Institute of Landscape Ecology, Slovak Academy of Sciences
Constantine the Philosopher University in Nitra
Slovak Ecological Society by the Slovak Academy of Sciences

Landscape diversity and biodiversity

18th International Symposium
on Problems of Landscape Ecological Research

23rd – 27th April, 2019
Congress Centre Smolenice SAS, Slovakia

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ABSTRACTS

The main topics of the Symposium:

- Landscape structure changes and land-use - influence on biodiversity
- Landscape protection and biodiversity conservation (national legislation, international conventions, implementation, etc.)
- Changes of historical structures in the landscape
- Urbanization and settlements development - impacts on the landscape

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ANALYSIS OF SOCIO-ECONOMIC FACTORS AFFECTING THE PERSISTANCE/ABANDONEMENT OF TRADITIONAL AGRARIAN LANDSCAPE IN SLOVAKIA

Pavol Kenderessy, Jana Špulerová, Ivana Kozelová

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The analysis was based on nationwide database of traditional agrarian landscape (TAL) consisting of 3013 TAL polygons encompassing 44,464 ha. TAL polygons were mapped from aerial photos, recording basic characteristics such as land-cover composition or degree of management. The results from the country-wide mapping shows, that 50% of the TAL area iregularly managed, 34% is partly abandoned, and 16% is abandoned. In order to assess main socio-economic drivers, the statistical data provided by Statistical Office of Slovak Republic were used. These data were analysed on level of individual cadastral areas with the presence of TAL polygons. The impact and relationship between landcover change, its intensity and trends, demography (inhabitants rate, age structure, unemployment rate, education, etc.) and TAL abandonment/persistence was further investigated and verified by social survey results from tree pilot areas.

Keywords: traditional agrarian landscape, abandonment, factors, Slovakia

MULTIFUNCTIONAL FARMING AS AN OPPORTUNITY FOR THE SUSTAINABLE EUROPEAN AGRICULTURAL LANDSCAPES: CASE STUDIES FROM SELECTED EUROPEAN COUNTRIES

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Historically, a variety of agricultural systems has been developed in Europe. Agricultural production depends primarily on natural conditions and the sale of agricultural products from farms is not easy. These reasons would motivate farmers to start non-agricultural activities balancing the irregular and often weak income from their agricultural production.

However, from the point of view of sustainable agriculture an increasing trend in self-sufficient farming is expected. Here, the diversification of activities on farms is assumed to be a solution. Extensive research done across the European countries confirmed that family size of farms and their structure plays a role in motivating farmers for the future diversification of activities.

Farming multifunctionality is the integration of different functions and activities that produce beneficial effects on local economy, environment and society. According to the different farm types, multifunctionality assumes different aspects covering specific sets of sustainability needs. It is important to move from the farm level multifunctionality to the landscape level multifunctionality in order to provide all services at a territorial scale. Multifunctional and sustainable farming activities have been slowly growing, mainly in sub-mountain and mountain regions where the traditional landscape with its specific character and features is preserved. Raising awareness of landscape values by farmers and stakeholders, adequate daily maintenance of agricultural landscapes respecting their heritage and values will improve the landscape quality and bring added value to the landscape. Thus, a high quality landscape would present a potential financial resource for tourism development. Diversified activities on farms and multifunctional agriculture allow farmers a certain level of the independence from basic agricultural production that is limited mostly by natural conditions. Inspirational ideas about landscape values applied in farming practices can be transformed into ecomuseums, they could became a part of local or regional products trademarks, and last but not least can be added into the tourist information system and farms could be hotspots in the network of tourist routes.

Keywords: multifunctional farming, agroecosystems, sustainability, young farmers

THE APPROACH TO MONITORING OF HIGH NATURE VALUE FARMLAND

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High Nature Value Farmland (HNV) are defined as those areas where agriculture is a major or dominant land use and where that agriculture supports, or is associated with, high species and habitat diversity and/or the presence of species requiring conservation (Andersen et al., 2003). Among three defined types of HNV farmland, we paid attention to the type 2 – farmland with a mosaic of low intensity agriculture and natural and structural elements. We established 40 monitoring sites to evaluate the development of this type of landscape depending on the management intensity and the contribution of subsidies from the Rural Development Programme for 2014-2020. The study focuses on answering the evaluation questions, which provides an independent assessment of the relevance, efficiency, effectiveness and achievements, impact and success and failure factors.

Recently there is no special measures within the Common Agricultural Policy (2014-2020) for support of HNV Type 2, therefore we analysed only existing measures applied for management of these type of landscape. We argue that governmental financial instruments should recognise the concept of High Nature Value farmland – type2, in order to maintain biodiversity values and cultural heritage, and to stimulate sustainable development of rural landscapes (Špulerová et al., 2017). This work was supported by the Scientific Grant Agency of Ministry of Education of the Slovak Republic [No. 2/0078/18 "Research of biocultural values of landscape"].

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Keywords: High Nature Value farmland, management intensity, Rural Development Programme for 2014-2020, evaluation

CLIMATE REGULATION IN URBAN AND SEMI URBAN LANDSCAPE MANAGEMENT

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Planning and management of urban systems can considerable exacerbates the negative effects of climate change while natural elements and green areas are shrinking. Sustainable provision of regulatory ecosystem services such as climate regulation in urban environment has been found essential for reducing the impact of climate change and for resilience cities. (EFB, 2015). Mainstreaming ecosystem services into spatial planning in urban and semi-urban areas thus can bring a numerous benefits for quality of life because microclimatic function of green infrastructure can mitigate the negative impact if well constructed and managed. The research concerns effective green infrastructure management in urban and semiurban systems, in such abatement of heat Island effect and adaptation to drown. It concerns (i) methodology to analyse perception of climate change risk ii) determine effective stimuli for behavioural change of key actors to sustainable provision of climate regulation ecosystem services at community level to enhance well-being. Key questions addressed in the paper are: How understanding the climate change risk (risk perception) can stimulate collective action for adaptive behaviour in a long term? How to set management so its greenery could effectively provide regulation ecosystem services?

Keywords: climate regulation, behaviour change, green infrastructure, urban environment, heat islands, adaptation, mitigation

ANALYSIS OF THE DEVELOPMENT OF THE AREA OF VARIOUS ECOSYSTEMS IN GERMANY

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Ecosystem mapping is the first step in implementing Target 2 of the EU Biodiversity Strategy 2020. This basis is propaedeutic for the valuation of the ecosystem states and services and goes beyond the land use statistics as integrated in the SEEA as "area by type of actual use". Accordingly, approaches were developed and coordinated with the BfN in order to allow for a complete, non-redundant description of land and water areas. Challenges exist in particular in the degree of thematic detail in the ecosystem mapping, mainly with respect to whether and which functional features should be included that can be suitable for supporting the attainment of the respective goals (e.g. protecting biodiversity, prioritizing the restoration of damaged ecosystems, ecosystem extent account) at the national level.

The development of the ecosystem typology was guided by the following premises:

- clear, coherent structuring principle for ecosystem types (ET): by land cover (vegetation/use)
- derivable from existing data sources
- compatible with international systems (such as MAES / SEEA)
- time sections available (monitoring): changes in the various stocks quantifiable (Which ET was replaced by which other one?)

Accordingly, three hierarchical levels were proposed: 5 main ET, 14 sub-ET and further differentiation into 37 CLC classes for Germany (Table 3). They are based on the European classification of Corine Land Cover (CLC), which is evaluated based on the digital land cover model of Germany (*Landbedeckungsmodell Deutschlands*, LBM-DE). The proposed classification is based – as far as possible – on the European biotope classification EUNIS (European Nature Information System) of the European Environment Agency (EUNIS 2007). For this purpose, similar biotope types from different CLC classes were sometimes combined into the ET.

Federal evaluations are to be carried out primarily on a 1 x 1 km grid basis (INSPIRE grid) in order to ensure compatibility with other data bases. The output of results can be implemented based on the "area proportion" in the form of individual maps for theme-specific propositions.

The time sections of the calculation primarily refer to 2012 and 2015, corresponding to the LBM data. For these two reference years (and in future every third year), population movements and changes in the types can be represented. Older time sections cannot be compared exactly due to changes in the data acquisition methods.

More finely differentiated ecosystem types in the framework of capturing and assessing habitat types according to the FFH directive and the mapping of high-nature-value farmland as well as differentiated state information from the federal forest inventory are assigned to the above comprehensive ecosystem types and used for describing and quantifying changes in their quality.

Keywords: ecosystem typology, changes in quality, FFH directive, ecosystem mapping

DRIVER SIGNIFICANCE IN LANDUSE/LANDCOVER PREDICTION MODELS

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The valuation of ecosystem services is important for current and also future decision making processes. For valuation of ecosystem services in future it is important to estimate a future development of land use. For the calculation of ecosystem service performance in the time and in the space, land use scenarios of the past development of land use are often used.
Individual drivers which play an important role in the predicted allocation of individual land use categories in areas of interest were tested. Testing of drivers and subsequent prediction of the future land cover by using the CLUE/CLUMONDO model was made for the whole territory of the Czech Republic. The classes of land use/land cover (LULC), mapped according to Corine Land Cover 2012 data, were aggregated into eight LULC classes.

More than 25 potential drivers, based on the most suitable spatial and free of charge data, available for the whole area of the Czech Republic, were selected. Some important but inaccessible drivers, as e.g. the structure and amount of farm subsidies, significantly affecting changes in arable land, meadow and forests, could not be involved. Finally, ten environmental and six socio-economic drivers were statistically tested for significant change in each LULC category, with taking into account other drivers.

The logistic regression with categorical dependent variable was used. Relationship between the categorical dependent variables and one or more independent variables was tested by a logistic function with the cumulative logistic distribution. Significant parameters were selected after validation by using AUC criteria with value higher than 0.8. For each LULC category maximum seven the most significant drivers were identified. On the basis of the identified most significant drivers, the transition rules and the current trend of LULC category the prediction of the development of the LULC for the whole Czech Republic by the year 2050 was created. In the year 2050 the most important differences, compared to the Corine Land Cover 2012, were the increased built-up and permanent grassland areas at the expense of arable land area.

Keywords: CLUE/CLUMONDO model, drivers, land use changes, LULC category

GEODIVERSITY AS DETERMINANT OF LANDSCAPE DIVERSITY IN REGION OF OGULINSKO PLAŠĆANSKA ZAVALA, CROATIA

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To characterize the landforms of scenery, one must be able to locate them according to two complement frames, which coexist in the visible geographical space but do not share the same properties and significance. That current topographic and geomorphologic space with its low points (basins, valleys, lowlands), or high points (knobs, ridges of mountain chains, highlands) and the space of geological features (stratigraphy, lithology, tectonic, etc.) can be inherited from the past or can be actually active in present (Reynard, E. & Giusti, C; 2018).

In the terms of spatial planning and environment protection procedures in Croatia, geomorphologic features are mostly considered marginally. Geomorphologic features of certain places are considered locally in the scope of the certain operation such as urban development, mining, and other activities which are being assessed in environment impact assessment procedures or spatial and strategic planning. Regarding the protection and with it connected planning processes, geomorphologic features should be considered in a right scale and with all its values and services which are providing to the environment on a landscape scale. In this work the connection of geomorphologic features and their role in landscape forming and changes will be connected and explained on the example of subgeomorphologic region Ogulinsko-plašćanska zavala in mountainous Dinaric karst part of Croatia. As it has been a region with long human and nature interaction, and in the other hand is still a region with preserved natural and seminatural landscapes, it is suitable area for such an analysis. In order to properly assess geomorphologic features as one of the determinants of landscape and basis for environment impact assessment procedures and planning procedures, geoecologic analysis with valorization of scientific and additional values such as landscape and ecosystem services is carried out.

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Reynard, E. & Giusti, C. (2018): The Landscape and the Cultural Value of Geoheritage, Geoheritage, Chennai: Elsevier, pp. 147 – 166.

Keywords: geomorphological analysis, Ogulinsko-plašćanska zavala, valorization of values

EXTINCTION OF AQUATIC VEGETATION AS A CONSEQUENCE OF LAND MANAGEMENT AND CHANGES IN WEATHER CONDITIONS: EXAMPLE FROM EASTERN POLAND

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The present-day changes in hydrogenic areas are usually caused by humans, mainly through an impact on catchment areas, leading to an increase in the supply of organic matter from the basin and accumulation in the lake. Humic substances affect, for example, the color of water and, consequently, decrease water transparency, even causing extinction of vegetation. The problem becomes very serious in the case of hard water lakes dominated by stoneworts, which play a very important role in the aquatic environment and are very sensitive to changes in light conditions. This problem is particularly noteworthy in regions where lakes with dominance of charophytes constitute a relatively small group of water reservoirs, e.g. in Eastern Poland.

The aim of the presented studies was to investigate changes in the management structure of a catchment area and to determine the role of anthropopressure and weather conditions in organic matter transport from a catchment area to a lake. The model object was Lake Rogóźno. Reconstruction of landscape changes and hydrological conditions in the lake catchment area between 1839 and 2018 was inferred by photointerpretation and cartographic analysis. Calculations were conducted in ArcMap 10.1 programme. Additionally, historical data on precipitation and temperature were used.

In the analyzed period, the catchment area of Lake Rogóźno was significantly enlarged, including transitional mire as a result of melioration. Land drainage at the turn of the 70s and 80s of the 20th century resulted in intensification of moorshing and decession of the peatlands. Part of the fen was drained and used for agriculture, mainly as grasslands. For several decades, the drained fen and transitional mire have been the main source of humic substances reducing the transparency of the lake's water, which negatively influenced the aquatic vegetation. In recent years, the area of phytolittoral has drastically decreased. In addition, warm winters favored the process, by extending the time of transporting substances to the lake. Therefore, the inflow of humic substances to the lake should be limited by blocking the outflow of water from the fen and transitional mire, and other, alternative drainage of transitional mire omitting the lake should be taken into account. It may contribute to improvement of the quality of the lake's water and creation of habitat conditions favoring spontaneous regeneration of stoneworts, as well as give the possibility of active protection with the use of the underwater seed bank.

Keywords: Lake Rogóźno, land management, anthropopressure, aquatic vegetation, stoneworts

RECENT CHANGES OF AGRICULTURAL LANDSCAPE: DRIVING FORCES AND PRESSURES FROM EUROPEAN AND SLOVAK PERSPECTIVE

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This paper is aimed at identification of main driving forces of agricultural landscape (AL) changes and related pressures at scales of European Union and Slovakia. We analysed global megatrends and driving forces at European, national and local levels. The special attention was paid to the regulatory frameworks, EU Common Agricultural Policy (CAP) and its implementation at national level, because CAP is a key policy determining the agricultural management trends and at the same time local decisions of individual farmers.

The agriculture in Europe underwent broad transformation during the second half of the 20th century, resulting in significant changes of AL. The agriculture intensification was accompanied by broad land use changes that led to landscape homogenisation, fragmentation of natural and semi-natural habitats, changes in their structure and loss of their conservation value. In Slovakia and other countries of Central and Eastern Europe, changes of political and economic system in 1990s provided an additional impulse for AL changes. They resulted firstly in broad abandonment of AL followed by restoration of major plots after the accession of Slovakia to EU and start of the CAP implementation.

The population growth, food demand and urbanisation were identified as the major driving forces of AL changes on European level, the accession to EU is an additional driver on national level. The importance of climate change, bioenergy demand, and changing consumption patterns increased in the last period. The main current pressures include changes of agricultural land to other land use classes (i.e. change to urban, industrial or transport zones, change to forest) and polarisation of AL use (i.e. intensification along with abandonment).

