenarios for treating post-mining areas in Polish Lowland. It presents a method of assessing the impact of reclamation on selected components (social, economic, or environmental) based on ecosystem service indicators. In evaluating the level of services provided by post-mining ecosystems, an expert approach is mainly used, using scientific knowledge supported by literature on the subject. This is because the information scope of publicly accessible databases is of little use for assessing ecosystem services. Developing simple tools to evaluate the benefits of post-mining ecosystems is crucial because decisions on the mode of reclamation can develop new potential for providing high-quality services and support strategic visions for the development of post-mining regions.

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Evaluation of Waste Separation and Recycling in the Municipalities of the Hrušovsko-Beňadický Microregion

Dominika Gdul'ová^{1,2}, Milena Moyzeová¹

¹Institute of Landscape Ecology, Slovak Academy of Sciences, Štefánikova 3, 814 99 Bratislava,

²Faculty of Natural Sciences, The Constantine Philosopher University, Tr. A. Hlinku 949 74 Nitra,

e-mail: milena.moyzeova@savba.sk, dominika.gdulova@savba.sk

Keywords: waste, separation, recycling, environmental quality, questionnaire

One of the negative factors influencing the environmental quality of rural settlements is the amount of waste produced and wild landfills. The production of municipal waste is increasing year by year based on statistical indicators (Štatistický úrad Slovenskej republiky, 2022). The separation rate is an important indicator of the quality of the waste management system set up in Slovak municipalities. Waste separation provides valuable raw materials for waste recycling. The paper focuses on the evaluation of waste separation and recycling in the municipalities of the Hrušovsko-Benadický Microregion, which consists of ten municipalities. Their priority is to set up waste management properly and thus improve the quality of the environment in the municipalities. This objective can be achieved by adapting the infrastructure to the specific urban and demographic conditions of the municipality and consequently increasing waste separation. The comparison is assessed for the period of 2016 - 2020. The resulting investigation showed that separation rates are increasing in all municipalities of the Microregion, with the exception of facilities containing chlorofluorocarbons, whose separated quantities are gradually decreasing. However, there are large differences in the quantities of waste separated in the municipalities of the Microregion, which are influenced by the different infrastructure as well as the activity of the municipalities to motivate the inhabitants to separate. The assessment was complemented by the results of a sociological survey conducted in the form of a questionnaire and a guided interview with the mayors of the municipalities and the local population.

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The preliminary results of the monitoring of effects of warming and nitrogen deposition on alpine meadows (Kráľova hoľa, 1946 m a.s.l., Low Tatra Mts.)

Katarína Gerhátovej, Stanislav David, Andrej Halabuk, Ľuboš Halada, Matej Mojses,
†František Kohút, Zuzana Poncová, Tomáš Rusnák

Institute of Landscape Ecology SAS, Slovakia, Branch Nitra, Akademická 2, 949 10 Nitra
e-mail: katarina.gerhatova@savba.sk (corresponding author)

Climate change has pronounced impacts on plants, particularly in environments vulnerable such as alpine zones. Therefore, the research on alpine vegetation under on climate change is necessary. In 2009 were established totally 24 experimental plots in research site Kráľova hoľa (Low Tatra Mountains). Each plot has 1 x 1 meter and was divided into 100 small squares. Through our study, we identified the occurrence of 22 species, and statistical analyses were performed based on the frequency of species occurrence. The highest frequencies have species: *Soldanella hungarica* and *Homogyne alpina* ($F = 90.28$), follows next *Carex bigelowii* and *Oreochloa disticha* ($F = 88.89$), *Polytrichum alpinum* ($F = 87.50$) and *Campanula alpina* ($F = 86.11$). On the other hand, *Nardus stricta* and *Helictotrichon versicolor* showed the lowest frequency ($F = 2.78$). The research areas were divided into four categories based on to the treatment method: 1. Ammonium nitrate solution ($100 \text{ g.m}^2/\text{year}$), 2. Ammonium nitrate + Greenhouses, 3. Greenhouses only and 4. Control plots. The vegetation analysis aimed to evaluate the overall species richness according to treatment and changes in overall frequency in the years 2009, 2015, and 2022. The Shannon and Simpson diversity indices were calculated based on treatment and years. Statistical analysis was performed using Means with Error plots and the nonparametric Kruskal-Wallis test: Count x treatment, $p = 0.0001$; Count x years, $p = 0.4836$; Frequency x treatment, $p = 0.0017$; Shannon x treatment, $p = 0.00003$; Shannon x years, $p = 0.9584$; Simpson x treatment, $p = 0.0002$. Preliminary results confirmed statistically significant ($\alpha = 0.05$) lower species count, frequency, Shannon and Simpson indices in plots treated with greenhouses and ammonium nitrate. The differences in these values between the years 2009 and 2020 were not statistically significant. Multivariate Principal Response Curves (PRC) analysis, were used to analyze the impact of treatments on plant species. Species such as *Carex bigelowii*, *Festuca supina* and *Luzula alpinopilosa*, showed a positive affinity to treatment intensity, while species like *Cetraria islandica*, *Campanula alpina*, *Homogyne alpina* and *Hypnum* sp. exhibited a negative affinity. These findings confirm that climate change significantly affects alpine vegetation.

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The impact of German settlement on the landscape in the village of Čermany

**Henrich Grežo, Andrea Molnárová, Alfred Krogmann, Lucia Petrikovičová,
František Petrovič**

Constantine the Philosopher University in Nitra

e-mail: hgrezo@ukf.sk, amolnarova@ukf.sk, akrogmann@ukf.sk, lpetrikovicova@ukf.sk, fpetrovic@ukf.sk

Keywords: *Čermany, German Settlements, Secondary Landscape Structure*

The article follows one of the last waves of settlement of Slovakia by Germans during the 19th century, specifically in the village of Čermany. In 1859-1860, 68 German families from Lower Saxony came to this village, representing 285 inhabitants. Mostly they were farmers, but there were also craftsmen. The arrival of German immigrants ultimately meant a fundamental change in the ownership relations of agricultural land. We evaluated changes in the spatial distribution of landscape elements based on historical time sections by geographic information systems along with historical, social, and culturally specific aspects. Land ownership conditions have changed significantly in their favour. However, it did not bring fundamental economic changes, as was with Hauerland or Spiš.



Recent transformation processes of ecosystems and landscapes in Germany in the context of multiple crises

Karsten Grunewald

Leibniz Institute of Ecological Urban and Regional Development (IOER), Werberplatz1, 01217 Dresden, Germany

e-mail: k.grunewald@ioer.de

Major ecological-economic challenges are facing us now and in the coming years with regard to energy supply, climate change and biodiversity loss. These challenges are overlaid by social and security crises in the EU and globally. Despite an increasing awareness of crises, destructive patterns of production and consumption are still stable and even spreading globally because ecological costs can be externalised, i.e. shifted in space and time. In this context, how do current transformation processes affect the condition and services of our ecosystems and landscapes? This will be questioned and demonstrated in the presentation by the example of Germany on a national scale. The information are based on the extensive National Ecosystem Assessments that have been carried out in recent years. Finally, an overview of strategies and measures to avoid the degradation of natural capital or the loss of ecosystem services will be given, but also ways to invest in nature for welfare enhancement will be shown.



Ecological significance of different types of rural landscape in Slovakia

Luboš Halada¹, Alfréd Trnka², Peter Gajdoš¹, Oto Majzlan³, Pavol Purgat¹

¹Institute of Landscape Ecology SAS, branch Nitra, Slovakia.

²Trnava University, Faculty of Education, Trnava, Slovakia

³Comenius University Bratislava, Faculty of Natural Sciences, Bratislava, Slovakia

e-mail: lubos.halada@savba.sk; nrukajd@savba.sk; pavol.purgat@savba.sk

Keywords: *biodiversity, conservation value, vegetation, birds, spiders, beetles, dragonflies*

The significant part of the overall biodiversity is linked to rural, agriculturally managed landscape. We studied habitats, vegetation, birds and several invertebrate groups (spiders, beetles, dragonflies) in seven case study areas distributed across Slovakia. The local-level case studies (mostly villages) were selected in order to represent different types of agricultural landscape and different biogeographical regions Pannonian region, Western Carpathians, and Eastern Carpathians. We assessed taxonomic diversity, naturalness, invasive species presence and conservation value separately for individual studied groups of organisms and calculated index of ecological significance (Dobrovodská et al. 2019).

In individual case studies, we mapped between 89 (Runina) and 159 (Báb, Nová Vieska) vegetation stands. The highest species diversity and highest vegetation naturalness were recorded for Upper Orava followed by Važec and Runina while in lowland case studies Nová Vieska and Báb both the species diversity and naturalness were lowest. The highest number of invasive species was found in Nová Vieska (25) and Báb (21) while we did not record any invasive species in Važec and Upper Orava. Važec has highest conservation value (22 protected and 45 threatened species), high conservation value have also Nová Vieska, Runina and Upper Orava.

The total number of vertebrate species varied between 103 (Malá Lehota) and 145 (Nová Vieska) species in the case studies. The main focus was paid to birds, we recorded between 66 and 104 species per case study. The conservation value was found highest in lowland case studies Báb and Nová Vieska probably due to occurrence of water and wetland habitats and in case of Nová Vieska also by availability of long-term data for birds. The total number of studied invertebrate species varied between 86 (Malá Lehota) and 463 (Báb). The main focus was paid to spiders, we recorded between 81 and 188 species per case study. Similarly as for vertebrates, Nová Vieska has highest conservation value also for invertebrates (39 threatened and potentially threatened species).

References: Dobrovodská, M., Kanka, R., David, S., Kollár, J., Špulerová, J., Štefunková, D., Moyses, M., Petrovič, F., Krištín, A., Stašiov, S., Halada, Ľ., Gajdoš, P., 2019: Assessment of the biocultural value of traditional agricultural landscape on a plot-by-plot level: case studies from Slovakia. – *Biodiversity and Conservation* 28: 2615 – 2645.

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Physical and socioeconomic characteristics of the Poloniny National Park with a focus on cultural ecosystem services

Bohdana Halas, František Petrovič, Peter Mederly

Department of Ecology and Environmental Sciences, Faculty of Natural Sciences and Informatics, University of Constantine the Philosopher, Slovakia

e-mail: bohdana.halas@ukf.sk, fpetrovic@ukf.sk, pmederly@ukf.sk

Keywords: *ecosystem services, national nature park*

National Park (NP) of Poloniny is an area full of natural beauties, which is included in the UNESCO World Heritage List and is a part of the Eastern Carpathians Biosphere Reserve. The aim of the studies is to analyzed the physical and socio-economic factors of the area with a focus on identifying the cultural ecosystem services provided by the area of National Park.

The work describes the natural conditions of the park, including relief, geology, climate and biodiversity. Socioeconomic factors, particularly demography and land use of the area, were also analyzed and cultural ecosystem services provided by the NP territory, such as recreational activities, cultural and historical sites and other tourist facilities, were identified. Various sources of information are used in the thesis, including literature, statistical data and field research. The Poloniny National Park has a significant ecological value and is also an important place for the traditional economy of the local inhabitants.



The importance of historical water management objects in landscape-ecological research

Marek Havlíček, Hana Skokanová

The Silva Tarouca Research Institute for Landscape and Ornamental Gardening

e-mail: marek.havlicek@vukoz.cz, skokanova@vukoz.cz

Keywords: water, object, historical, the Czech Republic

Historical water management objects, by their location, specific orientation, density of occurrence, and their continuity, can indicate what significance they had in the context of the development of the landscape and its use. Based on data from research throughout the Czech Republic, it is possible to evaluate the relationships and links between different types of water management objects and their impact on the landscape. The use of the water wheel as a valuable source of energy had a fundamental influence on the development of industry in history. The types of individual water management objects also give us information about the use of mineral resources in the region, or about specific requirements in the locality. On the basis of specific examples of water management objects, relationships in the landscape-ecological context are documented.



Transport availability as a prerequisite for the development of tourism the local action group assimilation of municipalities of the White Carpathians and Trenčín microregion and the Bošáčka microregion

Alexandra Hladká

Institute of Landscape Ecology, Slovak Academy of Sciences, Štefánikova 3, 814 99 Bratislava, Slovakia
e-mail: alexandra.hladka@savba.sk

Keywords: *transport availability, tourism, socio-economic development, cultural ecosystem services*

The contribution focuses on the tourism potential and accessibility of the area of the Local Action Group Association of Municipalities of the Bielokarpatsko-Trencian Microregion and the Bošáčka Microregion by various modes of transport. Depending on the mode of transport it is possible to identify public transport and individual transport. While public transport is more environmentally friendly, it is limited by its planned route and defined stops. Individual transport is more flexible and can provide access to tourism points of interest that cannot be visited by public transport. The aim of this paper was to compare the accessibility of the area by 4 modes of transport on a tourism potential index.

The formula used to calculate the tourism potential was according to Rodríguez, Ramírez and Velasco (2019)¹. The formula of the Tourism Potential Index (TPI) has the form $TPI = \alpha FR + \beta FA + \gamma FE$, the coefficients have the values $\alpha = 1.25$ (natural values) and 1.50 (cultural and historical values), $\beta = 1.0$ and $\gamma = 0.50$. FR is the value of tourism resource factors, FA is the value of accessibility factor and FE is the value of establishment factor. Based on the calculated TPI values, the municipalities were divided into 5 categories of tourism potential. For public transport, the greatest tourism potential is on the periphery of the area of interest. For individual transport, the greatest potential of the area of interest was in the southern and southwestern parts of the area.

