Institute of Landscape Ecology, Slovak Academy of Sciences

Landscape and Landscape Ecology

17th International Symposium, 27–29 May 2015
Nitra, Slovakia

SYMPOSIUM ABSTRACTS

Martin Boltižiar & Andrej Bača (Editors)

Nitra 2015

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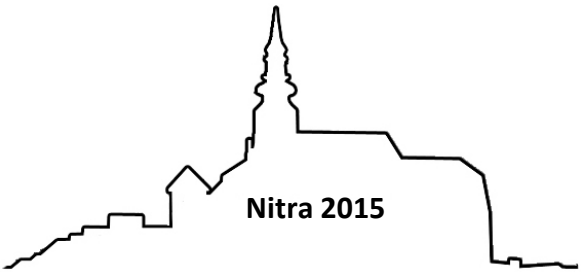

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Section 1: Theoretical issues of landscape ecology: current concepts and trends

Current concepts and trends in establishing Landscape Observatories at national and continental scales

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Many landscape monitorings are limited to the physical and biological space, despite the fact that land-use is strongly linked to the socio-cultural realm via people's perception. The latter is an important component for quality of life and people's place attachment. The European Landscape Convention (ELC) requires member states to monitor landscape-related changes both in the physical and the socio-cultural realm. Within the ELC framework organisations such as UNISCAPE (www.uniscape.eu) or the Observatory del Paisatge (www.catpaisatge.net/eng) have taken the lead in discussing and furthering the issue, whereas research is done in different European countries. Cassatella and Peano (2011) offer a comprehensive overview. Their Piemonte example comes closest to the requirements of the ELC. The Swiss Landscape Monitoring Program LABES (Kienast et al. in press) is one of the first large-scale landscape observatories (total area ca. 40'000 km^2) where landscape perception is systematically monitored with representative surveys. The entire monitoring consists of roughly 30 indicators that are embedded in the DPSIR framework (i.e. Driving force – Pressure – State – Impact and Response). Approximately 25% of the indicators measure perception properties. Respondents are instructed to base their statements on the landscape and places of their current home municipality rather than on pictures of specific landscapes. We distinguish two perception concepts: (1) an evolutionary determined perception component (concepts of Kaplan & Kaplan) and (2) a culturally determined component based on concepts such as e.g. fascination, landscape beauty or authenticity. Landscape perception indicators are then linked to innovative indicators of the physical space such as e.g. light emissions which is a straight-forward surrogate for urbanization and human activities.

To our knowledge only very few national landscape monitoring efforts used this bottom-up (and not expert-based) approach to gather information on cultural/perceptional aspects of landscapes, e.g. the Dutch landscape monitoring program reported in Farjon et al. (2009) and some environmental quality monitoring projects in Italian cities (e.g. Bonaiuto et al. 2003, 2006). The approach of mapping and monitoring landscape character areas is still state-of-the-art and the English Countryside Quality Counts (Haines-Young, 2007) is still a valid example how a comprehensive landscape observatory could be structured.

Judging from a few attempts that exist European-wide, we conclude that a landscape observatory should have the following characteristics:

- *Theoretically consistent* with recognized landscape theories, i.e. the "space and place" paradigm of landscapes currently accepted ecosystem goods and service concepts the Driving- Force-Pressure-State-Impact-Response Framework DPSIR
- *Measurable and sensitive to external change*
- *Comprehensive*: The indicator set consists of parameters covering physical characteristics of landscapes as well as their perceived and cultural characteristics.
- *Representative for a process and a specific geographic region*
- *Participatory in character*
- *Embedded in financially feasible frameworks*

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http://www.catpaisatge.net/eng/

The landscape, the European Landscape Convention and the law

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The integrated approach to the landscape management pronounced since the Rio Summit ´92 is still the command of the era. This approach is the most challenging topic for the landscape sciences. The theory and the practice of landscape sciences decisively influence several basement concepts of sustainable development, such as environmental protection, management of the natural resources, nature conservation, landscape planning procedures, integrated watershed management, and other policies. Therefore, right this approach requires an exact formulation of the main object of our interest – the landscape, as well as its formulation to the forms acceptable by the policy, decision making, planning, and projecting.

Nowadays, the concept of landscape occurs on broad scale of different sciences. Basically, at least two main streams should be identified: the so called "hard" geosystem based concepts, and, the "soft", cultural-heritage, value and perception based concepts of landscape. The first approach is represented by geographers and landscape ecologists, the second one by very different groups of "friends and lovers of the landscape", which includes specialists from landscape sciences, as well as a very broad group of social scientists, architects and artists.