Besides pressures to AL, we further analysed pressures to four broad habitat groups important for AL: agricultural, forest, freshwater, and wetland habitats. We employed data from reporting of pressures by the EU Member States based on requirements of the Habitats Directive Article 17. The main pressures identified by our analysis correspond to some generally recognised pressures like agriculture and forestry intensification, agriculture abandonment, drainage, chemical pollution (air, water and soil), urban sprawl, invasions of alien species. We found that some pressures were ranked among the most important ones for all four studied habitat groups.

Keywords: agricultural landscape, driving forces, pressures

INFLUENCE OF LANDSCAPE HETEROGENEITY ON THE TEMPORAL VARIABILITY OF LANDSCAPE FUNCTIONING IN THE SOUTH OF WESTERN SIBERIA

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The relationship between biodiversity and ecosystem functioning is a well-developed field of study. However, most of the relationships in this area have been evaluated at the community scale. Particularly, the most frequent pattern is: "biodiversity increases the stability of ecosystem functioning". In recent years, several studies have been conducted to identify and confirm these relationships at the landscape level, using traditional methods of landscape ecology.

In this study, we explored the relationships between temporal variability of landscapes (ecosystem) functioning and different features of landscapes heterogeneity, calculated them by the composition and configuration indices. Also, we tried to elucidate the theoretical mechanisms responsible for the resulting patterns in the diversity-stability system.

The research was conducted in a small lowland basin of Kasmala river, located in the South of Western Siberia (forest-steppe zone). This basin contains widely differ landscape types: areas of steppes and agricultural lands, as well as large areas of pine forests. Accordingly, it allows to explore the response of different ecosystem types to changing environmental conditions.

Climate is the major agent of temporal variability of ecosystem functioning. As the indicators, we used snow water equivalent (SWE) and soil moisture content in July. These indicators directly influence the development of communities and are highly variable at the landscape level. We collected the field data from 2011 to 2017.

For calculation of landscape indices, we used land cover map based on supervised classification of LANDSAT images. Data analysis was performed by using ANOVA and linear regression analysis.

Keywords: landscape heterogeneity, ecosystem functioning, Kasmala river, climate

THE IMPACT OF VITICULTURAL LANDSCAPE STRUCTURES ON THE DIVERSITY OF GROUND-LIVING SPIDER ASSEMBLAGES (MODEL AREA MODRA)

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Vineyard landscape is a highly-valuable area from a man-made and exploited landscapes and it is characterized by high ecological value with its associated biodiversity. Our research was carried out in the Little Carpathians vineyard region in surroundings of Modra town, which is characterized by preserved fragments of the traditional vineyard landscape, such as terraced vineyards, stone walls and mounds. The landscape also contains preserved elements of natural ecosystems that represent the remains of thermophilous oak forests with downy oak (*Quercus pubescens*). New landscape elements represent newly built vineyards as well as abandoned vineyards and fallow areas, where old vineyards were grubbed out and nowadays contains vegetation at various stages of succession. All these landscape elements have an impact on the biodiversity of the studied area.

The research of the epigeic spider assemblages within Modra region was carried out on 8 localities and 11 study sites during vegetation season in 2018. Selected study sites present typical structures which were chosen as characteristic for investigated area with focus on its heterogeneity and realised management. Pitfall traps were used to monitor the spider fauna at the selected sites. During the survey period, we collected 5,971 spider specimens belonging to 123 species and 26 families. Of the identified spider species, 18 species are listed in the Red List of Plants and Animals of Slovakia, of which two ones are classified as critically endangered (CR), three ones as endangered (EN), seven ones as vulnerable (VU) and the remaining six ones are listed as potentially threatened species. High spider richness of the spider fauna and occurrence of the rare and threatened species for Slovakia allocate on high biotic value of the studied areas.

The individual study sites are assessed and compared according to biological importance on the basis of their coenose characteristics as spider diversity, species richness, composition and according to sozological aspect (presence of threatened spider species in the evaluated assemblages). This study was supported by the Slovak Scientific Grant Agency VEGA 2/0171/16.

Keywords: vineyards, diversity, landscape structure, epigeic spiders

MULTI-SCALE SOIL-LANDSCAPE GIS MAPS AS A BASIS FOR LANDSCAPE MANAGEMENT AND PLANNING AT ALL SCALE LEVELS

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Practical recommendations on the use and improvement of landscapes at different scale levels differ in content, degree of detail and the application objects. Therefore, the management and planning of landscapes is a hierarchical system of solutions, which should have a uniform and systematic cartographic basis. As such a basis, it is proposed to use a system of multi-scale soil-landscape maps, the thematic content of which is harmonized, since legends of all maps are based on a single hierarchical natural soil-landscape classification system. The latter is being developed using the General Systems Theory (open system) approach and the General Theory of Classification and is considered as the basis of the classification system of anthropogenic landscapes.

Currently, the proposed classification system is not dynamic and does not reflect changes in landscapes and soils over time. To do the classification system dynamic, it is necessary to add a time coordinate to it. In addition, in order to facilitate its use and significantly increase its functionality, the classification system should be developed as an online version.

The creation of soil-landscape maps was tested on the example of the plains of the European part of Russia for four scale ranges: (1) 1: 60 000 000 – 1: 80 000 000, (2) 1: 15 000 000 – 1: 25 000 000, (3) 1: 4 000 000 – 1 10 000 000, and (4) 1: 500 000 - 1: 1 500 000. The maps are generated from integral polygon layers containing all necessary information. The layers are created manually based on the analysis of mainly thematic, geographical, and topographic maps. For practical purposes, it is possible to insert into integral polygon layers information about the possible use and improvement of soils and landscapes, and then generate appropriate thematic maps.

The multi-scale soil-landscape maps are very informative and could be indispensable for proper and sustainable landscape management and planning at all scale levels.

Keywords: multi-scale soil-landscape maps, General System Theory, General Theory of Classification

DEVELOPING OF A NEW FOREST LANDSCAPE ON DEGRADED COAL MINE HABITATS IN A DRY TROPICAL ENVIRONMENT, INDIA: A CASE STUDY

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Developing young forest landscape on any degraded ecosystems can play a significant role in mitigating the effect of global climate change. Present study was conducted on a degraded landscape of coal mine in a dry tropical region of India where mining is one of the serious industrial activities destroying natural forest landscape into degraded habitats. We selected sixteen plantation sites as a total in different ecological models (mono- and mixed culture) for assessing plant diversity (biodiversity establishment under planted woody species) and efficiency for ecological restoration of degraded landscape into forest landscape. Twelve plantation stands selected as mono-cultured and four (*1: Albizia lebbeck + Acacia catechu, 2: Azadirachta indica + Phyllanthes emblica, 3: Dalbergia sissoo + Tectona grandis and 4: Dendrocalamus strictus + Tectona grandis)* were selected as mixed cultured. Of which, eight woody species were indigenous, and in which, four of them (*Albizia lebbeck, Pongamia pinnata, Dalbergia sissoo, Albizia procera*) were leguminous tree and short stature in size; and four (*Azadirachta indica*, *Tectona grandis, Dendrocalamus strictus and Shorea robusta*) were non-leguminous. While remaining four woody species (*Acacia auriculiformis*, *Casuarina equisetifolia*, *Eucalyptus hybrid* and *Gravillea pteridifolia*) were exotic in nature.

Results indicated that influence of planted species under both models were significantly influenced ecosystem development with increasing plantation age. However, recruitment of biodiversity development among plantation stands was not so effective with time, origin and combination due to several reasons. However, in comparison to mono-culture plantation stands, mixed culture either legume or non-legume combination showed a strong tendency for ecological restoration and plant diversity development that could be better option to restructure degraded habitats into a desired forest landscape.

Keywords: Ecological restoration, Species recruitment, Native, Carbon, Landscape

LANDSCAPE APPROACH IN THE EVALUATION OF POLLINATION SERVICES IN THE POST MINING AREAS – A CASE STUDY OF ADAMÓW-KOŹMIN OPEN PIT LIGNITE MINE

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Undoubtedly, one of the largest human impact on the environment is opencast mining. Although the negative impacts of coal mining prevail, it is also possible to indicate positive effects. One of them is to increase the pollination potential, which is the result of the land reclamation method adopted in Poland. Dry grasslands and young pine forests have a huge potential as nesting resources, and arable land often sown with melliferous plants are a great foraging areas for bees. The authors proposed a new proximity index measuring the potential for pollination at the landscape level. It considers: the area of nesting resources and its potential for pollinators, areas of floral resources located within 600 m from nesting habitats and their potential for pollination and the mean distance between nesting and floral resources. The study results can be used by mine administrations planning ways of reclamation, beekeepers when choosing a place for apiaries and farmers who plan the structure of sowings. This study shows that landscape approach can and should be used in the mapping and assessmment of ecosystem services. It also gives methodology to use ecosystem services concept in Environmental Impact Assessment. The condition is also to investigate other ecosystem services with consideration to tradeoffs and synergies among them.

Keywords: pollination, ecosystem services, open pit, reclamation, land use changes, landscape metrics

IS THERE ANY RELATIONSHIP BETWEEN LONG-TERM LAND COVER CHANGES IN MILITARY TRAINING AREAS AND PRESENT NATURAL BIOTOPES? CASE STUDIES FROM THE CZECH REPUBLIC

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Military training areas (MTAs) have been created for military purposes. Often, they have been established in areas with no or sparse settlement. However, there are some cases where the landscape before establishment of MTAs was quite densely settled and used for agricultural purposes. Afterwards the landscapes were abandoned resulting into the slow tree succession[1]. Since only small parts of MTAs are usually used for intensive military training, many parts can contain valuable preserved historical landscape structures that can play an important role as biodiversity hotspots[2]. The study analyses potential relationship between long-term (190 years) land cover changes and present natural biotopes in five military training areas in the Czech Republic. Long-term land cover changes were assessed with the help of old topographic military maps and present ortophotos. Present natural biotopes were based on a digital layer of biotope mapping in the Czech Republic, which was created when the network of NATURA 2000 sites was established[3]. In particular, we studied whether present natural biotopes have any relationship with the length of continuity of respective land cover class (permanent grassland, forest, water area).

In total, nearly 55 % of the MTAs selected land cover classes did not change at all during the researched period (1836-2015). Out of these, only 28 % were represented by unique natural biotopes or their mosaic. Forests were dominant stable land cover category (92 % of the non-changed plots); however the two thirds of these plots are nowadays covered by habitats strongly influenced or created by man. In case of permanent grassland, where the stable/non-changed plots represented nearly 8 % of all non-changed plots, natural habitats prevailed – 56 % were covered by them with more than 30 % of so called pure grasslands (meadows & pastures – T1, nardus grasslands – T2, dry grasslands – T3, sand and shallow soil grasslands – T5). For water areas and related habitats (wetlands and riverine vegetation) the proportions of stable plots are similar to those of grasslands – 93 % of non-changed plots are covered by natural habitats.

To conclude, we can say that even though studied MTAs display quite a lot of plots where land cover has not changed during the past 190 years, majority of these plots do not host nautral habitats. It is mainly due to the fact that these non-changed/stable plots are predominantly represented by regularly managed forests, namely spruce and other coniferous plantations.

Keywords: military training areas, landscape changes, natural biotopes, biotope mapping, managet biotopes

A GRAPH-BASED APPROACH FOR ASSESSING LANDSCAPE ECOLOGICAL IMPACTS OF A HIGHWAY PROJECT: FROM MODELLING TO PUBLIC RECEPTION

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The development of new urban areas and linear transport infrastructure leads to an increase in road traffic and a gradual artificialization of the territory, resulting in a reduction in the ecological connectivity of animal species. Preserving ecological connectivity is essential to maintain the movement of animal species between their habitats, as its reduction can lead to a significant reduction in biodiversity. Since the 2000s, landscape graphs have been used to model the ecological networks of animal species as landscape graphs. This method allows quantifying connectivity using spatial metrics. Some studies are based on a prospective approach to assess the potential impact of different land-use planning scenarios such as the construction of a new highway or the development of new residential areas. These studies focus on the overall impacts of urban developments or major transport infrastructure at the scale of a territory (by global connectivity metrics) or habitat patches (by local metrics). However, few studies attempt to spatialize the potential connectivity of several animal species at any point in the territory. Based on these observations, our work aims to address two main questions:

- How to assess the ecological impact of a new highway using landscape graphs for several animal species?
- How can these results be spatially represented to make them explicit for the scientific community, local stakeholders and the general public?

The study area is a 60 km linear zone encompassing the two cities of Lyon and Saint-Étienne (France). The study area includes the A45 highway project, which will create a new communication route between these two cities. The first step of this work was to select focal species. For this purpose, we have created fourteen groups of virtual species, representative of their environments. The second step aims at creating a landscape graph for each of the virtual species groups in its current state, and after construction of the highway. The third step aims at measuring the loss of ecological connectivity using connectivity metrics, before and after construction of the highway, for each group of virtual species. Landscape graphs are the basis for calculating connectivity metrics for ecological habitats at several levels: for the entire graph (global connectivity), for each patch of the graph (local connectivity), or for each point in the study area (interpolation of local metrics).

The highway project impacts on the overall connectivity of the study area are generally rather small but differentiated according to the functional characteristics of the different species groups. In addition to the observed break of ecological connectivity induced by the highway we show that its impacts can be very high, even in areas remote from the highway. In addition, we propose a multi-species approach based on a combination of maps for the fourteen species groups. By taking for each point on the map the highest ecological impact of each group of

species, we propose a summary map of the various impacts. Finally, these maps have been presented and discussed in the form of workshops at a local meeting against the highway project in the Saint-Étienne region. The comments and remarks of the visitors allowed us to showing the interest of spatializing ecological impacts in the form of maps, collecting different suggestions for presenting these results in new cartographic forms so that this work can be used as a decision-making tool, both for local planners and for opponents of the A45 highway project.

Keywords: Lyon, Saint-Étinne, result presentation, highway, impact

DIVERSITY OF THE EPIGEIC SPIDER COMMUNITIES IN THE TYPICAL HABITATS OF SAND DUNES IN ZÁHORIE

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The Záhorie region, located on aeolian quartz sands, is one of the most important areas in Slovakia for conservation of inland sand dunes and dry heaths, which are among the most endangered natural ecosystems in the Central Europe. These European priority habitats are listed in Annex 1 to Council Directive No. 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (Habitats Directive). They represent unique habitats for many rare plant and animal species including also number of very specialized psammophilous species. However, the total area of these habitats in Záhorie, as well as in all Slovakia, has been dramatically reduced mainly by human interventions (afforestation, land reclamation, abandonment of traditional land uses, etc.). These activities have caused dramatic changes in landscape coverage, in habitat composition and in biodiversity as well.

For evaluation of these influences on biodiversity we have investigated the diversity of the epigeic spider communities on three localities (Plavecké Podhradie, Lakšárska Nová Ves and Sekule) and on 16 study sites during one year (from 4 April 2017 to 5 April 2018). For research we used methods of pitfall traps. Selected investigated study sites present typical natural or semi-natural habitats which were chosen as characteristic for the Záhorie region with different human interventions. From a structural perspective they represent moving inland sand dunes, dry heaths, meadows in oak forests, oak forests, monoculture pine forests, mixed oak-pine forests, birch-alder forests and meadow band in forests for fire prevention. During one year research 6,730 spider specimens belonging to 206 species were captured. Of the identified species, 22 species are listed in the Slovakian Spider Red list as threatened and 15 species as potentially threatened. We have evaluated species richness, sozological aspect, composition and diversity of the studied communities and according these criteria we were categorized the spider communities in evaluated habitat types. This study was supported by the Slovak Scientific Grant Agency VEGA 2/0171/16.