References: ¹Rodríguez, O. L., Ramírez, D., Velazco, F. 2019. *Evaluación del potencial turístico de una ciudad ubicada en la cuenca de burgos, Tamaulipas*. In: TURyDES, 2019, vol. 12, issue 27, ISSN 1988-5261 p. 1 - 15

Acknowledgment: This contribution is supported by project VEGA Integration of supply of selected ecosystem services for societal demand in terms of developing sustainable forms of tourism and grant UGA VIII/6/2023 Assessment of the prerequisites for the tourism development in the area of the Local Action Group Association of Municipalities of the White Carpathians and Trenčín Microregion and the Bošáčka Microregion.



Spatial model of the postglacial lake basin – Christlová in the southern foreland of Studena dolina in the High Tatras (Slovakia)

Juraj Hreško¹, Veronika Piscová², Gabriel Bugár¹, Malvína Čierniková³, Slavomír Celer⁴

¹Department of Ecology and Environmental Sciences, Faculty of Natural Sciences, Constantine the Philosopher University, Nitra, Slovakia, ²Institute Landscape Ecology, Slovak Academy of Sciences, Bratislava, Branch Nitra, Slovakia

³Department of Pedology, Faculty of Natural Sciences, Comenius University in Bratislava

⁴Office of Tatra National Park, Tatranská Lomnica

e-mail: jhresko@ukf.sk, veronika.piscova@savba.sk, gbugar@ukf.sk, malvina.ciernikova@uniba.sk, celer@sopsr.sk

Keywords: *paleo lake, peat bog, lacustrine sediments, postglacial*

The investigated territory of the pre-glacial paleo lake Christlová is part of a significant outcrop of moraine accumulations from the last glacial period - Würm in the SE foreland of the High Tatras. Lukniš (1968, 1973) mapped this depression on the moraine on the first complex geomorphological map of the High Tatras as an alluvium-filled moraine basin with a peat bog. According to more recent studies of the glaciation of the Tatras and detailed dating of glacial accumulations, the almost circular depression is part of the moraines of the Last Glacial Maximum (LGM), which they confirm (Engel et al. 2015). Our intention is to follow up on the previous knowledge of this important location from the point of view of its previous development in the foreland of the High Tatras, which represent the highest mountain range of the Carpathians. We want to contribute to the knowledge of the paleo-development of the extinct Christlová lake using data from the dating of the organic matter of the postglacial peatland, which was formed on the former bottom of the lake. The first discovery of paleo limnic sediments in a natural terrestrial outcrop, which we identified on the right side of the Studený potok creek, contributed to the knowledge about the development of the lake. Of the obtained sediment samples, only one was suitable for dating, which we took from the database of unique varvite sediments in a terrestrial position. In the process of learning about the paleo-development of the former lake, we also include georelief analysis using a new 3D model and ArcGIS tools. They point out the importance of proglacial lakes, which can influence the dynamics of glaciers, the hydrology of the basin and have the potential to cause floods (Irrazaval, I. et al. 2022). The authors further emphasize that knowledge of the development of proglacial lakes also contributes to the understanding of the processes associated with glacier activity and predicting the glaciers' response to climate change. The formation of mosses of the High Tatras was related to the phases of glaciation and deglaciation after the period of the glacial maximum in the Late Würm period - 22.0 ± 0.8 ka (Engel Z. et al. 2015).

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Impact of human activities on the current state of vegetation in wine-growing cultural landscape (Svätý Jur, Slovakia)

Natália Hurajtová^{1,2}, Veronika Piscová¹, Petra Gašparovičová¹, Michal Ševčík²

¹Institute of Landscape Ecology, Slovak Academy of Sciences, Akademická 2, 949 01 Nitra,

²Faculty of Natural Sciences, The Constantine Philosopher University, Tr. A. Hlinku, 949 74 Nitra

e-mail: n.hurajtova@savba.sk, veronika.piscova@savba.sk, petra.gasparovicova@savba.sk, msevcik@ukf.sk

Keywords: *Svätý Jur, human impact, vegetation, cultural landscape*

The aim of our study is to reconstruct the human influence on the current landscape and vegetation in the selected parts of the cadastral territory Svätý Jur. Svätý Jur is a small historical town northeast of Bratislava. The city is situated on the slopes of Little Carpathians mountains and surrounded by typical terraced vineyards with more than 700 years of winemaking tradition. Human activities have transformed natural environment in Svätý Jur since neolithic period. There are two very important historical sites in the area, the Great Moravian hillfort Neštich (early to late Middle Ages) and the Biely kameň Castle (13th-17th century). It is possible to trace the influence of past human activities on current vegetation by mapping vegetation on historical landscape structures. For our research we chose two study sites. Both of them are located in the Little Carpathians in the northern part of the territory, formed by typic oak-hornbeam forests and are part of the Little Carpathians Protected Landscape Area. It is possible to trace the influence of past human activities on current vegetation by mapping vegetation on historical landscape structures. For our research we chose two study sites. Both of them are located in the Little Carpathians in the northern part of the territory, formed by typic oak-hornbeam forests and are part of the Little Carpathians Protected Landscape Area. Our research has shown that there are significant differences between the investigated locations in the plant communities as well as in their demands on the environment.

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The origin and development of viticulture in Svätý Jur

Natália Hurajtová^{1,2}, Juraj Lieskovský¹

¹Institute of Landscape Ecology, Slovak Academy of Sciences, Akademická 2, 949 01 Nitra,

²Faculty of Natural Sciences, The Constantine Philosopher University, Tr. A. Hlinku, 949 74 Nitra,

e-mail: n.hurajtova@savba.sk, juraj.lieskovsky@savba.sk

Keywords: *Svätý Jur, viticulture, archaeobotany, history*

Svätý Jur is a small town in the Little Carpathian Wine Region, situated near the capital of Slovakia. It is known for its rich history, mainly linked to the wine-growing tradition. The aim of our work is to analyse data obtained from archaeological and archaeobotanical research, historical data and data obtained from the study of old maps to describe the development of viticulture in Svätý Jur. Systematic archaeological research, with archaeobotanical sampling, has been carried out since 2006. The archaeobotanical analysis gives an overview of the range of crops from the Great Moravian period. This was the first permanent settlement in the present-day cadastre of the municipality of Svätý Jur. It was during this period that viticulture was also considered in Svätý Jur, as there is no doubt about the cultivation of vines in the Great Moravian period in the territory of south-western Slovakia. First written records about viticulture tradition in this area is from the 13th century. Historical records show the distribution of vineyard, the size of the harvests and the problems faced by the vine-growers. The maps show how vineyard areas have changed. Changes are mainly driven by political and natural factors. Changes in political regimes, tax burdens, financing, wine trade, wars, etc. have all had an impact on viticulture. Among natural factors, the greatest damage to viticulture was caused by the phylloxera and downy mildews epidemic at the end of the 19th century. Climatic factors, such as dry periods and severe winters, played role as well.

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Allotments development in Bratislava

Daniela Hutárová, Ivana Kozelová, Dagmar Štefunková, Alexandra Hladká

Institute of Landscape Ecology, Slovak Academy of Sciences, Štefánikova 3, 814 99 Bratislava, Slovakia
e-mail: daniela.hutarova@savba.sk, ivana.kozelova@savba.sk, dagmar.stefunkova@savba.sk,
alexandra.hladka@savba.sk

Keywords: *green infrastructure, blue infrastructure, food provision, urban gardening, supporting ecosystem services, social aspects, wellbeing, agricultural land storage*

Favorable climatic conditions, soil structure, hilly and sloping terrain of Bratislava and the surrounding area created favorable conditions for the development of horticultural activities and especially fruit growing. After the second world war, many abandoned, confiscated gardens remained. First inspection in 1964 found 192 ha of neglected or ice-covered land, which were subsequently rented out to private individuals for a period of 1-3 years. In many cases, they had no relation to the gardens and tried to get the most out of them with almost no investments. This was eliminated by renting the gardens for a period of 6-10 years. Another reason for the neglect of the gardens is still the taking of land for the construction of the “Great Bratislava”. Allotments in Slovakia, so called Schreber gardens (Schrebergärten), were to be founded in accordance with urban plans and design models inspired by the ideas of Dr. D. Schreber. National Committees allocated land that could not otherwise be used for agricultural production and were not expected to be developed for construction or infrastructure for at least 30 years. The city of Bratislava covers 36,651.36 hectares in total. 2.5% of the area of Bratislava, or 914.54 ha, is included in our research of allotment gardens. Allotments and gardens expanded up until the 1990s (839.97 ha, or 91.85% of the study area), after which they gradually started to decline. The research area currently has 760.57 ha of complex cultivation patterns, which are mostly threatened by urbanization or abandonment. Nevertheless, we should look at allotments as an important part of the green-blue infrastructure and a part of the bio- cultural heritage and ensure a certain degree of protection.

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Drainage ditches like the butterflies diversity islands in agricultural landscape in eastern Slovakia

Henrik Kalivoda

Institute of Landscape Ecology, Slovak Academy of Sciences, Štefánikova 3, 814 99 Bratislava, Slovakia
e-mail: henrik.kalivoda@savba.sk

Keywords: *drainage ditches, agricultural landscape, butterflies, diversity*

Drainage ditches represent an important landscape element in the agricultural landscape with high ecological potential. Researches in recent years shows that they have a great importance not only as infrastructure used for agricultural purposes, but also as biodiversity islands in agricultural landscape. Drainage ditches create suitable conditions for the occurrence of a wide range of forest, grassland, and aquatic habitats. Drainage habitat biotopes represent important refuges for threatened and protected species in agricultural landscapes, providing a wide spectrum of ecological conditions. We recorded 43 butterfly species in this area. Many rare and endangered butterfly species live in these biotopes and we also recorded a larger number of ecological specialists (22 species). Species *Zerynthia polyxena*, *Melitaea phoebe* and *Glaucopsyche alexis* are characteristic for dry and warm habitats, while species *Lycaena dispar* or *Heteropterus morpheus* for wet non-forest habitats. The ditches are also important migratory corridor in this region.

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Soil filtration services in contaminated areas

Radoslava Kanianska

Matej Bel University in Banská Bystrica, Faculty of Natural Sciences, Tajovského 40, 974 01 Banská Bystrica, Slovakia

e-mail: radoslava.kanianska@umb.sk

Keywords: *filtration ecosystem service, soil and water contamination, lead, Fluvisol*

Floodplains create a complex interactions between water, sediments, soils and biota. They are often under the great pressure coming from human activities, especially from industry and agriculture. This pressure is reflected in the quality of the ambient compartments of the environment and is often accompanied by their contamination with possible negative consequences on human health. We focused on the Štiavnica river floodplain in central Slovakia covered mainly by Fluvisols which are severely contaminated by Cd, Pb, Cu, Zn even in arable lands. We found out from published data the state of contamination of underground, surface waters and sediments of the Štiavnica river and compared them with soil contamination and adopted limits. Further we performed health risk assessment by calculating hazard quotient (HQ). The total content of Pb in Fluvisols ranged from 154 to 2603 mg.kg⁻¹ exceeding the limit values for agricultural soils and even the guideline values for remediation needs. On contrary, the content of Pb in surface waters was below the limit values set up for waters. This indicates that Fluvisols play an important filtering role for Pb in floodplain ecosystems. However, the soil subsequently poses a potential health risk for children who come into contact with it (HQ_{ch} for Pb 4.1).

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Detailed vegetation research as a proxy for monitoring climate change in alpine ecosystems

Róbert Kanka, Peter Barančok, Jozef Kollár, Andrej Palaj

Institute of Landscape Ecology Slovak Academy of Sciences, Štefánikova 3, 81499, Bratislava, Slovakia

e-mail: robert.kanka@savba.sk, peter.barancok@savba.sk, andrej.palaj@savba.sk

Keywords: *climate change, vegetation, monitoring, Tatra Mts., Slovakia, GLORIA, sUMMITDiv*

Observed climate change, especially warming, is having a significant impacts on the distribution of Slovak, European as well as the World flora and these impacts include uphill range shifts, as well as potential local and regional extinctions of species. This process can be also called as a vertical migration of species. In this contribution we give an overview of the most interesting results obtained by analysing of the Slovak sites of the worldwide GLORIA (Global Observation Research Initiative in Alpine Environments), which is a long-term observation programme and international research network to assess climate change impacts on the biological richness of the planet's high mountain ecosystems using the unified methodological approach. In Slovakia, it is coordinated by the Institute of Landscape Ecology since 2000. The system of permanent plots was established in 2001 on the summits of the following four Tatra's peaks: Krížna (1,918.6 m a.s.l.), Veľká kopa (2,052.4 m a.s.l.), Sedielková kopa (2,061.3 m a.s.l.), Krátka (2,374.5 m a.s.l.). The plots are monitored in 7-year cycles – the first took place in 2001, the second in 2008, the third in 2015 and the last in 2022. The results revealed some changes in floristic composition, especially higher abundance of some grasses and chamaephytes and, on the other hand, retreat of some sensible species. The article is complemented by results obtained within the project sUMMITDiv, where the results confirm a continent-wide acceleration in the rate of increase in plant species richness, with five times as much species enrichment between 2007 and 2016 as fifty years ago.

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Analysis of soil moisture variability in relation to landuse transition – case study from Tematínske vrchy hills (Považský Inovec Mts, SW Slovakia).