Keywords: sand dunes, the region Záhorie, epigeic spiders

THE GREY HERON AS AN ENGINEERING SPECIES – HOW DOES IT INFLUENCE SEED GERMINATION SEEDLING RECRUITMENT AND THE STRUCTURE OF SOIL SEED BANK OF DIFFERENT FOREST COMMUNITIES?

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Colonially nesting Grey Heron (*Ardea cinerea* L.) is a good example of engineering species (definition according to Jones et al., 1994, 1997) which modifies soil properties under the heronries. Alterations of soil properties by deposition of guano, dropped or regurgitated food, egg shells, feathers etc. as well as direct damage of tree branches generate stressful conditions for trees and shrubs and often increase their mortality. Quantitative changes in tree and shrub layer as well as eutrophication of soil influence strongly the structure of forest floor. The most striking result is the enhancement of cover and diversity of eutrophic, light demanding ruderal species. The most probable seed source of these species are anthropogenic habitats adjacent to forest patches. Protection of nesting sites of Grey Heron is a good example of prioritization of flagship bird species conservation over the long-term survival of other populations. Such a conservation conflict was previously described by Fedriani et al. (2017) and the strong influence of engineering bird species on other sensitive ones should be taken into account during preparation of complex restoration programs.

The main goal of the study was to assess the structure of the soil seed bank and seedling fate in two types of microhabitats (nesting sites and control plots) in two contrasting forest types: suboceanic pine forest *Leucobryo-Pinetum* W. Mat. (1963) W. Mat. et. J. Mat. 1973 and degenerated form of riparian forest *Ficario-Ulmetum minoris* Knap 1942 em. J. Mat. 1976. Both are located in Eastern Poland in the close vicinity of river valleys (the Wieprz River for pine forest and the Bug River for riparian forest) which serves as foraging sites for the birds. Identified colonies within those forests had approximately 70 and 90 nests, respectively. The quantitative and qualitative structure of the seed bank was assessed with the use of seedling emergence method (number of seedlings, ecological spectrum, light and trophy requirements, seed size and seed bank type of species present in the seed bank).

The potential seedling fate after germination in two corresponding microhabitats in each forest type was evaluated by comparing their mean dry seed weight and relative growth rate values.

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Keywords: grey heron (*Ardea cinerea*), seedling fate, suboceanic pine forest, riparian forest, mean dry seed weight, relative growth rate

SIGNIFICANCE OF ARTIFICIAL DITCHES FOR MAINTAINING OF PHYTODIVERSITY IN THE LOWLAND AGRICULTURE LANDSCAPE

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Drainage artificial ditches represents important elements in intensively managed agricultural lowland landscape. In Slovakia, there are 6450 drainage artificial ditches with total length 5 844 km draining 460 thousand hectares. In addition to their primary function, they are potentially significant according to biodiversity as they are in majority cases the islands amidst arable land. There are not many scientific works dealing with biodiversity of ditches but much less evaluating biodiversity of ditches banks.

The studied ditches are situated in the Podunajská nížina (6) and Východoslovenská nížina lowlands (7) as these regions were most affected by building of ditches. Wide spectrum of habitats (15) including 6 NATURA 2000, 3 habitats of national importance and 4 ruderal habitats have been found here, developed in a various state. 23 taxa listed in the Red list of ferns and flowering plants of Slovakia (sensu Eliáš et al., 2015) including *Lathyrus palustris, Nymphaea alba* and *Nuphar lutea* belonging to the vulnerable IUCN category. On the other hand, artificial ditches provide suitable conditions for occurrence and migration of the invasive neophytes. 14 taxa have been found here in compliance with the actual list of alien Slovak flora distributed in tree, shrub and herb layer often with high abundances – up to 90 %. Summarily, habitats of the artificial drainage ditches increase significantly diversity of vascular plants within the investigated lowlands, however, often at the cost of strengthening migration corridors of alien taxa, especially invasive neophytes. The contribution was performed within the Grant project APVV 0735/14.

Keywords: artificial ditches, Slovakia, lowlands, importance, plant diversity

HIDDEN BENEFITS OF THE SLOVAKIAN AGRICULTURAL LANDSCAPE IN SOCIO-ECOLOGICAL CONTEXT

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Agricultural landscape provides multiple benefits to the quality of human life, except the most apparent provisioning services there are other "hidden" elements, i.e. ecological and cultural benefits.

Our contribution aims to identify the agricultural areas in Slovakia with high and low potential to generate such hidden benefits and to make a link to available sustainability indicators which can directly or indirectly reflect quality of life.

Selection of hidden benefits to be further evaluated was based on the previous research of the ecosystem services assessment in Slovakia by group of 18 national experts. They judged capacity of different Corine Land Cover (CLC) types to provide 14 individual ecosystem services within a geographical context of the Slovakia. Considering regulating and cultural services, "recreation", "biodiversity" and "flood protection" were ranked as three the most important ones for human wellbeing. We assessed their potential across main classes of the CLC in Slovakia – arable land, meadows and pastures and complex cultivation patterns – resulting to calculated an areal capacity index for the agricultural land. At the same time we identified social, economic and environmental indicators that were available at required level of detail, e.g. the net migration rate, ageing index, average wages of employees, emissions of particulates, etc. This data was overlaid on the above mentioned areal capacity index of the hidden benefits. Modelling was performed at spatial scale of NUTS4 (LAU1), which means 79 districts of Slovakia and reflected the socio-ecological data from 2015-2017.

It is obvious that quality of the agricultural areas in regard to particular benefits is strongly pre-conditioned by abiotic conditions. However, how the land is used is also strongly influenced by conditions set up by national funding and regulatory schemes, especially the Common Agricultural Policy, and by local context due to specific historical development and different socio-economic factors. Based on research results we can conclude that high potential areas for hidden benefits are mostly not indicated as sustainable areas for local people, or those having positive development trend, in respect to the assessed indicators. We argue that despite results for each region must be considered specifically, the quality of life is much shaped by marginal role of farming as a source of income and way of lifestyle, which is mainly driven by the recent agricultural policy. In other words, landscape workers producing public goods, being consumed by local residents and visitors too, are not sufficiently rewarded.

Keywords: agricultural landscape, ecosystem services, hidden benefits, agricultural policy

IMPACT OF ROAD INVESTMENTS ON BIOTA OF AGRICULTURAL LANDSCAPE OF EAST POLAND

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Intensive development of road infrastructure has recently taken place in Poland. This process is accompanied by a comprehensive road investment programs. Studies on the impact of road investments on biota of agricultural landscape were conducted during 2011-2016. Examination comprised regular studies on the areas of individual investment such as 3 expressways and 2 provincial roads with a total length of around 100km. It was found that the most common forms of the impact of road investments on biotas were damage and deforestation of trees and shrubs during the breeding period of birds as well as direct destruction of birds' nests. The cases of heavy equipment passing over protected species including amphibians and reptiles were also reported. The last ones were exposed to danger due to the destruction of fences preventing their penetration into investment areas. Another group of impacts of road investments on biotas related to emissions of harmful substances including leaching of petroleum substances or getting the construction materials into the environment as a result of their erosion. Cases of intentional waste stockpiling at the investment site, including substances hazardous for the environment were reported. In addition, resource bases were located directly next to the habitats of protected species. Cases of air dust generated by the work and movement of heavy equipment were also observed.

Keywords: road infrastructure, Poland, biota, road investment, impact

DEVELOPMENT OF LUBLIN COAL BASIN AS THE THREAT TO PROTECTED AREAS OF POLESIE ZACHODNIE (EAST POLAND)

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Marshes of Polesie Zachodnie (East Poland) belong to the most valuable natural areas of Europe due to the presence of many species of wetland's plants and animals. Unfortunately, a significant part of these areas during the communist period in Poland was drained, including the largest peat bog in Central Europe - "Krowie Bagno". Changes in water conditions in Polesie Zachodnie, on the one hand, resulted from the construction of a canal connecting the Wieprz and Krzna rivers, and on the other hand from the establishment of Lublin Coal Basin. In addition, some marshes were dried in the hope of using them for agricultural purposes. Unfortunately, despite the political changes in Poland and the binding of liberal democracy for nearly 20 years, the concept of constructing several coal mines in Western Polesie has returned. They may very seriously disrupt water storage and regulation at protected areas such as West Polesie Transboundary Biosphere Reserve, Polesie National Park and Natura 2000 areas. The above solutions will degrade habitats of valuable species, including, Aquatic Warbler *Acrocephalus paludicola* - the rarest migratory bird of Europe, as example.

Keywords: Polesie Zachodnie, marshes, coal mines, habitat degradation

WILDLIFE CORRIDORS IN THE BESKYDY MTS. AND THE BARRIER EFFECT OF TRANSPORT INFRASTRUCTURE. LESSONS LEARNED IN THE TRANSGREEN PROJECT

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The Carpathian Mountains belongs to most preserved landscapes and naturally unique areas in Europe. However, the growing transport infrastructure and the traffic intensities bring the immediate risk of landscape fragmentation and threat to the natural wealth of the Carpathians. Solutions for such infrastructure development which will have a minimal impact on local nature is main goal of the ongoing international project TRANSGREEN - Integrated Transport and Green Infrastructure Planning in the Danube-Carpathian Region for the Benefit of People and Nature. Within the Czech Republic and Slovakia, the project has one of its model areas in the cross-border region of Beskydy-Kysuce.

The centuries of anthropogenic activities in Beskydy area, concentrated in the favourable position in deep river valleys, developed specific linear type of settlement. Complicated orography also predetermined the best routes for transport networks, so in these valleys the multiple linear barriers were created, increasing the level of fragmentation for several terrestrial species. Only a few last corridors left to allow migration of fragmentation sensitive, migratory behaviour dependent, species such as the brown bear (*Ursus arctos*), the wolf (*Canis lupus*) and the European lynx (*Lynx lynx*).

To better understand impacts of existing transport infrastructure on ecosystems and these conflict points several field activities were undertaken:

- Assessment of the migration potential of the existing transport infrastructure for wildlife in the whole model area and its surroundings - detailed inspection and inventory of all existing passages from the 5 m wide on highways and 1st class roads and selected 2nd class roads and main railway corridors.
- Evaluation of the permeability of the road network for the migration of wildlife at selected conflict points - measurements of traffic intensities and evaluation of characteristics of the traffic flow with respect to the road's permeability for animals
- Monitoring the use of underpasses and animal passages - installation and control of phototraps on selected overpasses and underpasses
- Tracking of large carnivore population - focusing on the lynx to determine the size of the population in the area of interest, information on the movement of individuals and their territorial claims
- Monitoring the mortality of animals on the roads / railways - monitoring the mortality of animals (vertebrates) on selected sections of transport infrastructure - spatial database with findings of animal mortality in the pilot area and identification of "hot-spots" with frequent cases of animal collision with vehicles

The results of monitoring activities confirmed the original expectation, that the worst permeability can be expected for the 1st class roads included in the European system. These roads are hardly permeable in the day-time and only in the night wildlife has a chance to

cross the road. However, the higher intensity generates greater risk of vehicle-animal collision, so animal mortality is significantly higher on these roads than on 2nd class roads. Within the framework of the planned construction of fences along the 1st class roads, it is always necessary to maintain the permeability of the road for the animals (underpass/overpass). Fencing along the entire length of road converts it into absolute barrier to the free movement of wildlife.

These results will be used in major outputs of Transgreen project, including the Methodological Guide to Harmonization of Green and Transport Infrastructure in the Carpathians and the draft of Strategic Action Plan for the Sustainable Transport Protocol in the Carpathians, developed under the Carpathian Convention.

Keywords: Beskydy Mts., infrastructure, wildlife, permeability

MOTORWAYS AS A CHANCE FOR NATURE? IMPROVING THE BIODIVERSITY ALONG ROAD NETWORKS USING THE INTRODUCTION OF PARASITIC PLANTS

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Over the past century, road networks have largely expanded over urban and rural areas, and have strongly contributed to landscape structure changes and biodiversity loss. For instance, it is well known that the construction of roads has led to the loss and fragmentation of semi-natural habitats and that their utilization increases the mortality rate of many animal populations. On the other hand, it is not only the length of roads that have increased but also the road verges length. Nowadays, the area covered by these linear herbaceous elements is relatively large. For example, in the Czech Republic even highway verges reached near 90 km^2. In addition, due to their web like structure throughout Europe, the road verges support a conectivity between habitats at several spatial scales. Then, they may represent a favourable habitat and/or corridor for many plants and invertebrates, given appropriate management practices. However, as a result of the use of species-poor grassy seed mixture, road verges are usually dominated by few competitive grass species, producing large volume of biomass every year. Since the edges of roads, especially those with strong traffic, have to be clearly visible, the costs of regular cutting are as high as the biological value of such sward is low. More recently, a biological method based on the introduction of hemiparasitic plants has proved to be a valuable tool both to decrease plant community productivity and facilitate diversification of grassland habitats. In addition, this measure can also benefit other trophic levels such as pollinator insects.

We assessed the effect of a hemiparasitic plant able to grow in most grassland types: *Rhinanthus alectorolophus*, on plants' and invertebrates' communities of species-poor grassy road verges in the Czech Republic. Hence we selected ten experimental sites along major roads and highways for seed sowing and established pairs of plots (seeded with *Rhinanthus* and control). The first two years of sampling indicate that *Rhinanthus* had a suppressive effect on dominant grass species, reduced total biomass and supported forbs against grasses. Moreover, the abundance of some bumblebees directly increased on *Rhinanthus* plots, whereas vegetation changes influenced both bumblebees' and butterflies' abundance. Furthermore, we found various responses of other invertebrates' taxa distribution to changes in vegetation structure. Finally, given these positive effects of *Rhinanthus* on biodiversity, we developed a technology for seed production that gave us good prospects for the commercialization of seeds at a low price compared to the current cost of seeds in European markets. Based on this study, we suggest that the introduction of parasitic plants along road networks could provide an interesting avenue for biological conservation at the landscape scale.

Keywords: road verges, *Rhinanthus alectorolophus*, diversity, abundance, technology for seed production

ENVIRONMENTAL APPROACHES TO SUSTAINABLE URBAN DEVELOPMENT: AN OVERVIEW

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Urban development stands as one of the most urgent challenges that society faces nowadays. Vast pressures on the environment are caused by global socio-economic trends and unsustainable land and natural resources management. Yet, science has long ago recognized the importance of well-functioning biosphere to humanity. The concept of sustainability aims at restoring the balance between the human activities and the natural environment.

Urban environment (represented most visibly by large cities) is a socio-ecological system that accommodates a complexity of interactions. Sustainable urban development (SUD) integrates three main aspects: environmental, social and economic – hence, adequate quality of the environment became an inevitable predisposition for the SUD and for the wellbeing in cities. Recognition of the manifold ecosystem benefits of the environmentally-friendly management approaches and its importance to society have led to their integration into the development plans and are high on political urban agendas today. Ecosystem services, including those generated by urban nature, could be seen as the mainstream conception in this context.

However, there is an ongoing debate about appropriate sustainability measures referring to the quality of the urban environment. The number of measures applying different approaches and principles are tested in cities around the world. Nature-based solutions (NBS) and green infrastructure (GI) are one of such environmental measures, whereas climate change and ecosystems are the topics in focus. This is also the case of a few municipalities in Slovakia. Generally, these approaches are concerned e.g. about the size of green areas, their spatial distribution, ecological quality and connectivity, but also their usability and accessibility to the citizens. Specific measures are then proposed (and desirably also applied) to improve the climatic and environmental conditions in a given city or region.