Pavol Kenderessy, Jozef Kollár, Andrej Palaj

Institute of Landscape Ecology, Slovak Academy of Sciences, Štefánikova 3, 814 99, Bratislava, Slovakia
e-mail: pavol.kenderessy@savba.sk, j.kollar@savba.sk, andrej.palaj@savba.sk

In the study of Tematínske vrchy hills (Považský Inovec Mts, SW Slovakia), original thermophilous oak forests of Quercion pubescenti-petraeae alliance were transformed into pastures in the past. Later, in the period of 1960–1970, these were afforested by Austrian pine (*Pinus nigra*), which is an allochthonous species in the Western Carpathians. It has triggered changes in site conditions followed by changes in floristic composition and soil moisture regime. Our study is based on comparison of continuous soil moisture data collected in xerothermophilous oak-forests (potential vegetation), grasslands (seminatural vegetation on the sites of oak forests) and secondary Austrian pine forests established on grassland. In order to assess the differences between individual sampling localities in terms of soil water content (SWC) stability, continuous soil moisture measurements using EC-5 soil moisture sensors were performed. The mean relative difference (MRD) values were used in order to assess the SWC variability and its temporal stability. Our results revealed several different patterns concerning SWC regime and its stability in relation to various vegetation and land cover classes.

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Long-term changes in spring arrival dates of wetland birds into North - East Poland

Ignacy Kitowski¹, Grzegorz Pitucha², Marek Nowosad³, Krzysztof Bartoszek³, Adam Zbyryt⁴

¹State Academy of Applied Sciences in Chelm, Poczтовая 54, PL 22-100 Chelm, Poland.

²Institute of Agricultural Sciences, Protection and Management of Environment, College of Natural Sciences, University of Rzeszów, ul. Cwiklinskiej 1a, 35-601 Rzeszów, Poland.

³Department of Hydrology and Climatology, Faculty of Earth Sciences and Spatial Management, UMCS Al. Kraśnicka 2d, 20-718 Lublin, Poland

⁴Faculty of Biology, University of Białystok, Ciołkowskiego 1J, 15-245, Białystok, Poland

Biota on wetlands are undergoing various changes under global changes of climate. It seems that phenological studies can help us understand the nature of the processes taking place there. Bird phenology has been used for years to track the process of global climate change and processes zachodzących wtedy on avian breeding grounds. One of the signs of such changes is the phenomenon of acceleration of their arrival dates from wintering grounds during spring. The dates of arrival of the first individuals (first arrival date, FAD) of each species to the breeding grounds are used to learn about the mechanisms of their response to temperature changes. Despite the concerns raised, FAD still remains an important parameter for describing bird behavior. We investigate temporal changes of FADs for wetland birds in northeastern Poland. Spring arrival dates of wetland birds from 1990- 2016 were analyzed. During the analysis we showed that for a significant percentage of birds FAD were correlated with spring or winter temperatures. Also a significant number of birds accelerated the date of their arrival in the wetlands of North East Poland in the period indicated above. The authors also discuss the problem of the influence of changes in FAD on the relationship between biota on wetlands.



Mapping of brown biomass in an agricultural landscape using remote sensing

Košánová Svetlana^{1,2}, Hilbert Hubert¹, Rusňák Tomáš¹, Halabuk Andrej¹

¹Institute of Landscape Ecology, Slovak Academy of Sciences. Akademická 2, SK – 949 01 Nitra

²Faculty of Natural Sciences, The Constantine Philosopher University. Tr. A. Hlinku 949 74 Nitra

e-mail: svetlana.kosanova@savba.sk, hubert.hilbert@savba.sk andrej.halabuk@savba.sk

Keywords: *brown biomass, Prisma, remote sensing, Sentinel 2*

Brown biomass refers to those plant elements where photosynthesis is no longer performed, such as standing dead or senescent biomass, plant litter, or crop residue. Mixed grasslands represent a type of vegetation containing a high proportion of brown biomass, which can be seen mostly during the spring months, particularly in stands that are subject to less extensive management (or in abandoned overgrown sites), and hence have very little biomass removed from the preceding season. Mapping and quantification of brown biomass is important from several aspects, e.g. ecosystem dynamics, fire risk, agricultural management. Multiple successful applications of satellite-borne remote sensing of green biomass have emerged, primarily as a result of the distinct spectral responses of green plant material in the visible and near infrared spectral regions. This is not the case for brown biomass due to the observational limitations of past and present space-borne multispectral sensors (such as Landsat or Sentinel 2), which do not adequately capture the distinct short wave infrared (SWIR) spectral region. The advances of hyperspectral remote sensing for NPV mapping have been recognized, but the application of these approaches using space-borne imaging spectroscopy sensors (e.g., PRISMA - “PRecursore IperSpettrale della Missione Applicativa”) is still in its infancy. The additional problem referred to a low availability of precise in situ brown biomass data due to difficult approximation of NPV characteristics by field methods. To address this, we tried to contribute to this specific issue of satellite based remote sensing by delivering a field based NPV dataset with concurrent space borne spectral images from the Sentinel 2 and novel PRISMA mission. This scientific precursor and technology demonstrator mission can be used to pave the road for extensive exploration of its prospects to quantify and map NPV at farm and regional scales.

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Past and present landscape of Skalica district

Ivana Kozelová

Institute of Landscape Ecology, Slovak Academy of Sciences, Štefánikova 3, 814 99 Bratislava, Slovakia
e-mail: ivana.kozelova@savba.sk

Keywords: *land Cover, Skalica, Green Infrastructure*

The Skalica district is located on the border of Slovakia and the Czech Republic in the Záhorie region. The landscape of Skalica district varies, ranging from the lowlands near the Morava River in the west to the hills in the east. Viticulture has a long tradition in the hilly parts of the Skalica town. In the past, area had a dense network of small, unregulated watercourses and soil near these watercourses was often waterlogged, making it impossible to grow agricultural crops. Over time, the watercourses have been regulated and some waterlogged areas partially or completely drained. Some of the waterlogged areas were converted into fishponds; others are to this day waterlogged and unused. The greatest transformation of landscape took place in the 1950s during the period of collectivisation, when small plots of arable land were united into large blocks. This period also marked the beginning of construction of panel housing in towns. This led to an increase in the numbers of urban residents and expansion of the build-up area. Recently, the most significant trends in landscape change have been urbanisation and the abandonment of mainly agricultural land or industrial areas.

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Face-to-face interviews in the analysis of driving forces of landscape change on the example of Sobótka municipality in Poland

Piotr Krajewski*, Joanna Karpziel

Wroclaw University of Environmental and Life Sciences, Department of Land Management, Grunwaldzka 55, 50-357 Wroclaw, Poland

*e-mail: piotr.krajewski@upwr.edu.pl

Keywords: *landscape, driving forces of landscape change, landscape change, landscape history, face-to-face interviews*

The landscape as we know it today is the product of a number of factors and influences, for which specific driving forces of change are responsible. The study of the driving forces of landscape change is a method based on the study of the history of the landscape and allows us to identify the factors that have significantly influenced its perception. The approach used makes it possible to combine quantitative data obtained from analyses of cartographic resources with qualitative data obtained through face-to-face interviews with witnesses of changes in the landscape.

The aim of the study was to identify the driving forces of landscape change that played a key role in shaping the landscape in the Sobótka municipality. In addition to cartographic analyses, an equal part of the study was to conduct face-to-face interviews with witnesses of landscape change. Seven interviewees were selected, ranging in age from 33 to 91 and representing various professions, who had one point in common - their entire private or professional lives were related to the Sobótka municipality area. A direct interviews with them, which did not have a strictly defined scenario, but were moderated using a pre-prepared set of questions. The attention of the interviewees during the interviews was directed in particular to changes in the landscape and the factors they believe contributed to these changes.

On the basis of the conducted research, it can be noted that face-to-face interviews provided a lot of data to explain the processes identified on the basis of cartographic analyses. The identification of driving forces was divided into 3 periods - the forces shaping the landscape in the pre-war period, the 1945-1989 period and the post-transition period. For each period, primary and secondary forces were distinguished, and graphic diagrams were prepared to illustrate the relationships between the different categories of driving forces. Among the most significant are cultural and political driving forces, which influenced the transformation of the landscape in the Sobotka municipality to different levels in each period. The importance of cultural forces was particularly significant in the pre-war period (primary forces) and in the post-1945 period (secondary forces), when they resulted mainly from political forces. The last period under study is characterized by a much greater share of technological, natural and economic forces.



Soil retention potential as an important faktor of water balance in the landscape

Zdena Krnáčová

Institute of Landscape Ecology, Slovak Academy of Sciences, Štefánikova 3, 814 99 Bratislava, Slovakia
e-mail: zdena.krnacova@savba.sk

Soil is a crucial element affecting the overall capacity of landscape hydric potential. Its importance is understood not only for ensuring conditions for biomass production, but it is also a significant factor of ecosystem functioning and providing for the needs of human society. The ability of soil to retain water in its profile is one of the most important soil functions. It is expressed as the water storage capacity or retention capacity of the soil, and it is primarily affected by the physical properties of the soil.

Retention capacity can be expressed by the hydrolimits of field capacity. Field capacity is a hydrolimit limiting the water content between gravitation and capillary water and corresponds to the pressure of 2.0–2.9 pF1 (Antal, 1999). Given the fact that the direct measurement of soil hydrological parameters is very difficult in terms of capacity (Tietje and Tapkenhinrichs, 1993), statistically expressed pedotransfer functions (PTF) are currently used for the indirect estimation of hydrolimits. The apparent correlation between $\Theta(h)$, $K(h)^2$ and the content of individual soil grain-size fractions, led to the formulation of an empirical model – the so-called pedotransfer function (PTF) correlated to easily measured soil characteristics (granularity, specific weight, humus content, etc.) and hydrophysical soil characteristics. The data most commonly used for the PTF are easy-to-measure and usually readily available soil data, usually particle size, bulk density and organic carbon, but also the morphometric parameters of the environment (relief, slope, climate, etc.)

Given the fact that the direct measurement of hydrological data for the soil is very difficult in terms of capacity, statistically expressed pedotransfer functions (PTF) are currently used for the indirect estimation of hydrolimits.

We developed an algorithm for the quantification of water retention capacity of soils (WRC) using a suitable combination of the parameters of classified soil-ecological units (basic attributes of soil subtype, soil profile depth, granularity) and selected morphometric conditions of the environment (slope in combination with aspect). The data most commonly used for the PTF are easy-to-measure and usually readily available soil data on particle size, bulk density, organic carbon and morphometric parameters of the environment (e.g. slope of the relief, etc.).

The listed pedotransfer functions are deficient for the complex evaluation of soil cover; given disagreements about the attributes, they cannot be directly used for the vector database of classified soil-ecological units in the Slovak Republic. Therefore, we have created a model of an algorithm from selected parameters compatible with the vector database of classified soil-ecological units, which also allows for the spatial distribution of the cumulative coefficient of water retention capacity (CWRC) for the soils of the SR. The results of this evaluation are presented using case studies of the areas of Levoča, Hriňová and Svätý Jur.

Acknowledgement: The case study was prepared within solving the project VEGA No. 2/0135/22 Research of specific landscape elements of bio-cultural landscape in Slovakia and VEGA No. 2/0048/22



Driving forces of landscape change in Poland - the residents' perspective

Monika Lebiedzińska

Spatial Management Institute, Wrocław University of Environmental and Life Sciences C. K. Norwida 25,
50-357 Wrocław

e-mail: monika.lebiedzinska@upwr.edu.pl

Keywords: *landscape change, driving forces, landscape*

Intense changes in the landscape have been observed over the past 20 years. In Poland, this is due to the aftermath of accession to the European Union in 2004. In the research, we particularly want to identify those driving forces that influenced changes in the landscape after this event. For this reason, the time frame from 2005 to 2020 was adopted. It was decided to adopt as the research area 6 municipalities located in the Lower Silesian province characterized by different types of landscape within their borders. These are urban, urban-rural and rural municipalities, typical tourist areas, industrial areas, or suburban areas. A full list of changes was compiled for each municipality, taking into account in which type of landscape they took place. In the study of driving forces, the ability to identify and perceive changes by residents is an important source of knowledge. To this end, the previously identified processes of change were presented to residents of the municipalities in questionnaires. A separate questionnaire was prepared for each municipality depicting only the processes of change that took place within the boundaries of that municipality. The task of the respondents was to identify the possible forces influencing the change and to evaluate the change that had occurred. Obtaining information on residents' perceptions of change in landscape units provided an opportunity to determine which driving forces residents believe have the greatest impact on change in diverse landscapes, and how perceptions of the same types of change depending on the type of landscape on which they occurred. Are typically anthropogenic changes less well perceived in more natural units than the same changes in urban and suburban areas? Because of the holistic analyses of the survey results, broader conclusions can be formulated and the forces that most frequently affect landscape changes can be identified. In addition, it is possible to identify changes whose occurrence in units of different types is not well received by residents and has, in their opinion, a negative impact on the landscape, so as to try not to duplicate them in the future. Residents' perceptions of changes to date help determine how spatial policy should be formed in the area, so that residents can feel satisfied with their surroundings.



How can the new Common Agricultural Policy change the intensive agricultural landscape in Slovakia?

Juraj Lieskovský, Andrej Halabuk, Peter Bezák

Institute of Landscape Ecology, Slovak Academy of Sciences

e-mail: juraj.lieskovsky@savba.sk, andrej.halabuk@savba.sk, peter.bezak@savba.sk

Keywords: CAP, parcel size, scenarios, green infrastructure

The Common Agricultural Policy (CAP) is the main driver shaping the agricultural landscape in Slovakia after the EU accession in 2004. Current CAP (2023-2027) presents more ambitious goals towards the climate change adaptation and enhancing the biodiversity on agricultural land. Interventions such as limiting the maximum area of cultivated land or the overall increase of nonproductive areas can significantly change the agricultural landscape, especially in lowlands, which are typical of large-scale intensive agriculture.

Aim of the presentation is to visualize and analyse possible impact of a new CAP Strategic Plans for Slovakia on agricultural landscape structure. We selected the intervention that will affect the structure of the agricultural landscape and modelled its application in two scenarios. First, the minimalistic scenario considers only partial implementation of the eco-scheme, in particular parcel size limitation and increase of nonproductive areas. In this scenario, the modelled eco-scheme is assumed to minimise changes in farming management. Second, the environmental scenario applies the eco-schemes in a way that protects the agricultural land from degradation. Additional ecological interventions (not falling into this ecoscheme) such as windbarriers, grassing arable land, setting the agroforestry system, or afforestation are assumed by the second scenario as well. The results of those two scenarios are compared with the current landscape structure. We adopted those scenarios in three different areas. The first around Detva represents the submountain landscape with traditional agricultural landscapes, the second around Vráble represents the hilly agricultural landscape with medium and large-scale fields, and third around Sokolce represents the lowland agricultural landscape with large fields.

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Heritage of lost landscapes of Czechia

Zdeněk Lipský, Lucie Kupková, Pavel Chromý et al.

Charles University, Faculty of Science

e-mail: lipsky@natur.cuni.cz, lucie.kupkova@natur.cuni.cz, pavel.chromy@natur.cuni.cz

Keywords: *lost landscapes; heritage; landscape types; landscape changes*

Main results of the project “*Heritage of lost landscapes: identification, reconstruction, presentation*“, developed in 2018–2022 within the NAKI II programme of the Ministry of Culture of the Czech Republic, will be presented. The aim of the project is to use model examples to identify and present the types of traditional cultural landscapes that have disappeared during the dynamic changes that have taken place in the Czech landscape and society since the end of the 18th century. Both historical sources, mainly old maps and archival images, and modern geoinformation technologies were used to identify, document and partially reconstruct the disappeared or transformed landscapes. The processing of sources took place on the basis of geoinformatics, historical and geographical methods.

A typology of lost landscapes was created, which shows the diversity of lost or transformed landscapes as well as diversity of cultural heritage and values of various types of cultural landscapes in Czechia. Heritage of cultural landscape is a source of knowledge about history of society as well as nature. It is also an important part of the process of formation of territorial identities and self-consciousness of local communities.

In the framework of the project, 40 specific model areas of lost landscapes were investigated in a complex way. The model areas were divided into 9 types of lost landscapes:

1. mining and postmining landscapes;
2. postindustrial landscapes (lost industrial landscapes);
3. lost landscapes of intensive small-scale private agriculture;
4. lost landscapes of extensive, especially montane agriculture;
5. lost cultural landscapes of river valleys flooded by water reservoirs;
6. lost landscapes of former fish pond systems;
7. lost purposefully composed feudal landscapes;
8. military and postmilitary landscapes;
9. transformed urban and suburban landscapes.

All 40 model areas are available in the Digital Atlas of Lost Landscapes. The Atlas is freely accessible to the interested professional and general public on the website of the project (portal www.zaniklekrajin.cz). Viewers will get acquainted with the analysis of all model areas, which are presented not only with cartographic and visual materials, but also with 3D models.



The potential for the ecosystem services implementation at the landscape level - case studies from Poland

Damian Łowicki, Andrzej Mizgajski

¹Adam Mickiewicz University, Poznań; Faculty of Human Geography and Planning. Krygowskiego 10, 61-680 Poznań, Poland

e-mail: damian.lowicki@amu.edu.pl, andrzej.mizgajski@amu.edu.pl

Keywords: *ecosystem services, landscape level, aesthetic values, pest control, pollination*

The subject of research on ES at the landscape level is to recognize the benefits for humans resulting from the distribution of ecosystems in space. The most significant potential for benefits of this type is in the regulation and socio-cultural services. Regulation services are revealed primarily where the service carrier is mobile and moves between ecosystems. It applies to the pollutants migration in water or air, as well as the movement of pollinators between nesting and feeding sites. Concerning socio-cultural services, it is necessary to point out the aesthetic attractiveness of the landscape resulting mainly from the spatial composition of diverse land cover types.

The considered example of the potential for pest control is based on the finding that the agricultural landscape's saturation with semi-natural ecosystems determines the extent of natural control of plant pests. This parameter was confronted with the share of arable land. The results were presented for Poland in a grid of squares with a side of 10 km. Also, on the country scale, the aesthetic values of landscape mesoregions were introduced, combining topography and land cover forms.

At the local level, for Śrem as a medium town, the aesthetic value of the landscape seen from roads was associated with the potential of ecosystems for pollination. For 204 points on the town's main streets, fields of view were defined, for which natural and anthropogenic disturbing elements have been assigned. The spatial distribution of aesthetic values was compiled with the pollination potential measured by the size of flower resources and the availability of nesting sites for Earth Bumblebee (*Bombus terrestris L.*) and Red Mason Bee (*Osmia rufa*).

The country-level results identified regions with the most significant gap between the need for natural pest control and the potential to provide it. On the other hand, local research indicates areas that should be of particular interest to spatial planners to maintain synergy between both types of ecosystem services on the landscape level.

Acknowledgement: The research is a part of the project "Services provided by main types of ecosystems in Poland - an applied approach" and received funding from Iceland, Liechtenstein and Norway within the EEA Financial Mechanism 2014-2021 and from the budget of Poland.



Climate and landscape changes in Slovakia - facts against perceptions

Peter Mederly, Zuzana Pucherová, Viera Petlušová, Regina Mišovičová

Constantine the Philosopher University in Nitra, Dept. of Ecology & Environmental Sciences

e-mail: pmederly@ukf.sk, zpucherova@ukf.sk, vpetlusova@ukf.sk, rmisovicova@ukf.sk

Keywords: *climate change, Agriculture, Landscape management, Rural areas, Opinion survey*

Although overshadowed by other crises in much of Europe in recent years, the issue of climate change is still here and even the urgency of the need to address its impacts is increasing. Understanding and tackling the problem requires a combination of objective and subjective approaches. The facts have been evaluated for decades, the key drivers named, and the solutions described. However, subjective factors and tools requiring understanding and cooperation from different actors (from politicians to individual citizens) still lag behind. Opinion polls are one of the tools that can shed more light on this issue.

Agriculture is one of the sectors that is and will be significantly affected by climate change. It shapes the landscape in almost half of Slovakia's territory, with 47% of the population living in rural villages. As a part of a project focusing on the development of the rural landscape in Slovakia, we have carried out a public opinion survey in addition to assessing landscape changes and related factors. First, we approached a representative sample of the rural population of Slovakia with the topic of the climate change perception (its severity, causes, consequences and possible solutions), which allowed us to compare the results with national and European surveys. The second part of the survey focused on the attitudes of selected stakeholders in the rural areas of the Nitra region (farmers, entrepreneurs, mayors and local government members) – with the issue of the impact of climate change on the economy, the quality of life and environment in the municipality, as well as the necessary solutions. The final part of the survey was addressed to farmers to find out how they perceive climate change and its impact; and to what extent they identify with the measures and interventions of the European Common Agricultural Policy and the possibilities of financing them.

We put the answers obtained in the context of real landscape and management changes in Slovakia and with data in seven case municipalities and found that the perceptions of some stakeholders tend to be distorted or inconsistent with the facts. Also, some actors do not consider objectively identified environmentally relevant factors important. Evaluating such contradictions and unravelling their causes should be one of the pillars of the landscape planning and governance of the municipalities and regions.

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Bridging the natural and social sciences for comprehensive landscape and urban planning

**Peter Mederly¹, Simon Vaňo^{1,2}, Pavol Meszároš³, Lýdia Grešáková⁴, Viktória Mravčáková⁴,
Peter Beňo³, Eva Kocanová⁵, Soňa Kozárová⁵, et. al.**

1 Constantine the Philosopher University in Nitra, Department of Ecology and Environmental Science, Tr. A. Hlinku, Nitra

2 Global Change Research Institute of CAS, Department of the Human Dimensions of Global Change

3 OZ Huba – coworking space Košice

4 Spolka – architecture and sociology

5 OZ Take Naše – Tourism

Keywords: *landscape planning, sustainability, participation, ecological networks, green infrastructure*

The nature protection, urban development, and landscape planning and management are in constant dispute over diverging interests in the landscape that we can broadly categorise as environmental and socio-economic. Socio-economic interests are manifested through ever-increasing industrial and commercial activity, traffic, population growth, and associated large-scale construction which stretches out into the landscape. These take place at the expense of the overall state of the environment, putting pressure on ecosystems, biological diversity, natural resources, and contributing to climate change. Social and environmental problems are indeed complex challenges that require complex approaches. In 2022, the project MÚSES+ was launched in the town of Veľký Šariš to face these challenges on a local level.

Project MÚSES+ was executed in collaboration with researchers and experts from natural and social science, civic and public sector, with the aim to deliver strategies for planning and management of the ecological networks or green infrastructure (MÚSES) with an added social dimension (+). Several rounds of field research, mapping, surveying, inputs from local experts and residents via participatory activities, produced a collection of knowledge about the state of (a)biotic nature, human environment, actors, and activities in the area. The information was analysed iteratively in an interdisciplinary manner, understanding the landscape as a coupled ecological and socio-economic space. The MÚSES+ document offers a comprehensive assessment of the current state and future direction for development of the town of Veľký Šariš, and proposes strategies targeting sustainable urban planning, landscape management, tourism, and inclusion of important actors.

The specificity of this project lies in the combination of natural and social science approaches, which contrasts with strictly scientific or technical approaches of traditional landscape ecology that often struggle to engage with other important issues and disciplines. Human activity is the main source of pressures and drivers of environmental change; therefore, it is critical to broaden the disciplinary scope and see the whole picture. Project MÚSES+ was an experiment to tackle landscape and societal objectives comprehensively and showed the possible ways of integrating the established methods of landscape ecology in new ways. It is the plus in its name that conveys the level of complexity with which the document has been prepared.



Biosphere reserves in strategy documents of Slovakia – how these documents support Man and Biosphere programme?

Jakub Melicher^{1,2}, Bohdana Halas²

¹Institute of Landscape Ecology, Slovak Academy of Sciences, Štefánikova 3, 814 99 Bratislava, Slovakia

²Department of Ecology and Environmental Science, Faculty of Natural Sciences and Informatics, Constantine The Philosopher University in Nitra, Slovakia

e-mail: jakub.melicher@savba.sk, bohdana.halas@ukf.sk

Keywords: *biosphere reserves, strategy documents, UNESCO, sustainable development, Man and Biosphere*

Biosphere reserves are designated areas, that aim to conserve biodiversity, promote sustainable development, facilitate scientific research and education and support adaptation to climate changes. In Slovakia, there are currently four biosphere reserves: Polana, Slovak Karst, Tatra, and East Carpathians. Strategy documents are essential planning tools that outline the objectives and actions needed to achieve specific goals and can support Man and Biosphere programme objectives directly or they can benefit from them synergically. The purpose of this paper is to highlight the current situation of implementing the issue of biosphere reserves in Slovakia in strategy and development documents as a tool to ensure conditions for their protection, management, and model areas for sustainable development. The underlining is classification by importance of implementation of biosphere reserves in strategy documents and classification by which objectives the strategy documents targeted.

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The ecosystem services and their conflicts in study area of Rye Island

Viktória Miklósová, Ivana Kozelová, László Miklós

Institute of Landscape Ecology, Slovak Academy of Sciences, Štefánikova 3, 814 99 Bratislava, Slovakia
e-mail: viktoria.miklosova@savba.sk, ivana.kozelova@savba.sk, laszlo.miklos@savba.sk

Keywords: *landscape, conflicts of ES usage, landscape-ecological complexes, water services*

Every ecosystem has some potential to fulfill various functions and subsequently provide ES for man. However, use of one ES can threaten or limit use of another ES. Relationships in use of ES can be in various correlations:

- Mutually supportive – e.g. ES related to biodiversity protection can support various regulating ES (microclimatic regulation, anti-erosion protection, flood protection etc.),
- Mutually indifferent – groups of services that do not affect each other, neither in positive, nor negative way,
- Mutually threatening – e-g- use of many provisioning ES is often connected with negative impacts on ecosystems. This causes conflicts between provisioning, regulating and supportive (ecological) services (intensive agriculture negatively affects water protection, soil formation etc.).

Which ES will be preferred and how ecosystem will be used depends mainly on decision of human. While using ES, human either directly affects structure of ecosystems, or threaten them indirectly through change of ecological factors of given ecosystems. Human activities in landscape reflect in:

- Construction of new technical objects creates new artificial ecosystems.
- Large-scale use of natural ecosystems connected with their intensive transformation.

The methodological approaches were tested on a model region of Rye Island, Middle Europe's largest drinking water reservoir. Despite intense farming and urbanization, there are still fragments of high-value natural landscapes. The clear objective of society is to find the most effective technique to protect high-quality water supplies while also utilizing bio-productivity of extremely precious soil, and to maintain a high-quality environment for the human population.