The main objective of our research, to be introduced in the presentation, is developing a methodology capable of assessing the levels of SUD in Slovakian cities. Although the SUD is understood holistically in our approach, the prioritized topic is climate change and its adverse impacts. Environmental aspects like the air and water quality, biodiversity and green areas, environmental risks and security, but also human activities as a manufacturing, transport or recreation will act as sustainability indicators. The final methodological design attempts to improve trends in environmental politics by setting the adequate priorities, objectives, and measures of SUD. Desirably, introduced approach and proposed measures will be useful in modern urban planning process.

Keywords: sustainable urban development, Slovakia, methodology, Nature-based solutions, green infrastructure

URBAN BIODIVERSITY UNDER OF GLOBAL TRENDS AND DRIVERS – A COMPARATIVE STUDY OF URBAN PARKS IN POZNAŃ (POLAND) AND SALZBURG (AUSTRIA)

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Research on the biodiversity of urban parks has been carried out. The aim of the study was to compare the species richness and plant diversity of the spontaneous vascular flora in different climatic conditions. Two parks were mapped in Salzburg and 2 in Poznań. In both cities the average annual temperatures are equal (Poznań 8.7^{0}C, Salzburg 8.9^{0}C) but the average annual precipitation are different (Poznań 517 mm, in Salzburg 1 190 mm). Parks were similar in terms of: genesis, greenery composition and spatial and functional organization. The flora of 40 plots was mapped in 2017; 10 plots/park, each plot 500 m^2. Data about garden architecture and park management were recorded. The flora structure was analyzed in terms of the richness and plant diversity, synanthropization, and nature values. Biodiversity indicators were taken into account, among others: taxonomic and syntaxonomic rank, Raunkiaer's life form, geographical element, oceanizm index, geographical-historical status, and ancient woodland plants. The flora of Salzburg's parks was characterized by species richness (Salzburg 160 from 37 families, Poznań 150 from 27), and greater share of: native plants (S 137, P 106), phanerophytes (S 39, P 22), characteristic species from *Molinio-Arrhenatheretea* (S 43, P 28) and *Querco-Fagetea* (S 31, P 6), ancient woodland plant species (S 12, P 5) and oceanic elements (S 121, P 93). The flora of Poznań's parks was marked by the high anthropophytization index (P 29%, S 14%), and the greater role of: terophytes (P 51, S 26), synanthropic plants (P 44, S 23), continental (P19, S 10) and neutral to oceanizm (P 38, S 29) elements, and species from *Stellarietea mediae* (P 35, S 15), *Festuco-Brometea* (P 8, S 1) and *Koelerio-Corynephoretea* (P 7). The floras reflected: the climate (perhumid in Salzburg, humid with the semiarid seasons in Poznań), and methods of green care.

Keywords: biodiversity, urban parks, flora, Poznań, Salzburg, species richness

URBAN LANDSCAPES IN TRANSITION: MARKET VERSUS PLANNING IN THE CITY OF TBILISI, GEORGIA

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Over a couple of decades Tbilisi, the capital metropolis of Georgia, like many other post-Socialist cities, underwent a process of 'Multiple Transformations' (see Sýkora & Bouzarovski, 2011, Multiple Transformations: Conceptualising the Post-communist Urban Transition, Urban Studies, 49, p. 46). This process, along with cardinal legislative, institutional and socio-spatial changes, has been manifested in the significant transformation of Tbilisi's environment, both built and natural. The internal structures and urban forms of the city were strongly affected by (neo-) liberal policies - privatization of real estate and land parcels along with the extreme deregulation and commercialization of construction and development businesses. This process dramatically changed many urban neighbourhoods, cityscapes, and strongly influenced the social composition and cultural traits of the population. New building developments became the leading drivers of spatial growth and, in many cases, territorial sprawl. Meantime, production of the huge amount of new constructions, foremost housing spaces, didn't solve a problem of low life standard, housing affordability, homelessness, and urban poverty. Furthermore, new urban environmental challenges have occurred with private appropriation and reduction of public open spaces and green areas, while growing individualization of mobility patterns (use of private cars) and transportation modes added to ecological problems which always existed in big cities. Urban spatial planning has lost its former importance and often fell under influence of commercial and political interests.

The purpose of this presentation, which is based on several academic studies/publications undertaken by the author during last decade, is to identify and illustrate how Tbilisi's urban landscapes and environment could benefit from shifting from contradiction and confrontation between city planning and market forces to their synergetic interplay, supported by good governance.

Keywords: Tbilisi, post-socialist changes, benefits, urban planning

URBANIZATION AND SETTLEMENTS DEVELOPMENT- THE IMPACT ON LANDSCAPE

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Urbanization and settlements development are modern day facts of life. Today's cities must compete with one another to attract capital. To do so, many local authorities offer attractive financial incentives in addition to essential practical ones, such as well-functioning infrastructure and urban services, communications systems, efficient transport, sufficient housing and access to educational and recreational facilities.

Against a background of rapid social and economic development, urbanization has become a significant worldwide phenomenon. Global urbanization was less than 20% in 1990 but exceeded 50% by 2008, with no sign that this process will slow down in the near future.

Landscape patterns, including landscape composition and configuration, affect ecological processes. Landscape patterns are increasingly influenced by urbanization, resulting in a landscape mosaic of natural and managed patches varying in size, shape, and arrangement. For example, urbanization has aggressively consumed cropland, leading to poor land use structure and serious problems threatening ecosystem services wellbeing. Therefore, exploring the effects of urbanization on landscape patterns is of great importance to regional sustainable development.

Landscape patterns are complex, and different methods have been developed to elucidate, manage, and predict their changes.

Areas of built-up land expands, mainly through the conversion of cropland. Landscape patterns in low mountain sub-region and high mountain sub-region are more heterogeneous and fragmented over time, but they become homogenous and connected in the plain. Urbanization is significantly correlated with landscape patterns in the plain and also shows the same sign with landscape connectivity in the low mountain sub-regions.

We explored the process of urbanization to seek a sustainable urbanization strategy, and also checked its effects and impact on landscape.

But there was little correlation across regions in the high mountain sub-regions. To avoid the compromise of future development there should be strict laws to limit the loss of cropland during urbanization, and appropriate industries and tourism projects should be introduced.

Keywords: urbanization, landscape patterns

PRACTICAL ASSESSMENTS OF BIODIVERSITY AND HABITAT SERVICES IN CITIES – COMPARATIVE STUDIES/RESULTS FROM DRESDEN (GERMANY) AND LIBEREC (CZECH REPUBLIC)

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The sustainable supply of many ecosystem goods and services largely depends on maintaining biodiversity at a favorable conservation status. On the other hand, biodiversity itself can be considered as a result of ecosystem services, e.g. the habitat service (i.e. the capacity or the service to provide suitable living spaces and living conditions for plants and animals), which can be classified as a regulating, a supporting, or as an intermediate service, belonging to the group of "Lifecycle maintenance, habitat and gene pool protection" in the CICES classification of ecosystem services.

The choice of suitable biodiversity and habitat services assessment methods for practical purposes in city planning and decision-making is still a challenging problem. Data availability, personnel and monetary resources are crucial as well as the specific tasks to be solved, e.g. nature conservation (protection of species, habitats, areas), compensation and replacement measures, land use and landscape planning. A wide variety of methods and approaches was described in literature or used in case studies. But only few methods are actually applied under practical conditions in city administrations.

We show a bundle of methods which are presently applied or could be included into a practical methodical toolkit without major difficulties. The analyses have been performed in the framework of the current EU project BIDELIN (The value of ecosystem services, biodiversity and blue-green infrastructures in cities, exemplified by Dresden, Liberec and Děčín). We classify the methods according to their complexity, starting from the direct counting and mapping of species and ecosystems to rather complex, integrated approaches such as the degree of naturalness, the Habitat Valuation Method, the Global Biodiversity Model (GLOBIO) and monetary methods like valuation based on restoration costs. We show advantages and problems of methods, and we discuss necessities, chances and limitations for broadening the toolkit.

Keywords: biodiversity, ecosystem services, methods, analyses

ANALYSIS OF AIRBORNE THERMAL IMAGES IN RELATION TO DIFFERENT URBAN STRUCTURES AND LAND USES OF GRAZ

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Urban areas are heavily modified in terms of surface temperatures (UHI: Urban Heat Island) relative to their rural environment. By means of airborne or satellite-based Earth observation, it is possible to find out changes in radiation and energy flux densities in the mesoclimate of the city.

Land cover utilization and sealing aspects play a significant role in the modification of surface temperatures in a city. In the present work, both the surface temperature data, derived from the thermal scanner surveys of the years 1986, 2004 and 2011, as well as different city structure patterns of the Graz of individual years, were summarized in a geodatabase. With this GIS-based information, it is possible to analyze the thermal behavior, as well as the temporal and spatial distribution patterns of the surface temperatures in urban structures. Thus, functional relationships can be worked out. In addition to the description of the climatological features of the Graz urban area, a part of the paper is dedicated to the data preparation and methodology development, following by the analysis of results based primarily on statistical evaluations.

After successful creation of the database, the results show different surface distribution patterns. Most of these correlate with the degree of sealing, especially at lunchtime. The specific thermal characteristic varies depending on the land cover and land use distribution, resulting in an increased thermal loaded area can be elaborated. Predominantly the foundation area´s courtyards show higher temperatures connected with an increasing degree of sealing.

Keywords: database, surface temperature, urban area, methodology

THE EFFECTS OF LANDSCAPE STRUCTURES AND BIODIVERSITY ON ECOSYSTEM SERVICES

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Everyone in the world depends on biodiversity thus the variant of animal life and plant in the world or in a particular habitat.

The benefits that people receive from Biodiversity, depends on the movement of organisms and matter across landscapes, as well as the biodiversity and ecosystem functions that are present.

Human activities around the world are rapidly and significantly changing landscapes and biodiversity. This is particularly true in agricultural systems, where human activities to maximize the ecosystem service of food production often lead to the decline of other important ecosystem services. While we understand that biodiversity is critical to human well-being, our current knowledge of the provision of services across landscapes contains a number of significant gaps that limit our ability to manage for services and human well-being. In particular, we don't fully understand how changes in landscape structure the composition and configuration of land use types affect the provision of multiple biodiversity services.

In this thesis, I explore the theoretical and empirical relationships between landscape structures, and biodiversity.

I first reviewed our current understanding of these links, finding that while we commonly assume that loss of connectivity between habitat patches in a landscape will have negative effects on biodiversity service provision, we have little empirical evidence that this is the case. In particular, we know little about how this landscape connectivity might simultaneously affect multiple biodiversity services, especially for services other than food, pollination, and pest regulation.

Overall, my thesis indicates that understanding the connections between landscape structure, biodiversity, and ecosystem service provision will be a critical avenue of research, one that will improve our ability to design multi-functional human-dominated landscapes. Only by understanding how human activities and land use change affect ecosystem services can we generate management tools to maximize multiple ecosystem services at landscape scales. As human demand for biodiversity services and our impacts on natural systems continue to rise, this will be an increasingly important knowledge gap to fill.

Keywords: landscape structures, biodiversity

ASSESSMENT OF PROGRESS IN PARTICIPATORY PROCESSES IN ELABORATION OF THE CONCEPTIONS FOR DEVELOPMENT OF URBAN FORESTS IN BRATISLAVA, CAPITAL OF SLOVAKIA (PERIOD 1955-2018)

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The urban forests in Bratislava in the last 60 years have significantly influenced societal changes and changes in ownership relations (forest ownership after 1945 and reprivatization of forests after 1990), adoption of conceptual documents and legislation, establishment of the municipal organization forests in Bratislava (1st July 1994) as well as activities and initiatives of conservationists, civic associations and the local community. The main objective of the paper is to assess the progress in participatory processes and initiatives in Bratislava, the capital of the Slovak Republic, which have contributed to implementation sustainable principles to the management and governance of the urban forests in Bratislava in the years 1955-2018 with outlook to the year 2025. We present an analysis of tens activities and outputs (strategic documents, policies, projects, experts´ evaluations, civic initiatives, petitions and protests) which have been completed and implemented between the 1955-2018 years for the development of the urban forests in Bratislava. In the paper, we address the following scientific questions:

- To what extent the participatory processes, conservation and civic initiatives influenced the quality of conceptual documents approved for the management and use of urban forests in Bratislava and its surroundings during the period 1955 to 2018?
- Which participatory processes, conservation and civil activities between 1955 and 2018 can be considered as key milestones?
- To what extent are the current strategic documents for urban forests also taking into account the impact of climate change?

The relevant information about individual activities and outputs (as empirical material) were collected and assessed in the form of a timeline of the urban forests in Bratislava with identification of key "milestones". In the conclusions the intensity of influencing the participatory processes to quality of policy documents and decision-making processes was evaluated for selected important milestones. Case study of urban forests in Bratislava can contribute as an example of good practice and to share of positive experiences about public participation and stakeholders´ involvement in urban forests planning and management.

The paper was supported by the project Horizon2020 No. 653522: Climate Resilient Cities and Infrastructures (RESIN) and project VEGA No. 2/0013/17: The role of ecosystem services in support of landscape conservation under the global change.

Keywords: urban forest, Bratislava, sustainable management, participatory processes, activities

THE INFLUENCE OF SPATIAL DEVELOPMENT OF THE CITY ON THE AGRICULTURAL PRODUCTION SPACE, GORZÓW WLKP. CASE STUDY

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Within the urban fabric, apart from heavily invested parts, there are also areas used for food production. In Polish cities, this production takes place mainly on agricultural lands, allotment gardens and home gardens. Maintaining the agricultural production space in the city contributes to reducing the ecological footprint of the city and increasing circulative metabolism, which in turn fits into the concept of "resilient city". However, strong investment pressure on these areas and its favorable urban policy, as well as planning, legal and economic conditions, may affect the shrinkage of the urban agricultural production space.

We aimed to examine the directions of the agricultural production space changes within the city limits of the Gorzów Wielkopolski – the case study city and also to give an answer on the reasons for the changes. According to this we analyzed the dynamics of land use changes in Gorzów Wielkopolski in the period after political changes in Poland. For analyses we used statistical data and spatial data in various time sections.

Considering the fast pace of development in recent decades, which is also reflected in the acceleration of the spatial development of cities, we expect that the urban development of Gorzów takes place at the expense of the shrinking agricultural production space.

Keywords: urban agricultural production space, land use changes, urban development

IMPACTS OF UNCONTROLLED CONSTRUCTION OF SOLAR POWER PLANTS ON CZECH LANDSCAPE

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The aim of this contribution is to assess impact of construction of solar power plants on land use, ecological and economic damage to the land, potential of brownfield utilization for new solar power plants, and possibility of returning such used land to its original use. We focused predominantly on two aspects: 1) geographical distribution of solar power plants with respect to administrative units, physical-geographic characteristics and landscape typology, and 2) characteristics of occupied land, namely the proportion of soil types, soil quality, average yield and soil prices.

In 2015, a total of 1481 surface solar power plants were operated in the Czech Republic, covering 4120 ha, with an average size of 2.8 ha and the biggest size of 77 ha. The solar power plants were predominantly constructed on arable land (52 %), followed by permanent grassland (18 %). Solar power plants constructed at former brownfield sites were mostly at agricultural brownfields (10 %) and industrial brownfields (8 %). Not very high percentage of transformation of brownfields to solar power plants was caused by tight deadline to construct and operationalize them and therefore by the lack of time to negotiate with brownfields' owners.