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Influence of morphometric relief parameters on soil depth change in relation to erosion-accumulation processes (model site Dudince, Ipeľská pahorkatina sub-unit Sebechlebská pahorkatina)

Marek Moravčík, Viera Petlušová, Peter Petluš

Constantine the Philosopher University in Nitra, Faculty of Natural Sciences and Informatics, Department of Ecology and Environmental Sciences

e-mail: moravcik.marek@ukf.sk, v.petlusova@ukf.sk, p.petluš@ukf.sk

Keywords: *slope, landforms, LS factor, USLE, soil horizon strength*

Soil erosion is one of the important physical pedodegradation processes. It contributes significantly to the reduction of the productive capacity of agricultural soils in upland landscapes. As a result of erosion-accumulation activities, negative changes in the physical, chemical and biological properties of the soil occur. The drift of the soil horizon results in the loss of top, most fertile soil material, loss of organic matter and changes in soil structure. Eroded translocated soil matter accumulates, as a rule, in the lower parts of the slope. Evaluating erosion processes is a rather difficult process, given that erosion is the result of the interaction of several factors, the main ones being morphometric parameters and management practices. It is important to choose an appropriate method for obtaining, evaluating and interpreting data on the presence of erosion-accumulation processes. The aim of this work is to investigate the relationship between morphometric relief parameters and soil depth, with emphasis on erosion-accumulation processes. Morphometric parameters such as slope, relief shape, orientation to cardinal directions, LS factor which is a combination of slope length and slope gradient, and soil profile enter into the evaluation. Soil depth is an important indicator of changes in the soil profile. It was analyzed during a field survey of 71 probes in which soil type and other properties were also determined. Erosion-accumulation processes can also be identified from changes in soil depth. Erosive processes lead to the reduction or disappearance of the A horizon and, and vice versa, accumulation processes lead to the accumulation of the A horizon. On the basis of the assessment, we confirmed that the slope and shape of the relief are crucial parameters that significantly influence the development of degradation processes in intensively used agricultural landscapes, which was also confirmed in our research. At higher values of slope and convex relief shapes, changes in soil depth occurred. The value of horizon strength decreased or the soil type, subtype and its form changed. Less important parameters include slope exposure.

The soil management method at the study site has the most significant influence on the development of water erosion, but it is also a tool that can prevent it. The aim is to protect against pedodegradation processes by changing land use to sustainable land use.

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Protected trees in urban environment, significance, protection and hazard.

Milena Moyzeová

Institute of Landscape Ecology, Slovak Academy of Sciences, Štefánikova 3, 814 99 Bratislava, Slovakia
e-mail: milena.moyzeova@savba.sk

Keywords: *green infrastructure, protection of wood species, protected tree, buffer zone of protected tree, hazardous factors.*

The basis of green infrastructure in urban environment consists of vegetation elements including urban forests, parks, gardens, graveyards, green embankment corridors, street rows of trees, protected trees and other open public spaces with vegetation. These areal, linear and point elements and their significance for humans are gaining attention of scientist. Methodologies and methodical procedures involved with their assessment are offered with the aim to preserve and increase the incidence of vegetation in landscapes. The aim of this paper is to present the methodical approach to the assessment of protected trees as the point elements of green infrastructure on local level, to identify their presence in urban environment and to assess their significance, protection and susceptibility to possible hazards. The model area used for the research was Bratislava, the Capital of the SR. The reason for protection of trees in Bratislava is their high biological and aesthetic value, as well their scarce occurrence. They are mostly individual specimens or small groups that are important from the cultural, historical, scientific, and landscaping aspects. The principal objective of our research was to find how is the legal protection of trees and limitation of human activities in the buffer zone of trees (§49 paragraph 7) respected. The assessment was based on available data sources of the governmental nature conservation which were supplemented by data obtained by field research, that is, mapping of protected trees in five districts of the city. In case of individual city districts (statistical unit is the border of the cadastre and the border of inner built-up area of the settlement) we mapped location of the protected tree, number of specimens, and the current condition of the tree, classification regarding the object of protection whether it fulfils the aim of protection, factors active in the immediate environs of the tree in the distance stipulated by the buffer zone, factors that can negatively affect the existence and condition of wood species (respect for the ban on activities within the buffer zone next to the protected tree according to §49 paragraph 7), assessment of overall visual aspect of the tree and its surroundings. Results of field research were compared to the available data quoted in the List of Especially Protected Parts of Nature of the SR, along with the table assessment and photographs.

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Landscape- ecological aspects of green infrastructure in relation to the creation of an Optimal spatial basis of ecologically stable areas in urban landscape.

Milena Moyzeová

Institute of Landscape Ecology, Slovak Academy of Sciences, Štefánikova 3, 814 99 Bratislava, Slovakia

e-mail: milena.moyzeova@savba.sk

Keywords: *green infrastructure, socio-economic phenomena, urban and rural settlement, ecological condition of regions.*

Green infrastructure in general includes a set of natural areas (green areas and green ways), seminatural (worked farm and forest land) and other elements in urban areas of settlements which have a cumulated many-sided positive effects on the condition of ecosystems, existence of living organisms, environmental quality, and human health. If the green infrastructure is expected to bring effects in the economic, social and environmental fields it must be treated on all hierarchic levels. The objective of this paper is to present the methodology for the assessment of the ecological condition of regions in Slovakia in cartographic way, that is, series of maps. The aim was to identify regions where it is necessary to implement measures leading to the improvement of their ecological conditions based on the statistical assessment of landscape elements in individual cadastres of the urban and rural settlements of the SR, to identify regions calling for measures that would improve their ecological condition. Specification of regions leaned on the ecological quality of districts (Map 2) established based on the level of anthropization of the settlement environment. The assessment also included socio-economic phenomena associated to nature and landscape conservation and protection of natural resources processed in a form of the database of positive steps and phenomena (legend to Map 3 *Territorial system of positive elements and phenomena*). These elements support the existence of the GI and increase the quality of regions. Simultaneously, the point, areal and linear stress factors from the database of barriers (legend to Map 4 *Barriers*) entered the assessment, as their barrier effects threaten or limit the GI elements and affect the quality of regions. Ecological condition of regions of Slovakia (Map 1) is the summary of the basis characteristics of regions in five categories: optimal, favourable, good, unfavourable and bad condition of a region. A wide spectre of source material and data, mostly of statistical nature analysed in the GIS environment, further on systematically assessed and cartographically represented was used in this research. The applied methodology has brought about the basic information about measures aimed at the improvement of the existing ecological condition of the identified regions of Slovakia.

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Dynamics of Alpine Endemic Plant Species in the Western Carpathians

Andrej Palaj, Jozef Kollár

Institute of Landscape Ecology, Slovak Academy of Sciences, Štefánikova 3, 814 99 Bratislava, Slovakia
e-mail: andrej.palaj@savba.sk, j.kollar@savba.sk

Keywords: *alpine vegetation, endemism, assessment of changes, Western Carpathians*

The aim of this contribution is to evaluate the dynamics of some alpine endemic plant species in the Western Carpathians over the last 5 decades. In 2016–2022, we resampled 121 historical phytocoenological relevés of the most widespread vegetation types from 1970–1983. The assessment of changes was based on the method of pair comparison. We observed remarkable loss of plant taxa. Historical dataset includes 175 taxa, while current dataset only 134 taxa. The frequency of at least one endemic species in the relevés dropped from 79.3% to 69.4%. Their occurrence is mainly linked to the communities of the *Carici rupestris-Kobresietea bellardii*, *Mulgedio-Aconitetea* and *Salicetea herbaceae* classes, on the contrary, they occur the least in the communities of *Loiseleurio-Vaccinietea* class. In general, we observed a decline in the frequencies of ecological specialists, and, on the other hand, an expansion of stronger competitors. Linear mixed-effect models showed a big variability in the factors that have impact on abundance of endemic species; nevertheless, temperature and grazing cessation are the most important factors.

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Monitoring development of a flower meadows from seed mixtures in the urban environment

Anna Pástorová, Zdenka Rózová

Department of Ecology and Environmental Science, Faculty of Natural Sciences and Informatics,
Constantine the Philosopher University in Nitra, Tr. A. Hlinku 1, 949 01 Nitra, Slovakia
e-mail: anna.pastorova@ukf.sk; zrozova@ukf.sk

Keywords: *flower meadows, biodiversity, climate crisis, pollinators*

Semi-natural grasslands, also known as flower meadows, is a modern phenomenon of the urban environment reflecting the fight against with climate crisis. Currently, they represent a suitable solution for a functional biotope for many plant species and small animals - especially pollinators, which are an essential part of biodiversity.

In this publication, we focus on artificially established flower meadows from direct sowing, whose development we monitor in the city Park Hliník - Nové Zámky (Slovakia). Flower meadows were sown from commercial mixtures into reclaimed, herbicide-treated soil with an admixture of incorporated sand particles. From 2020, we monitor selected areas during the growing season at two-week intervals.

Data from the field we transfigure into the analysis of flower meadow stand properties, which than affect the fulfillment of the flower meadows functions in the urban environment. The result is an evaluation of the functionality (suitability) of flower meadows in terms of selected functions (such as aesthetic, soil protection, honey-bearing function, etc.) in an urban environment.

The results of the monitored flower meadow stands presented in this article are partial, considering the ongoing research of these stands.



Application of the adapted GLOBIO model on the territory of the Visegrad Group countries

Vilém Pechanec^{1*}, Ondřej Cudlín², Tereza Pohanková¹, Pavel Vyvlečka¹, Jan Purkyt², Lenka Štěrbová², Renata Včeláková², Marcela Prokopová², Pavel Cudlín²

¹ Department of Geoinformatics, Faculty of Science, Palacký University in Olomouc, 17. listopadu 50, CZ-771 46 Olomouc, Czech Republic;

² Global Change Research Institute of the Czech Academy of Sciences, Lipová 9, CZ-37005 České Budějovice, Czech Republic;

*Correspondence author: vilem.pechanec@upol.cz; Tel.: +420-585-634-579

Keywords: *Biodiversity; GLOBIO model; Landuse; Naturalness of habitats; Visegrad Group*

The main aim of our study was to apply the adapted GLOBIO3 model to the territory Visegrad Group to assess the loss of naturalness and biodiversity vulnerability across the entire area. An additional aim was to assess the main drivers affecting the biodiversity of habitat types and compare the influence of individual drivers for individual member states.

The GLOBIO3 model was adapted to CZ-GLOBIO by adapting global to local scales and using habitat quality and naturalness data instead of species occurrence data. Our approach calculates the total mean species abundance (MSA) index of habitat quality from the spatial overlay of the five MSA indicators.

The MSA indicator is built on simple cause–effect relationships between selected driving forces and biodiversity impacts. The pressure of individual drivers on biodiversity was determined on the basis of scientific studies on the occurrence of selected species of plants and animals. The MSA indicator with a value of 1 corresponds to the maintenance of all original species, while the value 0 refers to a completely transformed ecosystem without these species. Five major drivers that influence the ecosystem naturalness and directly impact biodiversity are used to assess the biodiversity status. These drivers are intensity of land use change (MSA_{LU}), infrastructure development (MSA_I), landscape fragmentation impact (MSA_F), atmospheric nitrogen deposition (MSA_N), climate change (MSA_{Acc}), and human encroachment. The GLOBIO model can be used to assess the impacts of environmental drivers on species diversity and to measure the expected trends in biodiversity loss under various future land use change scenarios.

The primary datasets used in our study were Copernicus project data (Corine land cover & High-Resolution Layers) and Open Street Map data.

The total value of MSA for natural and near-natural habitats was found to be affected mainly by infrastructure development and fragmentation. Simultaneously, intensity of land use change and atmospheric nitrogen deposition contributed primarily to the low total value of MSA for distant natural habitats. The impacts of five drivers to habitat naturalness of four Visegrad countries were assessed and compared each other. The GLOBIO model can be an important tool in political decision-making to reduce the impact of the main drivers on habitat biodiversity in central Europe.



Development of selected climate indicators and land use changes in Slovakia since 1990

Peter Petluš¹, Peter Mederly¹, Viera Petlušová¹, Martin Madara², Maroš Turňa², Ladislav Markovič², František Petrovič¹, Matej Mojses³, Juraj Lieskovský³

¹ Department of Ecology and Environmental Sciences, Faculty of Natural Sciences and Informatics, Constantine the Philosopher University in Nitra

² Slovak Hydrometeorological Institute

³ Institute of Landscape Ecology, Slovak Academy of Sciences

Keywords: *climate change, land use, land use changes, selected climate indicators*

Land use changes in Slovakia are mainly associated with the gradual transition from a planned economy to a market economy. Since the beginning of the 1990s, there have been significant changes in the representation of land use elements. The most significant changes are taking place in the agricultural landscape, in which we mainly observe the take-over and gradual loss of agricultural land, while there is an increase in forest land and especially built-up areas. In addition, there are changes in the relative representation of land types within agricultural land. At the same time as the mentioned changes in the use of the land, we are also observing the manifestations of climate change, which, according to SHMÚ data, have manifested in Slovakia, for example, an increase in the average annual air temperature over the last 100 years by 1.1 °C. The 12 warmest years since records began have been recorded since the early 1990s. A manifestation of climate change is also a significant decrease in relative air humidity due to increased evaporation and a lack of available moisture in the growing season, even though the amount of precipitation is not decreasing in trend. In the paper, we focused on the development and changes in land use and selected climate indicators. The evaluated indicators were temperature, precipitation, and potential evapotranspiration for the period 1981-2020. We analyzed the country's changes for the period from 1990 at the level of Slovakia and the seven model territories. The selected locations were chosen to represent the characteristic types of Slovakia's agricultural land and different climatic areas - with the aim of supporting the planning and optimization of land use in adaptation to climate change and minimizing the degradation of agricultural land. The comparison of changes confirmed the findings of several relevant studies indicating that most land-use changes have little to do with climate change. On the other hand, in the future humans should change land use, and especially land management, to mitigate and adapt to climate change and their consequences.

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The influence of selected soil properties on the character and changes in the use of the foothill agricultural landscape

Viera Petlušová¹, Peter Petluš¹, Michal Ševčík¹, Peter Mederly¹, Marek Moravčík¹, Juraj Hreško¹, František Petrovič¹, Matej Mojses²

¹ Department of Ecology and Environmental Sciences, Faculty of Natural Sciences and Informatics, Constantine the Philosopher University in Nitra

² Institute of Landscape Ecology, Slovak Academy of Sciences

Keywords: *Agricultural Land, Land use changes, Qualitative Properties of the Soil, Soil type*

Due to the transformation of the country and the transition from a planned to a market economy, significant changes in the use of the country have been taking place since the beginning of the 1990s. The most significant changes in the last 30 years are taking place in the agricultural landscape. For a long time, we have been observing the take-over and gradual loss of agricultural land. From a long-term perspective, there is a decrease in agricultural land and an increase in forest and especially built-up areas. There are also changes in the representation of species of plots within agricultural land. A characteristic feature of the mentioned land use changes in the foothill type of landscape is the process of agricultural extensification. In Slovak conditions, this type of landscape is characterized by a lower productive capacity of the soil. There is a significant decrease in arable land and an increase in permanent grassland. A fallow land with advancing succession is formed. The overall character of the country is this changing. In the paper, we focused on determining the appropriateness of using agricultural land based on its production potential and selected qualitative properties of the soil. Subsequently, we investigated the relationship between the processes of changes in the use of agricultural land and selected qualitative properties of the soil on the examples of three foothill municipalities. The research was carried out in the cadastral territories of the municipalities of Malá Lehota, Skerešovo and Runina (Slovakia). Malá Lehota with the late onset of collectivization and persistent individual land farming in the conditions of the foothills with scattered settlements. Skerešovo is a foothill village at the junction of the Juhoslovenská kotlina Basin and the Revúcka vrchovina Highlands. Runina is situated in the conditions of an isolated closed Carpathian Forest landscape. A common feature of the municipalities is the foothills nature of land use, a high proportion of forests, the morpho-positional fragmentation of the terrain and isolation. The determination of the quality characteristics of the soil was preceded by a detailed pedological survey carried out between 2019 and 2021. A total of 315 drilled soil probes were carried out in a regular network of points with a spacing of 200-250m. Soil depth, thickness of the humus horizon and soil type were determined. Subsequently, the identification of the spatial extension of individual soil types for the agricultural Land Parcel Identification System and determination of the biomass production potential on agriculturally used land was carried out. By synthesizing the evaluated features and biomass production potential, we determined the appropriateness of agricultural land use. We have identified areas used in accordance with the potential they offer. We obtained an overview of the areas that are used, or they do not use in accordance with the principles of the Common Agricultural Policy. We assumed that the addressed areas are included in the area with natural limitations (such as altitude - Runina, slope of the territory - Malá Lehota or poor permeability of the soil - Skerešovo). Based on the results, it will be possible to establish agricultural land use practices that allow farmers to continue to use agricultural land, maintain the landscape, as well as preserve and implement sustainable agricultural systems in the relevant areas, preventing land abandonment and biodiversity loss. The next step was to



determine the existence of a relationship between the processes of agricultural land use changes and selected qualitative soil properties (thickness of the humus horizon, total soil depth, soil type). Land

use changes were evaluated based on the representation of land use elements in two-time horizons from the 1990s to the present.

Acknowledgements: This research was supported by the project VEGA 1/0342/22 Identification, evaluation and consolidation by erosion threatened hill lands in the lowland regions of Slovakia.



Resistance of Regenerated Alpine Communities to Repeated Experimental Trampling in the Belianske Tatras, Northern Slovakia

Veronika Piscová¹, Andrej Sedlák², Michal Ševčík², Juraj Hreško², Terézia Slobodová², František Petrovič²

¹ Institute of Landscape Ecology of Slovak Academy of Sciences, Akademická 2, 949 10 Nitra, Slovakia

² Department of Ecological and Environmental Sciences, Faculty of Natural Sciences and Informatics, Constantine the Philosopher University in Nitra, Trieda A. Hlinku 1, 949 01 Nitra, Slovakia

e-mail: veronika.piscova@savba.sk, andrej.sedlak@ukf.sk, m.sevcik@ukf.sk, jhresko@ukf.sk, terezia.slobodova@ukf.sk, fpetrovic@ukf.sk

Understanding the impacts of human trampling on ecological environment is necessary for the utilization and management of recreational areas. Due to the destruction of alpine ecosystems by extreme human trampling, some alpine areas are closed to tourists. After years of regeneration, a tendency toward reopening these areas for tourism is envisaged. This situation also occurs in Slovakia. The Belianske Tatras represent the limestone part of the mountain range, with rare communities, many endemics and glacial relics, and are among the rarest and most endangered mountains in Slovakia. Currently, the area is protected as the Tatra National Park, the Tatras Biosphere Reserve, by the Habitats Directive and the Birds Directive, tourism is the only human activity in the area. Due to tourism, the ridge trail of the Belianske Tatras has been closed since 1978 and one of the trails has been open since 1993. To understand how regenerated communities respond to further trampling disturbance, we repeated the experimental research on short-term trampling after 14 years in three high-altitude communities in the Tatras in northern Slovakia. According to Cole and Bayfield's protocol, we evaluated the resistance of communities trampled in 2008 and 2022. Regenerated communities respond to the repeated trampling differently. Especially, the response of lichens and bryophytes to the trampling also offers many questions. The statements that the abundance of both lichens and bryophytes may be reduced or increased, or there may be a delayed reduction in the lichen and bryophyte abundance, was confirmed as well. However, after a delayed reduction in abundance, the species may become extinct during the regeneration of the destroyed vegetation. The results show that human trampling in alpine communities has a large negative impact, and therefore management plans should limit recreational activities in reopened alpine areas.

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Selected heavy metal accumulation in the food chain: plants, pollinators, birds in mining versus agricultural habitats

Aneta A. Ptaszyńska¹, Anna Rysiak²

¹Department of Immunobiology, Institute of Biological Sciences, Faculty of Biology and Biotechnology, Maria Curie-Skłodowska University in Lublin, Poland; e-mail:

²Department of Botany, Mycology And Ecology, Institute of Biological Sciences, Faculty of Biology and Biotechnology, Maria Curie-Skłodowska University in Lublin, Poland; e-mail:

e-mail: aneta.ptaszynska@mail.umcs.pl, anna.rysiak@mail.umcs.pl

Keywords: *heavy metals pollution, plants, wild pollinators, honey bee, birds/rook, anthropopression*

Anthropogenic changes impact/are affecting the environment all over the globe/world. Coal mining and excessive agriculture are associated with numerous changes in the environment and landscape. In order to study the impact of these anthropogenic characteristics on the surrounding environment, four locations were selected: a site directly next to the coal-mine the Lubelski Węgiel Bogdanka S.A. spoil heaps, an area at the mouth of the mine discharge waters, a site in an agricultural area (experimental sites), and an ecologically clean area (control site).

Samples for analysis were taken from all designated sites and links in the food chain: primary producers - pollen, primary consumers - bees and their products (honey, bee pollen pellets) and secondary consumers - rook feathers. Water and soil were also studied. Heavy metals, pesticides and petroleum products were measured.

The aim of the study was to determine the impact of industry and agriculture on the pathways of movement and accumulation of xenobiotics in a simple but universal food chain.

Samples were collected from each location in the form of water and soil, as well as insects, bees, bees' products as: honey and bee pollen, pollen from plants, and feathers of birds that feed on pollinators. The samples were analyzed for the content of heavy metals, pesticides and petroleum substances.

Small (but measurable) amounts of toxic elements such as lead, cadmium, mercury and arsenic were found in all samples. In samples of rook feathers from the site near Bogdanka coal mine, the amounts of these dangerous compounds were comparable to those found in control colonies.

Increased levels of manganese (Mn) and iron (Fe) were found near the Bogdanka coal mine. Whereas, increased levels of mercury, which poses a high risk to the environment, were found in samples taken from agricultural areas.



The importance of landscape mosaic heterogeneity for spider communities in the agricultural landscape of Slovakia

Pavol Purgat, Peter Gajdoš

Institute of Landscape Ecology of SAS, v. v. i., Bratislava, Nitra branch, Akademická 2, SK-94901 Nitra, Slovakia

e-mail: nrukpapu@savba.sk, nrukgajd@savba.sk

Keywords: *agriculture, Araneae, landscape ecology, Red List*

The consequences of the current rapid and extensive changes in agricultural landscape of Slovakia are insufficiently known and affect all its abiotic and biotic components. For this reason, in the years 2019 – 2021, araneofauna research was carried out in various habitats of the agricultural landscape of Slovakia. The aim of the research was to monitor and compare the araneofauna at the investigated habitats, which represent the typical landscape structure of the agricultural landscape of the monitored area. For these purposes, 7 model areas were selected (Báb, Drieňová hora, Malá Lehota, Runina, Skerešovo, Ťapešovo/Vavrečka, Važec), where research on epigeic communities of spiders was carried out. The research was carried out on study areas, including typical habitats of the agricultural landscape (various extensive and intensive pastures, meadows, old orchards, wetlands, forests, xerotherms, etc.). The method of pitfall traps with sampling at monthly intervals was used for the research of spider epigeic communities. The obtained material was processed and evaluated with an emphasis on the quantitative characteristics of the araneocenosis and its ecozoological significance. Spiders from the individual study areas were evaluated in terms of species abundance in epigeic communities and their ecosozological significance was evaluated according to the Red (Ecosozological) List of spiders (Araneae) of Slovakia (IUCN threat classification). The results of the research showed that in connection with the growing heterogeneity of the landscape mosaic, the spectrum of spider species that can be used in the agricultural landscape is increasing, which is evidenced by the fact that, in addition to typical agrobiont and euryvalent species, a relatively high number of rare and endangered species was also found. The high diversity of the agricultural landscape thus has a beneficial effect on the biodiversity of area.

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Data from Geocaching as a measure of recreation ecosystem services in cities: a case study of Bratislava

Tomáš Rusňák

Institute of Landscape Ecology, Slovak Academy of Sciences, Štefánikova 3, 814 99 Bratislava, Slovakia
e-mail: tomas.rusnak@savba.sk

Keywords: *geocaching, cultural ecosystem services, global positioning system, spatial analysis*

Recreation is one of crucial cultural ecosystem services that helps societies reap the direct and indirect advantages of using their surroundings experientially. Ecosystem service practitioners now have the chance to use this georeferenced data to evaluate recreational ecosystem services thanks to the recent surge in popularity of Global Positioning System (GPS) game applications, which combine information technology with an activity that boosts mobility and promotes outdoor enjoyment. One example is the worldwide phenomenon known as geocaching. There are set locations where people can conceal and search for caches. The geocaching data could potentially be used in this case study to represent recreational ecosystem services in the town Bratislava. We focused only on cache types that have accessible geographic coordinates and a logbook. For those cache types, we found a total of 1569 caches with 554581 logs within the administrative area of Bratislava. The most of caches - 34.37% (531 caches) are located in Continuous urban fabric. The second largest amount of caches 20.78% (321 caches) are in Unknown forests. The results show that most caches are hidden and looked for in urban areas, and that urban green infrastructure accessibility and availability are strongly associated with geocaching. Recreation is a critical cultural ecosystem service that allows for the experiential use of the environment, which benefits community members both directly and indirectly.

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Effects and application of grazing local livestock breeds as active grassland conservation in selected national parks in Poland

Anna Rysiak¹, Witold Chabuz², Mariusz Kulik³, Adam Gawryluk³, Krzysztof Patkowski³, Michał Pluta⁴, Barbara Futa⁵, Wioletta Sawicka-Zugaj², Paweł Żółkiewski², Jan Zdulski⁶

¹Department of Botany, Mycology and Ecology, Institute of Biological Sciences, Faculty of Biology and Biotechnology, University of Maria Curie-Skłodowska, Akademicka 19, 20-033 Lublin, Poland

²Sub-Department of Cattle Breeding and Genetic Resources Conservation, Institute of Animal Breeding and Biodiversity Conservation, University of Life Sciences in Lublin, Akademicka 13, 20-950 Lublin, Poland

³Department of Grassland and Landscape Forming, University of Life Sciences in Lublin, Akademicka 13, 20-950 Lublin, Poland

⁴Department of Horse Breeding and Use, University of Life Sciences in Lublin, Lublin, Poland

⁵Institute of Soil Science, Environment Engineering and Management, University of Life Sciences in Lublin, Lublin, Poland

⁶Research Institute of Horticulture in Skierniewice

e-mail: anna.rysiak@mail.umcs.pl, witold.chabuz@up.lublin.pl, mariusz.kulik@up.lublin.pl, adam.gawryluk@up.lublin.pl, krzysztof.patkowski@up.lublin.pl, michal.pluta@up.lublin.pl, barbara.futa@up.lublin.pl, wioletta.sawicka@up.lublin.pl; pawel.zolkiewski@up.lublin.pl

Keywords: *natural pastures, Polish White-backed cattle, permanent grassland, active protection*

Most European grasslands are semi-natural and require appropriate active management to maintain their high natural value. They provide habitats for many rare and endangered plant and animal species. The natural diet for all herbivorous species is grazing. Local breeds should be preferred for grazing on natural grasslands, as they are resistant to adverse weather conditions, are likely to meet their nutritional requirements through grazing and are highly resistant to disease. The objectives of our studies were to determine: patterns of changes in the flora and vegetation of grasslands induced by the introduction of extensive management, and the effect of the means and intensity of use of permanent grassland on the vegetation and its nutritional value in the context of animal welfare. The studies were conducted in: a forest settlement in the Roztocze National Park (eastern Poland) were pastures where native livestock breeds (Polish lowland sheep of Uhrusk and Polish Konik), buffer zone of the Polesie National Park (eastern Poland) the use of local cattle breeds for and the Magura National Park (southern Poland) grazing of local livestock (sheep and cattle). Extensive grazing of local livestock has been shown to have a positive impact on animal welfare and on the biodiversity of grassland ecosystems by preventing secondary forest succession, and can be used in areas of natural value for active nature conservation. The use of local breeds for grazing in valuable conservation areas conserves and protects livestock genetic resources.