Occupied land covered predominantly chernozems (24 %), cambisols (18 %) and pseudogleys (17 %). In term of profitability, very low production (27 %) and low production land (26 %) was used, reflecting at the same time the unsatisfactory state of soils threatened by soil erosion in large soil blocks. However, the proportion of highly productive soils (6 %) and very productive soils (6 %), which cannot serve agricultural purposes for at least 15 years, is significant.

Keywords: solar power plants, soil types, soil quality, impact

ECONOMIC EFFICIENCY OF LAND USE TO ENHANCE DEVELOPMENT

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A common phenomenon in developing countries is unplanned, and thus unexpected, urbanization mishaps. In most urbanized countries, opening of natural or agricultural land into built-up land is one of the major features of land use changes, predominantly in developing countries.

Efficiency of land use is influenced by economic, social and environment factors, so we must consider both environmental and economic performance. Our research constructs an integrated indicator evaluating efficiency of land use, using input and output data

First, the main input factors consist of land, capital, and labor for the differentiated land use efficiency, to achieve an output of development such as less crowding, appropriate land use for the right purposes to enhance economic boosters such as mining, farming and real estate.

Importance of land management saying, Land availability and the access to it are key factors in achieving economic growth and sustainable development. Land is a vital input for establishing the building blocks of any economic and social system, such as industrial, touristic, and commercial developments and other infrastructure projects which aim at providing social services such as housing, health care and education. In that respect, transparent and competitive land markets are considered a key factor in attracting investments".

Also, sustainable use of the soil is a form of land management which retains the natural fertility of the soil and allows the production of food and fibre supplies and renewable natural resources on a long-term basis. It implies that the natural environment should be treated and managed in such a way that the cycles and energy flows among the soil, bodies of water and atmosphere are preserved or restored.

In conclusion we empirically tested the dynamic trend of land use, efficient and differentiated land use can enhance the economy and also avoid mishaps as discussed above, categorizing lands and what it should be used brings economic improvement, without land management lands gets misused and he economy suffers.

Keywords: factors, land use, efficiency, sustainability, trend, economic improvement

Presented posters

Landscape structure changes and land-use- influence on biodiversity

RAPID AND DIVERSIFIED VEGETATION RECOVERY ALONG A HUGE-TSUNAMI DISTURBED COASTAL SAND-DUNE ECOTONE, SENDAI-BAY FRINGE, JAPAN

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Huge tsunami caused by the Great East Japan Earthquake on March 11, 2011 severely destroyed the fringe of Sendai Bay, northeast Honshu, Japan. In the present landscape ecological study, to clarify the resilience of vegetation against such catastrophic disturbance, we focused on the coastal sand-dune ecotone and carried out the multi-scale monitoring of vegetation dynamics since June 2011. Study site was set in Shinhama Coast (38°14.1′N, 140°59.5′E; ca. 550m in length and ca.700m in depth), and we distinguished six types of catenae (https://sites.google. com/site/ecotonesendai/); from seashore to interior floodplain, three main catenae that concerned in this presentation were, (1)sand-dune on the ocean side of seawall, which had been built and was restored along the ridge of sand-dune (ca. 80m in width at the post-tsunami period), (2)sand-dune on the interior side of seawall (ca. 220m in width) and (3)back-swamp behind the sand-dune (ca. 200m in width). Field investigations, such as floristic inventory, phytosociological survey, belt-transect mapping and census of woody species, were performed intermittently, together with remote sensing analyses. Our research revealed (1) that the presence of a total of 411 living vascular plant species until the end of 2013, including endangered species and alien/ruderal species, and (2) that the emergence of many symbolic vegetation patches, such as coastal sand-dune herbaceous plant communities, cohorts of *Pinus thunbergii* seedlings/saplings and *Phragmites australis*-dominated swamp communities, which coupled with heterogeneous specific micro-sites in each of catenae. (3) Numbers of native plants recovered from buried/drifted seeds and/or subterranean-organs since 2011, and most of them flourished and bore seeds under the sunny conditions. These results indicate that sources of autonomous vegetation recovery, namely biological legacy, remained and functioned even after the huge tsunami, and emphasize the necessity of wise-use under the integrated coastal management of the sand-dune ecotone.

Keywords: tsunami, vegetation, Sendai Bay, biological legacy, vegetation recovery

TREE-SPECIES COMPOSITION AND SEEDLING RECRUITMENT IN REMNANT FORESTS IN A TSUNAMI-INUNDATED AREA OF SENDAI, JAPAN

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Understanding resilience, species composition and other characteristics of remnant vegetation that survive large scale low-frequency disturbances such as tsunami is an important step in monitoring and managing the process of recovery. This research was implemented in a study area along the shores of Sendai Bay, a region that was heavily damaged by tsunami following the Great East Japan Earthquake of 2011. The purpose of the research is to clarify the tree species composition and process of recovery for a region heavily damaged by a low-frequency large-scale disturbance. Field surveys of all the remnant forest in the study area were conducted in 2014, 3 years after the disturbance. The research site was located along a section of low-lying coast between the mouths of the Nanakitagawa and Natorigawa Rivers on Sendai Bay in Miyagi Prefecture, in the Tohoku Region of northern Honshu Island. The dimensions of the study area are approximately 9 km in length and 2-3 km in width. The entire study area was inundated by the tsunami. A total of 202 patches of remnant forest were identified, and all of the tree species, including both canopy trees and newly established seedlings, were recorded for each patch. The identified trees totaled 88 species, which were classified into three indicator-species types by hierarchical cluster analysis. Comparisons based on species composition and similarity showed that resilience, species composition and other characteristics of the remnant patches was influenced by vegetation histories and other factors that only become visible at the regional landscape scale. For example, 7 of the 25 seedling species identified were not present in any of the canopy layers in the study area, indicating that they were dispersed from outside. The results show that despite the immense scale of the tsunami, many diverse patches of vegetation managed to survive the disturbance. These remnant forests function as seed sources, safe sites, and habitat and/or stepping stones for birds and animals, and as such can help to accelerate recovery of species diversity and regional ecosystems.

Keywords: Sendai Bay, resilience, vegetation, damaged habitat, recovery

RESTORATION METHOD USING LANDSCAPE ANALYSIS FOR THE GRASSLAND LANDSCAPE ALONG THE NATIONAL PARKWAY OF THE ASO-KUJU NATIONAL PARK, JAPAN

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The changes in the landscape are caused by the economic and social forces of the early 19th century and particularly of the 20th century. The community of Nezasa (*Pleioblastus yoshidake*) and Susuki (*Miscanthus sinensis*) plants forming the typical grasslands of Japan used to cover approximately 10% of the land of Japan until the 1930s. The grasslands have been managed by local agricultural activities such as controlled burning, mowing and pasturage for over 1000 years, but recently, due to the decline in the livestock industry and the gradually aging population, the landscape management of grasslands has become increasingly difficult. From the 1950s, some neglected grasslands were converted into plantation forests. The loss of grasslands, which have decreased to less than 3% of the national land has become a key issue. In the Second National Biodiversity Strategy of Japan, the Japanese government designated such landscape crisis as Crisis 2, which is "the degradation of Satochi-satoyama (rural landscapes formed by sustainable use of natural resources) due to insufficient level of management".

The region of Aso includes more than 50% of the grass plants Nezasa and Susuki in Japan, making it one of the most important biodiversity hotspots nationally. Therefore, the conservation activities in Aso's grasslands came to attract nationwide attention as pioneer examples of tackling such landscape crises. The key issue for such rural landscape restoration is having a sustainable vision for the grassland management. When considering the restoration of grassland landscapes, it is difficult to regenerate all the places that once used to be grasslands, due to the limitations in manpower and financial costs. Therefore, it is necessary to set priorities and decide which areas of the grassland landscape to restore.

The aim of this study was to develop a method for setting priorities for the restoration of the grassland landscape using GIS analysis. The study was carried out at the Parkway (public road inside the national park) of the so called Yamanami Highway of the Aso-Kuju National Park, located in the Kyushu Directory of Japan. The Yamanami Highway in the Aso-Kuju National Park is one of the major tourist attractions on which visitors can enjoy a dynamic grassland landscape.

The results of the research allowed: 1) to quantitatively clarify the transition of grassland landscape, using Multi-Temporal Aerial Photographs. 2) to analyze the viewshed at the Yamanami Highway, thereby grasping the location's characteristics. 3) to rank areas in terms of priority for the restoration of the grassland landscape by combining the results regarding the change in the land use at the Yamanami Highway and the results of the viewshed overlay analysis. Our goal was to identify issues vital to support the decision making for setting

priorities, considering the restoration of the grassland landscape along the Yamanami Highway.
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Keywords: landscape analysis, grasslands, restoration, priorities, method, Yamanami Highway

UTILIZATION OF LAND USE CHANGES AS A TOOL FOR DEVELOPING AN AFFORESTATION AND FOREST MANAGEMENT MASTER PLAN: A CASE STUDY AT THE PIGEON MIWA FOREST IN HITACHIOHMIYA, IBARAKI PREFECTURE, JAPAN

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In recent years the environment surrounding corporate enterprises has been changing dramatically. Factors include economic changes such as rapid development of ICT (Information and Communication Technologies) and globalization of trade and business opportunities; as well as shifts in the natural environment such as global warming, loss of biodiversity, degradation of ecosystems and decreased resilience to natural disasters such as floods, landslides. In order to adapt and prosper in these rapidly involving circumstances, many companies now integrate Business Continuity Management (BCM) plans into their corporate strategies. These plans target sustainability of both social systems, such as urban functions, local communities and end user volume, and local, regional and global biodiversity and natural ecosystems. Sustainability in both these areas is considered indispensable for a company to survive and prosper in the current volatile environment.

The aim of this study is to develop project management technologies for use in sustainable forest management. The study was implemented at the Pigeon Miwa Forest in Hitachiohmiya-city, Ibaraki Prefecture, located 120 km northeast of Tokyo. This forest is on land owned by the Pigeon Corporation, a major manufacturer of maternity and infant goods. An annual afforestation project, entitled the Newborn Baby Commemorative Tree-Planting Campaign, has been implemented since 1986, as part of the company's Environment Social Governance (ESG) investment strategy. Our research was designed to develop a scientifically based master plan for this afforestation project. A vegetation survey of the project area was conducted, and geospatial information technology was utilized to analyze changes in land use patterns. The results of the research allowed for identification of issues vital to sustainable forest management and conservation of biodiversity, such as zoning plans, selection of tree species and tree planting methods; and were used to develop and chart a comprehensive road map, called the Project Management Map, for future afforestation and scientific forest management activities at the Pigeon Miwa Forest.

Keywords: environmental changes, Business Continuity Management, forest management, master plan

MAPPING AND SUSTAINABLE MANAGEMENT OF IMPORTANT TREES AS KEYSTONE HABITATS FOR URBAN BIODIVERSITY

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The majority of the world´s population lives in urban areas, which expand rapidly. Urbanization has many implications for urban biodiversity and vice versa, biodiversity in urban areas is important for quality of life conditions for people. Urban areas often include green areas (parks, large gardens, woodlands etc.) which support a wide variety of animal and plant species. Keystone habitats for natural species in urban green areas are trees. Trees can be interesting by biologically, culturally or aesthetically. The concept of important trees in city environment is based on its historical, cultural and aesthetic value, as well as habitat value. Veteran trees have the potential to be both habitats for some rare/endangered species and stepping stones for species dispersal within ecological networks in urban areas.

Thus, veteran trees are an important part of bio-cultural heritage in urban areas. On the other hand, small and young trees can be very important in urban areas as both cultural identity symbols and future symbols of anniversary events. Thus, sustainable management of important trees in urban areas is very important topic. Case study is located to city of Prague (Czech Republic) which is world-famous by historical architectonical heritage with connection to natural heritage. Study presents main principles and discusses future perspectives and constraints of sustainable management of important trees as keystone habitats for urban biodiversity.

This study has been supported by the grant “Important Trees – Living Symbols of National and Cultural Identity” funded by Ministry of Culture of the Czech Republic in the frame of NAKI II Programme.

Keywords: urban areas, trees, Prague, biodiversity, sustainable management

THE INFLUENCE OF CHALK GRASSLAND OVERGROWING AND BURNING ON LONG-TERM SPATIAL PATTERNS IN A POPULATION OF *SENECIO MACROPHYLLUS* M. BIEB., THE POLISH RED BOOK SPECIES

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Changes in abundance and spatial patterning are among the most conspicuous features of plant population dynamics, which is affected by species traits and strengthened by ecosystem disturbances of various scales and intensity.

The model object was a population of ragwort *Senecio macrophyllus*, Asteraceae, a rare Central European species, in Poland with a VU (vulnerable) category of threat. The studies were carried out on White Mountain (Biała Góra), SE Poland (50°28'N, 23°29'E; 349 m a.s.l.), a hill built of cretaceous marls and loesses. A part of the area is covered with xerothermic grassland of the class *Festuco-Brometea* surrounded by shrubs and loose pine and mixed stands. In Central Europe, chalk grasslands are extra-zonal communities of semi-natural origin, strongly increasing the local biodiversity.

The abundance and spatial distribution of *S. macrophyllus* individuals were investigated 9 times in the period of 1990-2010, within 3 permanent plots differing in the initial ragwort density, according to changes in grassland density, particularly a cover of *Brachypodium pinnatum* (grass responsible for reduction of the floristic diversity of chalk grasslands), shrub/tree density (different light intensity: full light–shadow), and grassland burning episodes (0–6 times).

There was a drastic decline in the ragwort abundance within all the grassland patches, accompanied by a decrease in the population clustering coefficient and a gradual equalisation of the spatial distribution of individuals. The decline in the abundance was positively correlated (RDA analysis) with the increase in the *B. pinnatum* cover and negatively correlated with the number of grassland burning episodes, which may temporarily delimit a necromass cover and facilitate recruitment of new individuals. The decrease was in the range from 3.8 times (moderately shadowed, moderately high grassland; 6 cases of burning, last time in 2006) to 8.3 times (shadowed high grassland; 4 cases of burning, last time in 2004). The patch of low, loose, and sunlit grassland with the greatest initial density of *S. macrophyllus* has never been burnt and with time has evolved into high and dense grassland with dominance of *B. pinnatum* and *Calamagrostis epigejos*, additionally shaded by shrubs and young trees (a 6.8-fold decrease in the abundance).

The investigations have indicated that grassland overgrowing and burning largely determine the population structure as well as the composition and structure of the entire biocoenosis.

Keywords: *Senecio macrophyllus,* fragwort, Biała Góra, abundance, spatial distribution, *Brachypodium pinnatum*

EFFECTS OF AN ECOSYSTEM ENGINEER IN THE CARPATHIAN BASIN – OPINIONS OF CONSERVATIONISTS AND LOCAL PEOPLE ABOUT THE EURASIAN BEAVER

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The Eurasian beaver have started to come back into the Carpathian Basin in the last few decades. The species has reached all the rivers of Hungary by the last 5 years, and it appeared on most of the smaller, suitable water bodies in many areas. Local nature conservationists and researchers possess a great amount of unpublished information of this fast recolonization process which would be worth to be collected and synthetized.

We asked 55 conservationist experts and scientist from Hungary (49) and Romania (6), furthermore local people from both countries (60 and 30, respectively) about their experiences related to the beaver, using structured interviews. The most important topics of this survey were the beaver's food habits, and the beaver's impacts on riparian habitats and also on other habitats of the cultural landscape.