Quantitative evaluation on Enclosing Characteristics of Satoyama landscape in YATO valley topography

Hijiri Shimojima¹, Reiko Machida¹, Yoichi Kunii², Kenji Okubo³, Kaoru Tsuchiya⁴

¹Department of Regional Regeneration Science, Tokyo University of Agriculture, h3shimoj@nodai.ac.jp

²Department of Landscape Architecture Science, Tokyo University of Agriculture

³Department of International Food and Agricultural Science, Tokyo University of Agriculture

⁴Department of Contemporary Sociology, EDOGWA University

Keywords: *GIS, Satoyama, topography, DCM*

Satoyama, which extends into peri-urban areas, is an important part of green infrastructure and an ecological link between urban and rural areas. Satoyama provides a multitude of ecosystem services, including clean air, water regulation, shade, wildlife protection, and space for recreation and sports.

Recreational functions are important in satoyama, which is located near densely populated urban areas because they provide visitors with healing and stress-reducing benefits. The number of visitors to green spaces has been increasing in recent years as it has become widely known that spending time in nature is good for one's health. In 2020, when COVID-19 became a pandemic across the globe, governments enacted various regulations to reduce human contact and lower infection rates. One of the few privileges that remained was the opportunity to take walks and exercise outdoors, activities that often took place in nature. Satoyama also became the venue of these activities. However, satoyama landscapes are most threatened by abandonment, commercial timber plantations, and urbanization. Therefore, understanding these landscape values by visitors to satoyama near urban areas can contribute to the promotion and conservation of these landscapes.

The focus of this study was the Tama Hills, located approximately 20 km southwest of Tokyo. The natural environment of the Tama Hills is topographically characterized by valleys called Yato, which is one of the typical landscapes of the Japanese countryside. the Yato valley is a horseshoe-shaped terrain of flat land intruding into a hilly plateau. The Yato valley is a unit of production and living environment, and a unit of social environment, combining a satoyama on a slope, a water source deep in a stream, a field on a gentle slope, a rice paddy field on a flatland, and a residential area protected by the terrain.

The purpose of this study was to conduct a quantitative evaluation of the sense of enclosure of the satoyama landscape in the yato valley topography using GIS analysis. The results of the study enabled us to 1) estimate the height of satoyama forests by differencing Digital Surface Model (DSM) and Digital Elevation Model (DEM) from GIS analysis and obtaining Digital Canopy Model (DCM); 2) Use the estimated Satoyama forest height values to characterize the enclosed landscape within the Yato valley formations.; 3) Quantitatively clarified the changes in the satoyama landscape by using aerial photographs of multiple periods.

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Future landscapes reflecting climate change and (lack of) adaptation efforts

Hana Skokanová

Silva Tarouca Research Institute for Landscape and Horticulture, Lidická 25/27, 602 00 Brno, Czech Republic
e-mail: skokanova@vukoz.cz

Keywords: *landscape scenarios development; optimistic scenarios; business-as-usual scenarios; adaptation measure; Czech Republic*

Due to human overexploitation, current landscapes experience worsened water retention and its quality, increased soil erosion or decrease in biodiversity. These processes are accelerated by the impacts of climate change, like long-term draught or floods. It is necessary to implement both mitigation and adaptation measures. Generating scenarios and maps of future landscapes with/out these measures can help in raising awareness about impact of climate change and humans (non)activity on the landscape and can also provide guidance where adaptation measures should be carried out.

The aim is to introduce mixed-method approach to landscape scenario development that includes climate change scenarios, scenarios of landscape elements development and predicting societal processes. We have chosen several case studies from south Moravia, Czech Republic and set the date to 2050. This date enabled us to reflect real plans of human activities, specified in various strategic documents on different levels. For the map creation, we used maps of current land cover as a basis. Other input data consisted of spatially explicit data (natural conditions, potential soil erosion, landowners, spatial municipalities' plans, historical land cover) and narrative data regarding spread/decline of land cover (municipalities development programs, stakeholders interviews). Combination of these data led to first versions of the maps. These were introduced at stakeholders' workshops and adjusted to their comments. We produced optimistic and business-as-usual scenarios. Optimistic scenario reflects implementation of adaptation measures and social readiness and willingness to do maximum for the resilience of the landscape. Such landscape experiences increase of woody vegetation, permanent crops and more resilient crops due to spread of irrigation, accompanied by decrease of the field size. The business-as-usual scenario assumes failures of efforts to implement adaptation measures due to reluctance of land managers or due to a lack of support. The resulting landscape suffers from consequences of climate change – it is dry, barren and with minimum of woody vegetation.

Combination of “traditional” data (historical/present land cover, natural conditions) with social data (both spatially explicit and narrative) enables better planning for future challenges and reflects realistic land cover changes based on society demands and possibilities.



Transhumance - environment-friendly pastoralism and biocultural values in Europe and Slovakia

Martina Slámová, Ingrid Belčáková, Miriama Mikušová, Branko Slobodník, Attila Rác

UNESCO Department for Ecological Awareness and Sustainable Development, Technical University in Zvolen, T.G. Masaryka 24, 9601 Zvolen, Slovakia;

e-mail: slamova@tuzvo.sk, belcakova@tuzvo.sk, xmikusovam@is.tuzvo.sk, slobodnik@tuzvo.sk, racz@tuzvo.sk

Keywords: *transhumance, pastoral landscape, mountain shepherding, high nature value farming system, biocultural diversity*

Extensively grazed pastures are present in 70 % of the European Union's geographically disadvantaged areas and contribute to maintaining the landscape, preserving biodiversity (including local native breeds) and combating natural hazards (EUROPEAN PARLIAMENT, 2018). Transhumance is a kind of pastoralism that is friendly to the environment. The article explains current situation of transhumance in the European countries, in detail focusing on the countries joined in the ERASMUS+ TRANSFARM project no. 2021-1-NO01-KA220-VET-000025048. In Slovakia, transhumance is tightly related with the mountain shepherding connected with the colonization under the Wallachian law. A new pastoral system has introduced a variety of cultural traditions. The main objective is to compare pastoral land-use with protected and high nature value farming systems at the European level indicating areas where transhumance might be practiced and based on the TRANSFARM research identifying biocultural values in the selected transhumance areas to compare and evaluate them among the different countries. In the international context, the research targets to define the transhumance biocultural values in Slovakia and propose optimal land use management targeting to integrate protection of natural habitats and sustainable pastoral land use with soft-tourism activities.

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Prospects for the development of the Novohrad region (Slovak Republic) in the context of the construction of the R2 expressway

Lucia Spodniaková, Lukáš Wittlinger

The Novohrad region is one of the important historical regions of Slovakia. Despite this, it is an underdeveloped region, in which it is necessary to ensure the development of the territory and thus bring a perspective for the young generations so that they do not leave for other regions of Slovakia, or abroad. In the districts of the Novohrad region, a relatively high rate of unemployment is registered, which exceeds the Slovak average of 5,90 %. In Lučenec district it is up to 10,08 %, in Poltár district 11,56 % and in Veľký Krtíš district 7,79 %. The long-term neglected infrastructure, civic amenities and lack of job opportunities are important. The aim of the paper is to analyze demogeographical processes with a focus on selected indicators - population, unemployment and educational level. The analyzed data will predict the development possibilities of the region in the context of the started construction of the R2 expressway, which will create a highway connection from Bratislava to Lučenec. The development of transport infrastructure is currently transforming the current use of the landscape and the functional structure of the Novohrad region's infrastructure. In the end, the transport connection created will take up space for complex geographical research, the aim of which will be not only to analyze the development of regional trends and differences, but also to monitor the impact on the country and to model the possible perspectives of the development of the given region. At the end of the paper, we propose solutions and measures in the event of adverse effects of construction on the environment.



Landscape-ecological consequence of European beaver introduction to wetland ecosystems in Łęczyńsko-Włodawskie Lakeland (Eastern Poland)

Piotr Sugier¹, Marta Edeńska¹, Kinga Brzozowska¹, Zbigniew Cierech¹, Radosław Olszewski², Stanisław Chmiel³

¹Department of Botany, Mycology and Ecology, Faculty of Biology and Biotechnology, Institute of Biological Sciences, Maria Curie-Skłodowska University, Akademicka 19, 20-033 Lublin, Poland

²Poleski National Park, Lubelska 3a, 22-234 Urszulin, Poland

³Department of Hydrology and Climatology, Institute of Earth and Environmental Sciences, Maria Curie-Skłodowska University, Kraśnicka Av. 2d, 20-718 Lublin, Poland

e-mail: piotr.sugier@mail.umcs.pl, marta.edenska@gmail.com, kinga.brzoza@interia.pl, zbigniew.cierech@mail.umcs.pl, radoslaw.olszewski@poleskipn.pl, stanislaw.chmiel@mail.umcs.pl

Keywords: *wetland ecosystems, European beaver, landscape transformation, macrophyte changes*

In the last decades, the number of populations of the Eurasian beaver (*Castor fiber* L. 1758) increased as a result natural dispersal and introductions or reintroductions. Their activity changes the vegetation structure directly and affects other ecosystem components indirectly. Beavers play an important role in the management of water resources and terrestrial ecosystems. Therefore, our special attention was paid to the water-land ecotone, which serves many important functions in the environment.

There is an increasing need for understanding the impacts of beaver activity on the vegetation and landscape especially in protected areas. Therefore, the aim of the present study was to investigate changes in the vegetation and landscape structure induced by the activity of introduced European beaver during last 30 years in the lakes of Poleski National Park. Changes in the aquatic and mire vegetation were determined on the basis of research carried out in permanent research transects. The reconstruction of landscape changes in the water-land ecotone was inferred by photointerpretation. Simultaneously, the hydrological conditions in the lakes and mires were monitored.

During the last few decades, beaver foraging in the studied areas caused changes in the phytolittoral, especially in the structure and composition of rush vegetation. The network of canals in the mire, which constitute the natural water-land ecotone, may contribute to changes in the dynamics of water runoff from the catchment area and to changes in the quality of the lake water. In turn, the canals dug by the beaver within the mire are microhabitats favoring colonization of typical aquatic plants, which is reflected in the greater species richness of the mires. The presented phenomenon is increasingly common in shallow lakes dominated by macrophytes, surrounded by floating mires, and very sensitive to changes in hydrological conditions.



Field Work and Geodata Acquisition - experiences with students in the High Tatra

Wolfgang Sulzer, Josef Gspurning

Institute for Geography and Regional Sciences, University of Graz, Heinrichstrasse 36, A-8010 Graz, Austria

e-mail: wolfgang.sulzer@uni-graz.at; josef.gspurning@uni-graz.at

Keywords: *Education, GIS, High Mountain Environment, High Tatra, Landscape Ecology, Remote Sensing*

This paper is intended to show in exemplary form the experiences, possibilities, difficulties and results of Geospatial Technologies geodata acquisition in the alpine environment of High Tatra. This combined GIS, Remote Sensing and Cartography practice for geography students has been held almost every two years since 2002 on the south side of the High Tatra. The course imparts knowledge and skills about advanced methods and techniques of GIS and remote sensing-based fieldwork. Taking into account the most important contents and competences of the study branches as stated in the local curricula particular attention is paid to the following focal points: Introduction to human- and physiogeographic settings in the investigation site, design and implementation of project-related geodatabases for the study area, GPS or device-supported sampling and integration of the results into a heterogeneous data environment of analogue and digital geodata, metadata generation, data quality issues. Selected natural, cultural/touristic and ecological landscape topics had to be investigated by small student groups, each field work year. From the beginning of planning and work assignment of a virtual project the students have to work out time schedules, proposals and to realize the project. During these about 20 years of various topics could be applied during this practice. Geodata acquisition at the home University (maps, satellite images, accompanying information as photographs, literature, etc.) must be planned and put into practice in the fields. During fieldwork they have to map additional valuable information and (field)check and update their prepared data base. Methods of acquiring (remote sensing) geodata as part of an applied project: Primary acquisition methods, Secondary Acquisition Methods, Spatial data infrastructure, Quality of geodata, Metadata and Geodata management. After field work the students have to integrate the field work data into their project analyses. Some results and problems of work are shown in this paper.



Identification of key landscape characteristics for beekeeping in Slovak mountains using a participative approach

Diana Surová

Czech University of Life Sciences Prague

Email: surovad@pef.czu.cz

Keywords: *mountains, beekeeping, landscape, resilience, participation*

Honeybee breeding has been delivering numerous products for humans since ancient times and provides essential ecosystem services, including pollination of plants and biodiversity support. It is crucial for agriculture, rural development, and the environment. However, with ongoing threats resulting from ongoing climate and socio-economic changes, beekeeping needs closer attention to safeguard its resilience. The presented study applies a multi-actor participatory approach to identify the key landscape resources needed for successful beekeeping in Slovak mountain areas. A sequence of different methods was used, including semi-structured interviews, questionnaires, and participatory workshops. During the application of each method, various actor groups were targeted: beekeepers, farmers, foresters, local and regional authorities, and researchers. Results highlight a close connection between successful beekeeping and specific landscape characteristics for beehive installation. Especially important for beekeeping was the land cover richness, presence of extensive grasslands with high plant diversity, low infrastructure density, and absence of heavy industry. The favorable landscape conditions provide a good quality bee pasture resulting in healthy and productive bees. Additionally, a road infrastructure allowing access to beehives and some buildings for beekeeping equipment in the field were perceived as necessary. Stakeholders also perceived that the key territorial resources for beekeeping had been negatively impacted over the last decades by results from ongoing climate changes and by interrelated changes in land use management. Finally, the stakeholders agreed that a territorial approach, innovative thinking, and collaborative governance are necessary for safeguarding the resilience of beekeeping against exogenous and endogenous threats. The study also served as an exercise of a participatory approach applied in a country where interest and participation in research dealing with territorial development often face disinterest and skepticism from the public side.