Our results show that the main sources of conflict are: cutting trees in poplar plantations; cutting of other tree species; causing accumulation of coarse woody debris near bridges and water engineering works; increasing flood risk by weakening flood protection dykes; flooding caused by beaver dams and crop damage. From the conservation biological perspective the activity of the beavers shouldn't be judged exclusively positive, either. On the one hand, the construction of dams can lead to formation of new valuable habitats, and water retention can improve conditions of wet meadows. On the other hand, sensitive species may be negatively affected. Moreover, in some cases selective cutting of trees and creation of gaps in the canopy layer can alter the species composition of the riparian woodland (e.g. the proportion of native and invasive tree species).

As a consequence of the continuing population growth of the beaver, all of the aformentioned effects of the species could become more serious and the coexistence of humans and beavers could be more challenging.

Supported by the National Talent Program (NTP-NFTÖ-18-B-0395), Hungarian Ministry of Human Capacities (EMMI), Human Capacities Grant Management Office (EMET).

Keywords: beaver, Carpathian Basin, conflicts, survey

BUTTERFLIES DIVERSITY OF THE RIVERS INTER-DIKE SPACES IN THE WEST AND EAST SLOVAKIA

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The study of butterflies was performed on selected rivers inter-dike spaces: 7 study plots on Podunajská nížina lowland (West Slovakia) and 7 study plots on Východoslovenská nížina lowland (East Slovakia). During the study, a total 65 butterfly species was found, with 38 of them on study plots in Podunajská nížina lowland and 41 on study plots in Východoslovenská nížina lowland. The highest number of species (41 species) was found on study plots with optimal structure of biotops. On these study plots were recorded the highest number of ecological specialists also (22 species). The most numerous species were *Polyommatus icarus*, *Pieris rapae*, *Coenonympha pamphilus*, *Pieris napi* and *Issoria lathonia*. Species *Zerynthia polyxena*, *Melitaea phoebe* and *Glaucopsyche alexis* are characteristic for dry and warm habitats (warm and dry dike habitats with south exposure) while species *Lycaena dispar* or *Heteropterus morpheus* for wet non-forest habitats (dike habitats with north exposure).
There were 3 butterfly species of European importance in Východoslovenská nížina lowland discovered (*Zerynthia polyxena, Lycaena dispar* and *Maculinea teleius*) and two species in Podunajská nížina lowland (*Zerynthia polyxena* and *Lycaena dispar*). This contribution was supported by project APVV-14-0735 (New possibilities of use of drainage canal systems with taking into account the protection and use of a landscape).

Keywords: Východoslovenská nížina lowland, Podunajská nížina lowland, inter-dike, diversity

HISTORICAL STRUCTURES OF AGRICULTURAL LANDSCAPES AND LOCAL DEVELOPMENT OPTIONS IN THE GEMER-NOVOHRAD REGION

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In the south part of central Slovakia, on large area of historical regions Novohrad and Gemer, were recorded numerous plots of mosaics composed from five to six land use elements – arable fields, grasslands, vineyards, orchards, building and also gardens. According to historical maps from 1955–1957 there is documented authentic agricultural utilisation comparable with today's which were not affected by collectivisation that started in 50-ties of 20th century and continued till 80-ties. Area constitutes proper conditions for active country tourism coupled with wine tasting in tuff wine cellars and products of traditional kitchen. Strong potential for tourism has geothermal energy and thermal wellness. There is also great possibility for cross-border cooperation with Hungary. This kind of trade and tourism could start up to raise interest in agriculture. But low promotion and inadequate accommodation facilities with poor services is a weakness for region development today. There is decrease of population and adverse balance of work trips in all districts of the region Gemer and Novohrad. This results in population ageing. Gemer region is also characterized by the highest unemployment rate from all over Slovakia. The aim of this study is to investigate the possibility how to raise the level of living and preserve agricultural landscape diversity in regions with cheap labour and rich in history and countryside.

Keywords: Novohrad, Gemer, historical agricultural landscape, tourism, development

THE RECENT CHANGES OF HIGH TATRA MTS. LANDSCAPE

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In recent decades, the disturbance has led to significant changes in the Tatra Mts. landscape structure. Wind storm and bark beetle outbreak significantly affect the structure and condition of forest habitats. High sums of precipitation in the summer period, especially in the high mountainous environment, cause significant ground-breaking processes. The aim of the contribution is to evaluate changes in the structure of the landscape in relation to the disturbances in the selected valley complex in the territory of High Tatra Mts. The mapping and assessment of the landscape structure is carried out by combined remote sensing methods and field surveys. The analysis of selected components of the natural environment determines the basic factors that most influence the structure of the landscape. Based on the results of the research, a management method will be proposed in the selected territory of High Tatra Mts.

Keywords: High Tatras, changes, forest habitat, valley, factors, management

THE IMPACT OF FORMER VINEYARD LAND USE ON THE SOILS (LITTLE CARPATHIANS, SW SLOVAKIA)

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We dealt with soil properties in the forests, which have formed on the sites of former vineyards in the study area abandoned in the late 19th century, when they were strongly impacted by the phylloxera epidemic, and the vineyard area has significantly reduced here. These forests are usually dominated by oak (*Quercus petraea* agg.) and mostly have formed spontaneously. Soils were affected here strongly by former management. Soil horizon was modified by deep-ploughing before vineyard establishment and was deprived of stones. Vineyards were maintained without vegetation cover and this, together with orientation of the plant rows along the fall line, promoted erosion. Five sampling sites were chosen and following soil properties were addressed: aggregate stability, pH and Cox content. Of sampling sites, three were former vineyards on the various bedrock, and two were located in natural forests (reference sites). The organic carbon content in surface Ao horizon is very high in almost all samples. In deeper horizons of climax forest soils we found high values of Corg, while these were low and very low in Akm horizon. The climax forest soil texture is determined by the bedrock, but in in the former vineyards is clearly influenced by long-term management. The values of the soil aggregate stability found in the former vineyards (80 %, 85 % and 86 %) are comparable with those in the climax forest (88 % and 90 %). Upper horizon porosity of all sites is about 60 %. This value is decreasing in the deeper parts in the former vineyards. Conclusion is that former vineyard land use has left still identifiable traces, which, however, are mitigated over time in most of parameters.

Keywords: vineyards, soil horizon, erosion, management impact

LANDSLIDES AS A LIMIT OF POSSIBLE LAND-USE PLANNING IN THE KYSUCE REGION

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The Carpathian flysch region forms a contiguous belt at the outer edge of the Western Carpathian Mountains and extends through extensive spurs to the inner Carpathian Mountains. The rock complexes of the flysch formation have a dominant position, of which the most widespread is the rhythmic-bedded clayey-sandstone flysch. The flysch territory belongs to the areas with the highest landslide occurrences in Slovakia. Almost 67% of all landslides in Slovakia take place within the Carpathian flysch.

In this study we proceeded from the field research, the database of ZB GIS and Landscape Ecological Complexes, which are vector representations of synthetic units expressing relevant properties of the landscape together with the landscape cover elements. The input parameters from the cover elements were: build up area, forest stands, transitional forest-shrubs stands, grassland, traditional agricultural landscape and arable land. Another input parameters were landslides. According to the activity, the landslides were divided into three categories: active, potential and stabilized. Statistical evaluation of input parameters were processed in GIS. The largest area (up to 40% of the territory) is occupied by coniferous forests, and landslides disrupt 24% of the area. Traditional agricultural landscape make up the second largest land area (occupying 21% of land), landslides are on 23% of the area. Grasslands and transitional forest-shrubs have almost the same coverage in the area, and so are the landslides. They occupy 25% of the grasslands and 24% of the transitional forest-shrub in the area. Other areas occupy from 1% to 4%, but the largest landslide area is in mixed forests (22%) and built up area (12%).

The limited development of land intended for single-family housing should be subject to the following rules: new development cannot be located in areas of active and potential landslides, including the addition onto and reconstruction of the existing buildings; new development in areas of stabilized is possible only after drawing up geological and engineering documentation confirming that the proposed investment does not affect the balance of the land and will not activate a landslide; it is possible to maintain buildings in areas of active, potential and stabilized landslides with the recommendation of drawing up appropriate geological and engineering documentation identifying the need for the implementation of security measures. The limited development of land intended for farming and forest: management of agricultural and forest land without heavy machinery in the area with active and potential landslides; area with active and potential landslides should not be used as arable land but as meadows and pastures; stabilization of large grassland areas in areas with active and potential landslides by forms of non-forest vegetation with predominance of shrubs; do not use the clearcutting method of timber production; do not build roads in areas with active and potential landslides.

With the gradual urbanization and the increasing need for higher living comfort, it is necessary to look at the evaluation of complex engineering-geological conditions in detail, in the assessment of land, underground, line, water and other types of buildings. The contribution

was prepared within the grant project of the Ministry of Education of the Slovak Republic and the Slovak Academy of Sciences No. 2/0132/18 “Historical and present changes in the landscape diversity and biodiversity caused by natural and anthropogenic factors”.

Keywords: landslides, flysch zone, land-use, landslides limits, zonal statistics, geographical information systems (GIS)

INFLUENCE OF VINEYARD MANAGEMENT ON SMALL TERRESTRIAL MAMMALS COMMUNITIES IN VINEYARD LANDSCAPE OF THE LITTLE CARPATHIANS

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Six types of vineyard management were chosen to find the most suitable one for biodiversity of model organisms - small terrestrial mammals. The research took place at hillsides of Little Carpathians in the communes Modra, Svätý Jur and Vinosady from May to Novembrer 2018. Catch-mark-release method using „Chmela" live traps was applied during the research. Altogether, six species of small terrestrial mammals were captured (*Apodemus flavicollis, Apodemus sylvaticus, Crocidura suaveolens, Microtus arvalis, Mus musculus, Mus spicilegus*). The most abundant species was *Crocidura suaveoles* even though it was captured only at localities where chemical supplements are not used. There were proven differences between species composition and biodiversity indices (D) among the studied types of management. The highest Simpson´s index of diversity at exploited vineyards was recorded at biologically farmed vineyards and that is why they show to be the most suitable vineyard management for maintaining biodiversity of small mammals and biodiversity overall as they stand in the middle of food webs. This contribution was supported by project APVV-14-0735 (New possibilities of use of drainage canal systems with taking into account the protection and use of a landscape).

Keywords: small mammals, vineyard management, biodiversity

MODELLING OF DRAINAGE CANAL INTERACTION INCLUDING IMPACT ON NEIGHBOURING ENVIRONMENT

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The main objective of the project APVV - 14 - 0735 New possibilities of use of drainage canal systems with taking into account the protection and use of landscape is the elaboration of the concept of extension of drainage canal use. This concept will provide background for improving manipulation and operational orders on irrigation and drainage systems and pumping stations. Drainage canal systems were constructed as a tool for intensification of agricultural production. They form an artificial anthropogenic element in a landscape. Du to gradual vegetation grazing/colmatation, the drainage canals stop to fulfil their original mission. On the other hand, they are important connective landscape elements serving as a refuge or bio centre for different organisms. A partial objective of the project is the evaluation of other possibilities of drainage canals use, namely water retention in area and thus flood protection improvement. Besides that, former canals may contribute to keeping the biodiversity and sustainable landscape use. The model canal for our research was selected Hanský canal in the area of the village Čiližská Radvaň (Danubian Lowland). This canal is a border between agricultural area and protected area of European importance SKUEV1227 Čiližské močiare (Čiližské marshes). The reason why this canal was selected, is the measures anomaly of ground water table on both sides of Hanský canal in the area with different functional use. The objective of our research is to determine with the help of mathematical model Hydrus 2D/3D the interaction of drainage canal with neighbouring environment in the soil aeration zone, and the water flow in the system wetland – canal – agricultural land. The research methods include field measuring of hydraulic conductivity and detail analysis of soil samples in order to determine necessary hydro-physical parameters for the mathematical model. Determined principles of interaction of canal with neighbouring environment will be standardized and used as methodology for evaluation of canal systems in lowland areas of Slovakia. This paper was supported by the project APVV 14 – 0735 New possibilities of use of drainage canal systems with taking into account the protection and use of landscape and is one of project outputs.

Keywords: drainage canal, Hydrus 2D, modelling of water movement in soil, biodiversity, landscape, Čiližské močiare (Čiližské marshes)

COMPARISON OF A MANAGEMENT IN NATIONAL PARK POLONINY AND UZHANIAN NATIONAL NATURE PARK

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This thesis deals with the issue of the cross-border conservation area of the Eastern Carpathians, where the legislation and management of this biosphere reserve is compared between Slovak Republic and Ukraine. The aim of the thesis is to analyze, compare and critically evaluate the condition of protected areas according to the environmental legislation in the individual states and the management in these protected areas. The first part presents brief information about the development of the observed areas and its gradual transformation into a tripartite biosphere reservation of three countries - Poland, Slovakia and Ukraine. The work continues with the comparison of selected aspects of nature conservation legislation in the Slovak Republic and Ukraine. Environmental management of both parks was also analyzed and compared. The thesis points to defects in the nature conservation legislation of both countries, which do not provide sufficient legal protection for these territories.

Keywords: Poloniny, Uzhanian, legislation, management, national park, biosphere reservation

THE SPATIAL ANALYSIS OF CONSERVATIVE LAND USE AREAS IN MORAVIA

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During the inventory of pre-industrial landscape segments in Moravia (approximately the eastern one third of the territory of the Czech Republic), around 800 secondary landscape structures (land use mosaics) have been registered. In these areas, there is the same or very similar landuse as it was recorded by the maps of the so-called stable cadastre completed in the 1820s. Other quantitative and qualitative characteristics were found for each identified landscape segment with unchanged or stable land use mosaic. The results of the geodatabase analysis of the pre-industrial landscape segments are presented in this paper with respect to the altitude. The results show that although numerous segments of stable ancient landscapes have been preserved at higher altitudes, larger individual areas and larger total area of the ancient landscape exist on more fertile soils in lower positions. The hypotheses attempting to explain this territorial disparity offer the text of the paper.

Keywords: landscape structures, analysis, geodatabase

Presented posters

Landscape protection and biodiversity conservation

(national legislation, international convensions, implementation, etc.)

ALTITUDINAL DIVERSITY OF FLORA WITHIN JUNIPER FORESTS IN THE FANN MOUNTAINS (WESTERN PAMIR-ALAY), TAJIKISTAN

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The investigation conducted in the area Fann Mountains in the valley of Uredz river within juniper forest with contribution of *Juniperus seravschanica* and *Juniperus semiglobosa*. These species occurs and grow from 950 to 3300 above sea level in this region. The habitat differentiation and vegetation communities at the lower part of Uredż catchment are not much differ despite favourable temperature.

Floristic analysis has been carried out only tree stands with more than 50% crown coverage, where found occurrences of 134 vascular plants. The species are belonged to different ecological and geographical groups. Within Juniperus *seravschanica* community (950-2400) are dominated *Cotoneaster oliganthus, Rosa Fedtschenkoana, Ephedra equisetina, Spirea hypericifolia, Lonicera bracteolaris, Berberis oblongata* and others. The dominant herbaceous species are represented by *Artemisia lehmanniana, Artemisia dracunculus, Ligularia thomsonii, Poa relaxa, Ferula kokanica, Hipericum scabrum, Ziziphora pamiroalaica.* The mentioned species often created patches. In case of *J. semglobosa community* dominated more xerophyle species as *Festuca sulcata, Thymus seravshanicus, Poa bulbosa, Stipa turkestanica, Arenaria serpyllifolia, A. Lehmanniana, Scutellaria hissarica, Ziziphora clinopodiodes, Thalictrum isopyroides.* Most importance ecological role played shrub species from different genera *(Rosa*, *Lonicera*, *Berberis*, *Cotoneaster, Ephedra, Sorbus* and *Cerasus)* with high adaptive ability in extreme environment in this association. The area is characterized by high geomorphological, topographical, habitat/microhabitat differentiation and also landscape diversity. Temperature variation along with the height has significantly influence on the structure and species composition of juniper forests association. Such differentiation created varies habitats and new ecological niche for colonisation other organism, in this way they affect biodiversity.

Keywords: Fann Mountains, juniper forest, floristic analysis, shrub species, biodiversity

ECOSYSTEM SERVICES AT NATIONAL LEVEL IN SLOVAKIA

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The presentation describes the methodology and first results of the national ecosystem services (ES) assessment in Slovakia, based on the results of MAES process, previous ES research in Slovakia, but mainly on the original research methodology using secondary spatial and statistical data.

The first step of the national ES assessment was realised during the Slovak MAES process, which has resulted in selecting important ES for the evaluation process. As a result of deliberative valuation of involved experts, 14 ES were selected - of which 10 ES were finally selected for further assessment in our research (3 provisioning, 5 regulating & maintenance and 2 cultural). Next, the theoretical and methodological framework for the national ES assessment is being established - a comprehensive conceptual model of ES assessment was designed, inspired also by other national studies. The first result is an assessment of the landscape capacity for ES provision, based on development and actual state of the ecosystems and the natural landscapes. Further ES demand evaluation is based on the socio-economic indicators at the levels of administrative and landscape units. The assessment of the real ES flows, the overall balance and identification of the spatial and functional mismatches are results of the final methodological step.

The ES assessment process is currently being implemented. It is based on the selection of spatial units and indicators at the level of ecosystems (habitat types, watersheds), administrative units (municipalities, districts), natural features (topology, geology, soils, climate, water, biota) and on the selected socio-economic parameters (population, human activities, resources use). Models of capacity, demand, flow and final balance of ES use are gradually created and evaluated for each of the 10 ES.

An integrated ES assessment will be implemented as a final step of our research. It will be based on the evaluation of the balance of different ES groups (provisioning, regulation & maintenance, cultural); and also on the evaluation of the spatial / functional mismatches for the whole territory of Slovakia, expressed in detailed spatial grid.

Keywords: National ecosystem services assessment, Slovakia, model, ecosystem services

THE METHODS OF WATER EROSION IDENTIFICATION IN OPTIMIZING OF AGRICULTURAL LANDSCAPES USE

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The agricultural landscape is undergoing continuous development, causing it is disturbance by natural and anthropogenic factors. The effect of the disturbance is dependent of the time and of the intensity and the periodicity of the factors. If the action and intensity of the factors are high, negative processes develop. These include water erosion too. It is development influences morphological conditions of the territory and intensive agricultural activity. In Slovakia, it is mainly in the highlands and in the uplands. According to Imeson et al. (2006) there is several "soil risk", including soil erosion. He considers it the most serious degradation process, which often leads to complete soil loss and thus to its extinction. The EU is participate on reduce its negative impacts of soil erosion using Common Agricultural Policy. A mechanism has been put in place to observe Good Agricultural and Environmental Conditions (GAEC). This concerns soil protection against erosion, preservation of organic matter and soil structure, prevent of worsening of habitats and management of water. Soil protection against erosion is also ensured by legislation. Legislation and methodological guidelines for soil protection in the Slovak Republic are mainly Act no. 220/2004 Coll., Decree of the Ministry of the Interior no. 508/2004 Coll., Order of the Government of the Slovak Republic no. 58/2013 Coll., Methodical Instruction of Ministry of agriculture and rural development no. 2319/2007-930 and many more.

An important step in protecting the soil from water erosion is its identification. The aim of the research is to test various methods of identification of water erosion in the uplands landscape and to point out the need for their combination in order to objectify them for the needs of elimination of water erosion in agricultural practice.

We use different methods for identification. The method of spatial extension and digitization of surface water erosion using aeronautical images was used. Also was used, modelling water erosion processes using the universal equation for calculating soil loss by water erosion. Other identification methods were based on the need to conduct a field survey. The method of visual identification, verification of erosion processes by soil probes and identification of soil organic matter and soil structure was used. Each of the methods used confirmed the presence of erosion processes and proved to be appropriate. The results of the evaluation show that individual methods cannot be generalized and strongly recommended for any area of assessment because erosive processes are influenced by specific natural and anthropogenic factors. These methods have their positive and negative sides. An efficient identification of erosion processes is possible with combination of methods. The importance is in exact localization by the erosion of endangered areas with the possibility of designing a

precise soil anti-erosion protection. This paper was supported by project APVV-17-0377 Assessment of recent changes and trends in agricultural landscape of Slovakia.

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Government Regulation no. 58/2013 Z. z. on precipitation and unauthorized coverage of agricultural land

Methodological Instruction of MP SR no. 2319/2007-930 to Government Regulation no. 81/2007 Coll. on the conditions for granting aid in the form of a single area payment

Keywords: agriculture, land use, water erosion, methodology, identification

GREEN INFRASTRUCTURE

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Green Infrastructure is a planning tool that supports the protection and rational use of the landscape. The concept of Green infrastructure, the same as the territorial systems of ecological stability, is aimed at the progressive transition from the black-and-white division of the country to the protected and unprotected parts, to an all-area differentiated system preserving ecologically convenient landscape structure with different ways of use.

The paper presents theoretical-methodical procedure for elaboration of the green infrastructure. The methodology consists from the following steps:

- Analyses – the basic characteristic of the landscape-ecological conditions of the territory and characteristic positive and negative socioeconomic elements
- Syntheses and evaluation – specification of the landscape ecological and environmental problems on the landscape
- Proposal – proposal for the elimination of the specified problems of the landscape. Proposals of the creation of the green infrastructure and managements measures.

The aim of the proposed green infrastructure and mitigation of the negative effects of its barriers is conservation and support to biodiversity and diversity of Slovakian landscape and provision for their beneficial effects on the surrounding ecologically less stable parts of the country, support to variants of multifunctional land use with the aim to protect individual components of the environment, conservation of important landscape elements and specification of barriers and mitigation of their negative effect on individual green landscape elements.

Keywords: green infrastructure, methodology, elaboration, management, land use

POTENTIAL RETENTION CAPACITY OF TRADITIONALLY USED AGRICULTURAL LANDSCAPE IN THE MODEL TERRITORY OF LIPTOVSKÁ TEPLIČKA IN CONDITIONS OF THE WESTERN CARPATHIANS (SLOVAKIA)

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The assessment of the hydrological potential of the country is an increasingly important attribute of the landscape in the period of advancing climate change, which allows us to express water retention and the possibility of identifying critical hydric zones. This study has taken into account the landscape-ecological approach, where the Retention Water Capacity of Soils (RWCS) and its spatial imaging through GIS in the landscape are compared with the existing use of the traditional agrarian landscape. Landscape areas with low soil retention capacity and inappropriate landscape utilization are identified as critical hydric zones where there is a high presumption of high drainage of soil and surface water.

In order to support the assessment of the Retention Water Capacity of Landscape (RWCL) we used synthetic linking of analytic vector layers to create homogeneous polygons of soil subtypes and selected physical parameters such as granularity, soil quality, type of geological substrate, some morphometric parameters such as relief and altitudinal vegetation zones, taking the climatic factor into account. Another significant database for assessing the hydric capacity of the landscape is the use of landscape, positioning of parcels and their orientation with respect to contour lines and slope curves. Since our research was carried out in a traditional agriculturally used foothill landscape, it was important to map the historical landscape structures, the degree of their conservation, the orientation of the parcels relative to the contours and the current management and use of the landscape.

To estimate the overall landscape retention potential, we followed the predictive model USLE by Wischmeier and Smith (1978) using GIS tools. The aim is the spatial estimation of the retention capacity of the landscape, taking into account the current land use, including historical anti-erosion measures to reduce unwanted water drainage and soil erosion.

Using zonal statistics, we have achieved the following results. The surface area of the model area with very low and low RWCL represents 39.83% of the agriculturally used landscape. This category is represented by the soils of rendzinas and cambisols on the distinctive slopes, with the predominant use as pastures. Prevalent is the occurrence of the historical structures of the agricultural landscape in a form of balks, stony valleys and terraces oriented in the direction of the slope curves. The area with medium RWCL occupies 43.01%. The meadows predominate and the occurrence of HSAL (historical structures of agricultural landscape) represents the areas with oblique and in some places also perpendicular orientation of the valleys to the contour lines. We record a high RWCL at an area of 14.39%, with

predominating meadows and cultisolic cambisols and cultisolic fluvisols in the floodplain. The built-up area of the intravilan is 2.69%.

The results confirmed that the orientation and spatial arrangement of elements of historical landscape structures is a significant factor in the soil cover water retention capacity in the study area.

Contribution was supported by project GP VEGA 2/0078/18 Research of biocultural values of landscape and project APVV-17-0377 Assessment of recent changes and trends in agricultural landscape of Slovakia.

Keywords: Retention Water Capacity of Landscape (RWCL), landscape-ecological approach, GIS tolls, critical hydric zones, zonal statistics, traditional agricultural landscape, predictive model USLE

CHANGES OF LANDSCAPE DIVERSITY AND BIODIVERSITY BY THE INFLUENCE OF NATURAL FACTORS AND HUMAN EFFECTS IN DEVÍNSKE KARPATY MTS.

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Bratislava as the capital of the Slovakia is constantly growing and for its development needs more and more area. Although the restoration of old unused parts in the parts of the city is underway, there is an ever-increasing pressure to expand the town residential areas to the city's outskirts, in satellite villages or urban areas. At the same time, Bratislava is situated in an area with several important localities from the view of nature conservation, not only at the national but also at the European level. To the city area interfere three Protected Landscape Area (PLA) – PLA Malé Karpaty, PLA Dunajské luhy a PLA Záhorie. There are 29 small-scale protected areas in categories National Nature Reserve (NNR, 1), Nature Reserve (NR, 9), National Nature Monument (NNM, 1), Natural Monument (NM, 3), Protected Site (PS, 14), Protected Landscape Element (PLE, 1), 10 Special Area of Conservation (SAC) – area of European interest and there are interfering 4 Special Protected Area (SPA) – protected bird area.
One of the most important parts of Bratislava city in terms of natural values is the territory of Devínske Karpaty Mts and the surrounding valley positions on the floodplains of the Danube and Morava rivers. Almost the all territory of Devínské Karpaty Mts belongs to PLA Malé Karpaty, of which parts are also NNR Devínska Kobyla, NR Štokeravská vápenka and NR Fialková dolina. Out of PLA territory are situated NNM Devínska hradná skala and NM Devínska lesostep. A large part of these areas also falls into SAC – SKUEV0280 Devínska Kobyla, SKUEV0502 Štokeravská vápenka and SKUEV0800 Devínska hradná skala. The larger part of rivers Danube and Morava floodplain is protected within NR Slovanský ostrov, PS Devínske alúvium Moravy a PS Sihoť as well as SAC – SKUEV0312 Devínske alúvium Moravy, SKUEV0314 Morava and SKUEV2064 Bratislavské luhy. Morava river floodplain is part of Ramsar sites and Emerald sites and big part of Devínske Karpaty Mts. are Emerald sites. All of Devínske Karpaty Mts are surround by the city parts Karlová Ves, Dúbravka, Devínska Nová Ves and Devín that are located on slopes of the mountain and in the adjacent valley parts. Individually planned or realized activities on city part regions, therefor find limits, which effect on conservation of nature and land. There are constant conflicts in interests of city's development activities, individual construction, recreational and sporting activities, mining activities and etc. with interest in the nature conservation.
In the past, the most important parts of the city in terms of nature protection were surrounded by gardens, vineyards, orchards, small gardens connected to small family houses. There was extensive farming activity. These elements formed a buffer zone that eventually increased landscape diversity and created biotope, to which some plant and animal species were fixed. In the present, building activities are more intensive on borders of the protected areas, they take up areas of vineyards and orchards, natural grasslands, low scrubs and forest edges. Park lawns are created near new buildings, where the diversity of plant species is very low. Unsuitable grass types and herb species are often used in recultivation work. This significantly reduces

diversity of the site conditions and diversity of local fauna. The contribution was prepared within the grant project of the Ministry of Education of the Slovak Republic and the Slovak Academy of Sciences No. 2/0132/18 “Historical and present changes in the landscape diversity and biodiversity caused by natural and anthropogenic factors”.

Keywords: current landscape structure, biodiversity, nature conservation, urbanization, human activities in the area, changes and impacts on landscape structure and biodiversity

Presented posters

Changes of historical structures in the landscape

PRE-INDUSTRIAL LANDSCAPES OF MORAVIA - ITS IDENTIFICATION, MAPPING AND ASSESSMENT

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The landuse of the Czech lands has undergone profound changes in the period of the industrial society. The decisive reconstruction of the rural landscape was recorded in the years of the so-called real socialism (1950-1989), when the phases of collectivization of agriculture (in 1950s), of transition to the mechanized extensive large-scale agriculture (in 1960s), of the chemization and industrialization of agriculture (in 1970s) of specialized intensive agriculture (in 1980s) took place. These phases led to significant homogenization of the landscape with vast monocultural areas of arable land. The areas that avoided these changes remained aside from the study of the landscape. Areas with an ancient landuse structure, preceded by the middle of the 19th century - the period of the onset of the main wave of the industrial Revolution, thus become a special case of the cultural heritage in the Czech lands. For Moravia - one of the historical Czech lands - a process of the identification and mapping of ancient pre-industrial landscape residues, with the appearance of the structure that was common before 1850, was developed. The procedure consists in application publicly available cartographic materials representing both the current state of the landscape (in the recent orthophotomap) and the situation in the first half of the 19th century (maps of the stable cadastre). The process of searching for the old landscape is based on the identification of an old landscape mosaic in the contemporary landscape represented by the orthophotomap and its confirmation and specification according to the maps of the stable cadastre from the 1820s. Subsequently, the outlines of the detected old landscape segment are saved in the geodatabase and the area of the detected area is calculated. Segments are classified into three size classes. The GIS technology and other public geodata were used to determine the terrain (slope, exposure, altitude, location in the relief), geological and soil conditions of each segment, its location in the administrative and natural units of the Czech Republic. The current state of the unit was specified in the field, and according to it, the pre-industrial landscape segments were classified into three quality classes. The compiled geodatabase is the starting point for a series of spatial analyzes.

Keywords: Moravia, land use, historic, segments, assessment

HISTORICAL LAND-USE CHANGES OF CULTURAL LANDSCAPE IN OLOMOUC ARCHDIOCESE AREA (CZECH REPUBLIC)

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The paper deals with historical land-use changes during the 19th and 20th century in study area Haná, which is situated in centre of historical territory of Olomouc Archdiocese. This area is a typical central European cultural landscape with rich nature and historical heritage. This study is based on methodological approach of environmental geography, using GIS analyse as support tool for assessment of land-use changes. Historical land-use changes in study area has been investigated during the period between the second (1836-1838) and third (1876 - 1878) historical Austrian military surveys. Results of the historical land-use changes in Haná region are compared with current state of agricultural land, which has been strongly influenced during 20th century by socialistic transformation of agriculture. Presented results indicated that consequences of historical land-use changes in Haná region in the 19th century were very similar to impacts of socialist collectivization on agriculture in the mid-20th century. These historical land-use changes have still some important environmental consequences for cultural landscape in 2017. Understanding to these historical land-use changes can be consider as a key to sustainable management and protection of historical heritage in Olomouc Archdiocese cultural landscape. This study has been supported by the grant “Cultural landscape of Olomouc Archdiocese - research, presentation and management” funded by Ministry of Culture of the Czech Republic in the frame of NAKI II Programme.