From ecosystem services to ecosystem accounting. The application of ecosystem accounting principles at the local scale.

Marta Sylla

Institute of Spatial Management, Wrocław University of Environmental and Life Sciences, Grunwaldzka 55, 50-357 Wrocław, Poland

e-mail: marta.sylla@upwr.edu.pl

Keywords: *ecosystem accounting, landscape park, peri-urban, Ślęza mountain*

The paper introduces the principles of the System of Environmental-Economic Accounting—Ecosystem Accounting (SEEA EA), which provides guidance to recognising the contribution of ecosystem services (ES) to economy and human well-being. The spatial aspect is in the hearth of each of the steps of the SEEA EA framework. The spatial perspective enriches the standard economic indicators that are used to describe the level of socio-economic development of the region or municipalities. This also poses a lot of challenges, especially in the integration part of the ecosystem accounting with economic activities. The aim of the work is to present the application of the conceptual framework of linking ecosystem services, benefits and economic sectors. The case study area represents five municipalities that are part of the Ślęza Landscape Park in Poland. We mapped four ecosystem services and attributed them to the benefiting sectors. The socio-economic character of the case study is determined by the set of indicators, while the economic sectors are classified according to ISIC v4. The analysis relates to year 2012 and 2018. Thanks to the local character of our case study, we were able to spatially allocate the ecosystems and beneficiaries. We present in a spatially explicit ways the contribution of selected ES to local economy. We discuss the applicability of ecosystem accounting to spatial planning and local governance.



Assessment of the potential of selected landscapes of Poland to provide landscape services

Marta Sylla, Iga Kołodyńska, Piotr Krajewski*, Monika Lebiedzieńska, Marek Furmankiewicz

Institute of Spatial Management, Wrocław University of Environmental and Life Sciences, Grunwaldzka 55, 50-357 Wrocław, Poland

e-mail: marta.sylla@upwr.edu.pl, iga.kolodynska@upwr.edu.pl, piotr.krajewski@upwr.edu.pl, monika.lebiedzinska@upwr.edu.pl, marek.furmankiewicz@upwr.edu.pl

Keywords: *landscape services, expert scoring, service potential, Polish landscape types*

While the term ecosystem services has gained considerable attention in the scientific forum, the landscape services seem to be less investigated. We identified three different approaches in the scientific literature to defining landscape services and we applied the landscape service classification by María Vallés-Planells et al. (2014). We surveyed 38 Polish landscape researchers about their expert scoring of the potential of selected 16 landscape types (according to national landscape typology) to offer services of : (1) providing space for daily activities such as living, working and commuting, (2) regulating the spatial structure by landscape's diversity and compositional richness of the natural and/or cultural elements as well as buffering disturbing use, (3) improving physical and mental health, (4) , providing (passive and active) enjoyment of observing nature and/or active outdoor leisure activities, (5) providing opportunities for personal fulfilment such as improving knowledge, spiritual fulfilment, inspiration for art and culture, (6) providing opportunities for social fulfilment while social gatherings, community integration, providing place identity, sense of belonging. The results of the expert-based assessment of the potential of the landscape services. Combined with the ecosystem service matrix, the landscape service potential metrics provide a supporting tool for the landscape decision making process. The landscape service potential assessment could be used as a basis for further service use analyses.



COMMON JUNIPER (*Juniperus communis* L.) Cultivation Options for Fruit Production (introduction of scientific monograph)

Ivan Šalamon

Department of Ecology, Faculty of Humanities and Natural Sciences, University of Presov,
01, 17th November St., SK-080 01 Presov, Slovakia

e-mail: ivan.salamon@unipo.sk

Keywords: *beverage, berries, cultivation, Juniper, monograph*

Nowadays we often face a national problem of country desolation, also considered a trouble of overgrowth of abandoned or uncultivated land in Slovak Republic. Reasons for such desolation of formerly cultivated land vary, e.g. devastation of forest vegetation, not mowing and not using of meadows and pastures leading to a decline of certain unique ecosystems. Plant populations of Common Juniper (*Juniperus communis* L.), which typically grows in rocky, infertile soils, in fields, meadows, pastures, open woods and other settings, almost from sea level to alpine sites.

Borovicka beverage production is carried out in many Slovak companies. Today's commercially for distillery industry needs commercially 500 thousand kilograms of juniper berries per year. Paradoxically, juniper berries required for production of spirits, liquors, syrups and other products are exclusively imported from Albany and Macedonia. On one hand, these berries are predominantly of prickly juniper (*Juniperus oxycedrus* L.) which contain more sugar, on the other hand they contain low aromatic compounds than the common juniper berries. Elimination of this situation was done by realization of the mentioned project and its outputs which is published in the monograph about Common Juniper in Slovakia. Part of it devotes the realization output for practice with all the information required by entrepreneurs interested in plantation farming of juniper cultivation for fruit production. The monograph could also be used for introduction of regional systems of ecological stability to practice.



The importance of regulated water channels in agricultural land for the occurrence of the dragonfly *Libellula fulva* (Müller, 1764)

Zuzana Šíblová¹, Milena Moyzeová²

¹Department of Ecology and Environmental Studies, Faculty of Natural Sciences and Informatics, Constantine the Philosopher University in Nitra, Trieda A. Hlinku 1, 949 01 Nitra, Slovakia

²Institute of Landscape Ecology, Slovak Academy of Sciences, Štefánikova 3, P.O. Box 254, 814 99 Bratislava, Slovakia

e-mail: zuzana.siblova@savba.sk, milena.moyzeova@savba.sk

Keywords: *Odonata, bioindicators, biodiversity, Libellula fulva, wetlands ecosystems*

It is already known that many species of animals are gradually adapting to the ongoing changes in the country. Whether it is global warming, increased pollution, fragmentation of the landscape or the complete disappearance of original habitats. Even today, dragonflies are considered bioindicators of environmental quality. With their abundance and species representation, they have the ability to reflect various changes in the character of aquatic as well as surrounding terrestrial habitats. Currently, we can also observe the ability to adapt to new conditions in this group, and it is increasingly represented in anthropogenically created sites. A great contribution should be attributed to various water channels, which, despite their anthropogenic origin, replace original habitats and thus provide supporting ecosystem services.

In our study, we focused on the species of national importance, *Libellula fulva*. Until recently, this species was considered rare and endangered in our territory. Nowadays, however, it has started to appear more abundantly on various types of regulated water channels. That's why we chose the approximately 22.5 km long section of the Zohorský canal located in the Borská nížina lowland (western Slovakia) as the model area. Zohorský canal is a lowland regulated stream that flows through a diverse environment. We set out 6 different transects (Z1-Z6) on it in order to find out which type of habitat *L. fulva* will prefer the most. In 2020, we carried out a complete odontological survey. The comparison of transects based on the calculation of the Shannon Diversity Index (H) and equability (E_H) revealed no significant differences. However, when we took into account only the abundance of *L. fulva*, the differences were demonstrable. Zero representation of *L. fulva* was on transect Z5, which flows through the municipality of Gajary and was heavily polluted. The largest number of individuals (83) was on transect Z4, which is only about 6 km downstream from Z5. This section is covered on both sides by forest and a strip of trees separating the canal from the surrounding fields. The habitat of the water course itself is fragmented with plenty of regularly mowed coastal vegetation and aquatic macrophytes. *L. fulva* prefers slightly flowing to stagnant warmer water, which was proven in this case as well. The lower frequency was in sections with unmaintained banks, which points to the necessity of regular mowing of coastal vegetation. Based on the findings of new habitat preferences of dragonfly species, the management of regulated streams can be set up more efficiently in order to achieve an increase in their biodiversity and abundance.

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Examples of Assessment High Diversity Landscape Feature

Jana Špulerová, Zita Izakovičová, Marta Dobrovodská

Institute of Landscape Ecology of the Slovak Academy of Sciences, Štefánikova 3, Bratislava, Slovakia
e-mail: jana.spulerova@savba.sk, zita.izakovicova@savba.sk, marta.dobrovodska@savba.sk

Keywords: *green infrastructure, territorial network of ecological stability, traditional agricultural landscape*

High diversity landscape features (HDLF) are small fragments of natural or semi-natural vegetation and specific habitats in agricultural land which, compared to their relatively small size, provide important contributions to ecosystem services and biodiversity. They have long-standing historical and cultural roots in the agricultural landscapes of Europe, but with the advent of intensive agriculture, landscape features became threatened. Landscape features include several non-productive elements of traditional European agricultural landscapes, such as buffer strips, hedges, ponds, ditches, trees in line or in group or isolated, field borders, terraces, dry-stone or earth walls, flowering borders, patches of natural habitats that receive no fertilizers or pesticides. As an examples to delineation and assessment contribution of HDLF in agricultural landscape we included approaches to: (1) Territorial Network of Ecological Stability – methodology for regional or local study of territorial network of ecological stability; (2) Traditional agricultural landscape – national inventory, evaluating the contribution of the rural development program to high nature value farmland dominated by traditional mosaic landscape in Slovakia; and (3) Live landscape – competition initiated by NGO, cooperation on evaluation criteria, motivation of farmers for ecological farming and increasing landscape diversity of farmland.

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Stone terraces and walls – the remains of disappearing traditional vineyards in Slovakia

Dagmar Štefunková

Institute of Landscape Ecology, Slovak Academy of Sciences, Štefánikova 3, 81499 Bratislava, Slovakia

e-mail: dagmar.stefunkova@savba.sk

Keywords: *Agrarian stone terraces and walls, traditional vineyard landscape, natural capital, biocultural systems*

The paper deals with the systems of stone walls and terraces as a remnant of medieval to early modern viticulture in Slovakia. The mounds and terraces are often the only sign of the existence and spread of traditional vineyard landscapes that were still common in the first half of the 20th century. They represent a natural capital that is largely undiscovered by contemporary society and therefore undervalued in terms of its ecosystem services and landscape heritage values. Using examples from the territory of Slovakia, we analyse the typical pattern of stone terraces and mounds in the context of its typical use and land subdivision in the past and today; we also discuss the natural, economic and socio-cultural factors of the emergence and gradual disappearance of these systems since the second half of the 20th century. We compare the biocultural systems of disappearing vineyards with stone walls and terraces with similar systems in other wine-growing regions of Europe and look for differences that affect their sustainable use and conservation.

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Ecosystem services provided by avian species along an elevation gradient

Miriam Vlachovičová

Institute of Landscape Ecology, Slovak Academy of Sciences, Štefánikova 3, Bratislava 81499, Slovakia

Keywords: *avian diversity, ecosystem services, elevational ranges, mountain environments*

Abstract: Mountain environments are unique and biodiverse ecosystems that face mounting pressures from climate change and anthropogenic disturbances. Birds play a crucial role in mountain ecosystems by providing essential ecosystem services such as seed dispersal, insect pest control, and nutrient cycling. This study aims to examine the relationship between avian diversity and regulating and provisioning ecosystem services across different elevational ranges. We used ecological traits to investigate interspecific variation and calculated various community metrics including functional diversity, taxonomic diversity, community specialization, trophic index, phylogenetic diversity, and community evolutionary distinctiveness. The study is not limited to mountain specialists but includes widespread species. The preservation of biodiversity and the enhancement of other ecosystem services are frequently viewed as competing objectives. It is imperative to give greater consideration to the plausible variable associations among species while utilizing tools designed for evaluating biotic communities. Ecological communities are comprised of species interactions that exhibit temporal changes in response to abiotic and biotic factors. The analyses conducted emphasize the necessity of adequately considering the significance of biodiversity in decision-making processes that aim to incorporate various ecosystem services.

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Urban landscape and its ecosystem services perception: insights from Poznań, Poland

Iwona Zwierzchowska, Małgorzata Stępniewska

Department of Integrated Geography, Faculty of Human Geography and Planning, Adam Mickiewicz University, Bogumiła Krygowskiego 10, 61-680 Poznań, Poland

e-mail: iwona.zwierzchowska@amu.edu.pl, małgorzata.stepniewska@amu.edu.pl

Keywords: *parks, river valley, postindustrial areas, urban green.*

The landscape of the city and the related composition and configuration of green infrastructure (GI) translate into the supply and distribution of ecosystem services (ES). In this study, we aimed to recognize the social perception of ES at the background of the urban spatial structure (from the dense centre to the rural-like suburbs) based on a case study of Poznań city in Poland.

The city is 0,5 million inhabitants and covers an area of 262 km². It is an interesting example, as the city structure was shaped through different periods of time reflecting various patterns of development.

First, the quantitative GIS analysis has been applied to diagnose the distribution and diversity of GI along urban core and rural-like suburbs in the administrative units functioning for local decision-making. The distribution and diversity of GI have been analyzed within three main urban zones including: (1) core zone; (2) inner suburbs; (3) outer suburbs – peripheral areas. Secondly, we applied quantitative and qualitative assessments of social perception and demand for ES based on a comparative analysis of surveys conducted among users of various GI categories in Poznań. Data for the analysis were obtained from available original datasets supplemented with data from journal articles and theses.

The findings revealed that although distribution and types of GI vary among main urban zones, inhabitants appreciate the cultural ES of GI regardless of its type or location. They expressed the demand for the enhancement of recreational ES and the importance of accessibility to green spaces. The study also emphasised the complex trade-offs between cultural and regulating ES highlighting the role of ES-oriented planning.

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