Keywords: historical land changes, agricultural land, Haná, historical heritage, cultural land

TRANSFORMATIONS OF HISTORICAL STRUCTURES IN LANDSCAPE OF PROTECTED AREAS IN POLAND IN LAST 150 YEARS ON THE EXAMPLE OF ŚLĘŻA MASSIF

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Human activity is considered as one of the main driving forces of landscape change from global perspective as well as local scale. The spatial distribution of landscape transformations depend on specific system of forces which has changed from centuries. Technology development, human population, urbanization processes and land use policies are some of many factors which cause transformations of historical structures in landscape. The changes of these factors have directly or indirectly impact on type and level of landscape changes. The main aim of the studies was to determine the level and character of changes in historical landscape within the protected area, Ślęża Massif, in last 150 years and identify those parts remain constant. Analyses of available historical and current land cover maps prepared in ArcGIS software allows to compare three different time intervals in the context of types and levels of changes as well as changes in area and features of landscape units. To determine level of changes in the landscape in analyzed periods landscape change index was used. The results of research show that the most transformations were connected with afforestation at the end of 19th century and land abandonment and forest succession in last 40 years.

Keywords: landscape change, historical structures, Ślęża Massif

COMPARISON OF DISPERSED SETTLEMENT AREA CHANGES IN TERCHOVÁ IN THE YEARS 1945 AND 2015

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Dispersed settlement was created during youngest settlement waves and it is a result of natural and socioeconomical conditions and historical events. The individual settlement units do not create a centre, but they are dispersed in surrounding area. Dispersed settlement in Terchová, which belongs to "Javornícko-Beskydská kopaničiarská" area and Žilina subarea, undergone in last decades some changes due to historical events and changing social climate. These social and historical changes lead to different use of land and house fund. During several decades, mainly production function was shipped into mainly housing or recreational function. This change is dependent especially on the dispersed settlement accessibility and attractiveness of the landscape.

We assessed 74 dispersed settlement units in term of their area changes for which we used aerial photography and QGIS tools. In majority of dispersed settlement units there were increase in the area. Only several dispersed settlement units have no or negative area change. Area changes were most obvious in the valleys where due to the area growth of dispersed settlement units it is difficult to recognize where one dispersed settlement unit ends and the other one begins. But if we look at dispersed settlement units located in harder accessible terrain we can observe that the area growth isn't so great.

Terchová as a tourist centre of the Micro region Terchovská dolina and Malá Fatra National park has great possibilities for using dispersed settlement for recreational purposes and save our cultural heritage for future generations. But we are observing that developers are rebuilding dispersed settlement unit and local and traditional architecture is disappearing. It is necessary to protect those dispersed settlement units that remained unchanged or the changes aren't that obvious.

Keywords: dispersed settlement, land use change, Terchová, tourism

PROPOSAL OF REVITALISING PLANS FOR THE WORLD HERITAGE UNESCO VLKOLÍNEC AND ITS BUFFER ZONE

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The contribution represents results from the cross-border cooperation project INTERREG V-A-SK-CZ/20/16/02: (ITMS2014+:304031D001): UNESCO World Heritage Sites in the Life of Municipalities, Towns and Regions (project duration: September 2017 – June 2019). The aim of the project is to improve the quality of cross-border cooperation by exchanging experience and examples of good practice in the management of cultural and natural heritage of trans-regional importance. The localities of interest include the Natural Park Mikulčický Luh and Vlkolínec – UNESCO locality. Over the last 70 years, the way of managing the landscape and the landscape structure has changed fundamentally in the Vlkolínec area. The fields around the built-up area ceased to be machined, the pastures (in the past intensely grazed) gradually become wooded, as a result of the poor technical condition, hundreds of hay-barns have been lost from the countryside, which in the recent past have created, together with the built-up part of Vlkolínec, landscape image of the Liptov region.

Within the project, outputs containing information on the restoration of traditional farming in Vlkolínec were prepared. One of these results is the Landscape study, which includes a set of proposed measures for the development of traditional farming. The old regional varieties of fruit trees were mapped. The fruit trees were mapped to their vitality. The data were processed in the form of a geodatabase. Practical stages of the project have also been realized – examples of the restoration of traditional farming, revitalization of orchards and gardens.

The members of the Local Gardening Organization, the Civic Association of Vlkolínec and the experts from many professional organizations were actively involved. As part of the outputs, a manual on traditional farming was prepared.

Co-operation of regional and local project partners (Ružomberok City, Catholic University in Ružomberok, Civic Association of Vlkolínec, The Monuments Board of the Slovak Republic – Regional Centre in Žilina, Mestske lesy Ruzomberok Limited, Administration of the National Park Velka Fatra, Ludrova Agricultural Cooperative, Local Gardening Organization in Ružomberok and Vlkolinec and others) gives a high level of assurance that the project results will be progressively reflected in the new planning documents for the Ružomberok – Vlkolínec District and will contribute to improving the quality of life of the local population and services for visitors. The paper was supported by the projects VEGA 1/0658/19 Ecosystem approaches to assessing of anthropogenic changed territories according to selected indicating groups of species, project INTERREG V-A-SK-CZ/20/16/02: (ITMS2014+:304031D001): UNESCO World Heritage Sites in the Life of Municipalities,

Towns and Regions and project VEGA No. 2/0013/17: The role of ecosystem services in support of landscape conservation under the global change.

Keywords: landscape, Vlkolínec, UNESCO, traditional farming

MOSAIC LANDSCAPE STRUCTURES IN RELATION TO THE LAND USE OF THE DISTRICT OF NITRA

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Mosaic landscape structures with traditional forms of land use are currently the most important landscape features, especially from the point of landscape and cultural-historical perspective. Their typical features are the alternation of the areas of narrow-field fields, meadow vegetation and permanent cultures, especially vineyards and orchards. Their presence in the territory is mainly related to the rich vineyard and fruit-growing tradition. On the territory of the Nitra district, we record the most extensive mosaic landscape structures from the south to the north-eastern part. These are heterogeneous units, typical of the rotation of small-area land management, scattered by non-woody vegetation and habitat. In the mosaic landscape structures, we also find elements of the traditional settlement architecture of the houses "hajloch". Significant landscape elements in the form of mosaic structures survive thanks to the rich viniculture tradition. In the long run, however, there are changes in their use, they are often the subject of inheritance, they are converted into holiday homes or they are used for the needs of an expanding residential development.

The aim of our study is to point out the dynamics and changes that occurred in the mosaic landscape structures between the two time horizons (the 50s of the 20th century and the present). For this purpose, we use geospatial analyses to evaluation their area representation, spatial characteristics in relation to the surrounding settlement structure and selected properties of relief forms. The analysis and evaluation of the spatial diversity of mosaic landscape structures as important landscape elements play an significant role in protecting the natural and cultural heritage values of the area from the aspect of species diversity and rich gene pool, the visual perception of the landscape, the preservation of the ecological stability of the landscape, landscape potential and the overall landscape diversity.

Keywords: mosaic landscape structure, land use, tradition, spatial characteristics, cultural heritage

Presented posters

Urbanization and settlements development - imapcts on the landscape

LANDSCAPE ANALYSIS OF THE SUBURBAN AND RURAL AREAS OF THE CITY OF ZAGREB (CROATIA)

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Suburbs and rural areas around cities are considered to be the most dynamic parts of urban areas. Because of the introduction of new spatial elements and the intertwining of different functions in the service of the city, population and economy, these are areas of intense spatial transformation that have their reflection in the landscape. The state of the landscape was explored in the suburban and rural areas of the City of Zagreb, which due to the significance of the capital is rapidly developing. The analysis was based on the habitat map of the Republic of Croatia, geomorphological, geoecological and demographic data. Initial research was carried out within the study of the analysis and evaluation of development potentials and restrictions of the City of Zagreb suburban and rural area. It was made for the City Office for the Strategic Planning and Development with the aim of planning spatial development. Landscape regionalization and research of the composition, structure and ecosystems services of the landscape units was carried out. In the research area unbuilt surfaces prevail. Most of them are forests thanks to the significant proportion of the mountain and dynamic hilly areas of Medvednica Mt. and Vukomeričke gorice. Other mostly unbuilt areas are mosaic landscapes of agrarian active areas around the settlements. These are the areas of fragmentation and degradation due to the strong anthropogenic pressures and accelerated landscape transformations due to the urbanization. Their geographical layout, features and condition are the result of relief, climate and pedological conditions and anthropogenic influences. Among natural areas under the strongest pressure there are parts of the forest ecosystems in the transitional zone between Nature Park Medvednica and Zagreb. In the past decades there were recorded the consequences of serious disturbances of the landscape and the quality of the ecosystem services. With the deterioration of climate change effects geomorphological and hydrological risks may be exacerbated, especially in the cases of settlements and roads in hilly areas with degraded slope stability.

Keywords: suburban, rural areas, Zagreb, spatial development, disturbance

FLORISTIC DIVERSITY IN THE LANDSCAPE OF CITY PARKS IN SOUTHERN POLAND

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Ecosystems of city parks are one of the most important refugia of biodiversity in urbanized areas. Recently, the interest of naturalists has increased in the issues of floristic diversity in regions which highly transformed by human activity and particularly in urban spaces. Investigations are conducted at various levels of the biological organization, to protect the environment and to promote floristic diversity. The aim of this study is to present floristic diversity in the areas of urban parks in southern Poland. The research was conducted in 10 parks (Grabek, Jordan, Haller, Zielona, Sielecki, Środula, Leśny, Góra Zamkowa, Syberka Niska and Park Wojkowice) and located in 3 cities (Dąbrowa Górnicza, Sosnowiec, Będzin). These parks have been formed at different times, on various parent rocks both natural and anthropogenic transported ground has also different size surfaces (the smallest 6h and the largest 67h). Their common features are way of use and management. In result of investigation has been confirmed occurrence of 438 vascular plants belonging to 83 family and 237 genera. The most domination of species is presented by Asteraceae and Poaceae. The park of Grabek richest in species (282 species) in compare other investigated parks. Researches on the urban parks are important links in floral diversity and biodiversity within highly urbanized areas in city centers and in generally urban space. This variety includes both native species and alien which often called park species with decorative origin. Floristic diversity here is conditioned by the way of land use and habitat mosaic. Despite the anthropogenic character some fragments of urban parks should be protected by law.

Keywords: city parks, diversity, vegetation, land use

IMPACT OF THE URBANISATION ON THE LANDSCAPE AND ITS ECOSYSTEMS

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The development of cities is linked to qualitative changes of the landscape aimed at strengthening economic, administrative and cultural-social functions, which are associated with ever-increasing pressures on ecosystems and their individual components of the surrounding area. These pressures are subject to various factors – socio-economic, political, environmental, etc. Like many post-communist countries, Slovakia has undergone significant changes. The transformation of central planning into a market economy was the basis of these changes, which conditioned following strong pressure of investors on the landscape, construction of technological parks, shopping and logistics centers, transport infrastructure, but also construction of residential complexes, etc. The conversion of natural and semi-natural ecosystems into building lands represents activities with significant negative ecological impacts (e. g. habitat destruction due to the reduction of forest and urban vegetation, occupation top-quality soils for non-agricultural activities, increasing of anthropisation of the area, the reduction of spatial ecological stability,etc.). Effects on ecosystems and their negative consequences are also recorded due to rapidly changing needs and consumption patterns (luxury living, transportation and energy). These trends negatively reflect not only on the ecosystem changes and as threats of ecosystem services, but also on the deterioration of the quality of the environment. The loss of natural ecosystems, arable land or the elimination of permanent crops (vineyards and fruit orchards), are basic phenomena that have changed the suburban landscape of Slovakia. The poster willl present:

- the changes to land use in the peri-urban area Trnava in connection with urban development trends
- negative impacts of changes on the landscape, their components and also on the quality of the environment (ecological and environmental problems)
- the main driving forces of these changes - the factors most influencing the spatial development
- the main tools that can be used to guide the spatial development of the area according to the principles and criteria of sustainable development.

Ecological and environmental assessments may indicate both land-use and planning inefficiencies, and can help to identify negative urban development issues and to direct urban development towards a sense of sustainable development principles and criteria. The paper is the result of the international project FP7 EU: OpenNESS.

Keywords: Trnava, impact, landsuse changes, factors, development

RECREATION IN THE CITY – PART OF CULTURAL ECOSYSTEM SERVICES

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Cultural ecosystem services are immaterial benefits derived from aesthetic and other experiences, recreation, cognition and spiritual enrichment, the ability to distinguish values. In other words, what makes the service "cultural" is precisely its "uneconomic" character. Cultural ecosystem services are directly responsible for the quality of life in urban systems and are directly appreciated by residents and visitors of urban systems (Plieningeret al., 2013). An assessment method has been developed to determine the degree of use of existing vegetation areas in an urbanized environment for recreation within cultural ecosystem services. In our research, we evaluate public green spaces in terms of the following factors: vegetation quality, space design, environmental quality, management and equipment. The method was verified on three model areas in the city of Nitra in the Chrenova settlement. The results show that areas are included in the category of average benefits. The biggest deficiencies in evaluated areas are in space design and equipment. Other deficiencies such as vegetation quality and management can be removed with appropriate measures. The method is usable to all vegetation areas in an urbanized environment in order to determine the current state of provision of benefits for cultural ecosystem services - specifically recreation. It can be supplemented from different perspectives and from different areas (eg availability, etc.).

Keywords: urban green spaces, recreation, benefits, cultural ecosystem services

OVERVIEW OF SUSTAINABLE CITIES INDICATORS

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„Sustainable cities and communities“ are one of the 17 goals of the Sustainable Development Goals Agenda to 2030, which define a general framework for eliminating poverty and achieving sustainable development (SD); simultaneously these are one of the priorities of the EU environmental policies. In this regard, other related indicators/information are raising more attention too. Sustainable cities indicators represent measurable data that inform whether the municipal policies and activities are leading to the desired sustainable future. They should help to analyse the current state and trends, diagnose the problems and predict the future development of the city from the social, economic, environmental and institutional point of view.

In the 1990s, the UN Commission on Sustainable Development has started to deal with the SD indicators issue. The commission pointed out their importance and have developed the first framework for measuring the state and the progress of the countries/regions towards the sustainability. The core indicator set has gradually expanded and was adjusted to the specific conditions of SD assessment at the levels of municipalities, regions and countries. Currently, different institutions (besides UN e.g. World Bank, European Commission, OECD and others) are dealing with the ways of defining and evaluating the development indicators. Therefore, different approaches based on measurable indicators exist for evaluating the SD of the countries, regions and municipalities.

Presentation gives the overview of selected indicator systems and concepts for the SD assessment of cities in the global, European and Slovak context. This overview is the basis for designing an adjusted set of the SD indicators, applicable in Slovakia or in countries with a similar background. The scheme of such indicator system is presented, which considers the environmental, social, economic and institutional dimensions of urban sustainability. A main goal of our follow-up research is to elaborate a methodology for the assessment of the sustainable urban development, using qualitative and quantitative indicators that evenly represent all the SD dimensions. Research should aim at the development of the complex methodology which will be useful in the process of planning and management of the sustainable urban development; and finally will be tested in selected Slovak cities.

Keywords: sustainable development indicators, approach, scheme