A huge asset towards the development of the acknowledgment of landscape in politics is played by the European Landscape Convention. However – like every international convention – also this one shows the compromises between professionals, diplomats and politicians. Basically the scope of the Convention allows understanding of the landscape in a very broad scale, including the perception, cultural heritage, and value oriented approaches: *"Landscape is an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors".* The problem is not the loose definition itself, but the possibilities of the real acceptance of the landscape in science and in the practice. Namely, the Convention states, that the „softly" defined landscape should be treated by "hard" policies, as protection,

management and planning. But all such procedures require a materialistic, system definition of the concept of the landscape in the legislation, as resource for all other policies, management, planning and projecting practice. If we will not succeed to formulate the concept in legal form, the practice will apply the theoretical provisions of the Convention in a voluntary way.

All above mentioned problems force us to reopen repeatedly the theoretical questions on the definition of the landscape and its implementation to real policies.

At the Interface of Soil and Landscape Sciences, Philosophy and GIS technologies

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Interdisciplinary research, which is being conducted at the interface of soil and landscape sciences, philosophy, and GIS technologies, is distinguished by a combination of the theoretical questions on the definition of the natural landscape and its implementation to real policies.

It is suggested to consider the systems approach as the most challenging topic for the landscape sciences. The reasons for this are the following: (1) the systems approach is a philosophical and, therefore, general science and interdisciplinary approach; (2) natural landscapes can be regarded as systems, and (3) it is well known that the most interesting researches and scientific breakthroughs are made nowadays at the interface of disciplines.

In accordance with the systems approach the natural landscape is defined as a geographical system which is elementary structural unit of the earth's landscape envelope composed of interacting and interrelated elements with homogeneous genetic properties. All elements of the natural landscape are material substances: rocks, air, water, and organisms, which are basic elements, and soil – a derived element. The latter comes into existence through the interaction of the basic elements. The results of the research show that on the basis of this definition creation of supra-national world landscape classification and, consequently, multiscale global landscape map, containing all data required to ensure sustainable land management, are becoming a reality. However, it is absolutely essential to engage the modern GIS technologies for an expert analysis of a large number of different scale thematic maps, digital elevation models, and remote sensing data and eventually for creation of a resulting vector integral map containing information on the landscape features.

A comparison has been made between 'The landscape map of the USSR' (1988) compiled as a result of a field survey and our 'Agroecological soil-ameliorative map of the non-chernozemic zone of European Russia' (2006) compiled in an office mostly on the basis of the systems approach without using the landscape map. The comparison has showed that boundaries on our map are almost the same with that on the landscape map.

At present the systems approach is just pronounced in landscape sciences and is not implemented in its entirety.

Augmented Reality (AR) and landscape perception

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In an earlier study, the author (Pietrzak, 1999) presents the possibility of using research on the perception of the landscape for recreational landscape management. It is supposed that the further - possible - progress in research on the perception of the landscape can be achieved only through formalization of the research. This may be related, for example, with a technique called eye tracking, used e.g. in psychology, medicine and marketing. In the literature we can find the first attempts to use this approach also in the study of perception of landscape (e.g. De Lucio et al., 1996; Potocka, 2013). It seems that the new perspectives in the study of the perception of the landscape also makes use of the concept of augmented reality (AR - Azuma, 1997), especially that is already used in landscape architecture (e.g. Konopacki, 2014). The presented poster attempts to use this idea in the study of perception of recreational landscape in selected areas of Wielkopolska (Great Poland region, West Poland). The study showed that the use of the concept of AR provides information that cannot be obtained through traditional techniques using surveys and questionnaires. It can also be used in the promotion of knowledge about landscape and landscape ecology and landscape sustainably management.

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Patterns of woody plant encroachment on montane meadows in the Polish Carpathians

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In many developed countries over the past few decades an overall increase in forest area (Kozak, 2004; MacDonald et al., 2005; Sitzia et al., 2010; Munteanu et al., 2014) and the consequent decrease in semi-natural grasslands area (Prach et al., 1996; Prevosto et al., 2011) is observed as a result of the abandonment of agricultural land. This process is especially visible in the mountains. Cessation of mowing and grazing led to the encroachment of forest vegetation and the gradual disappearance of montane meadows also in the Polish Carpathians. In order to obtain better knowledge of species composition as well as spatial and temporal patterns of trees

and shrubs invasion, 45 meadows situated in the lower and upper montane belt in 6 national parks in the Polish Carpathians were examined. Patterns of woody plants encroachment varied among meadows, reflecting differences in environmental conditions.

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Landscape, memory and historical sources

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Landscape memory is very common term today and its usage is various. The term is usually connected with social sciences as ability of organisms to save and use information about previous experience. One of the possible explanations is a memory as composition of biotic and abiotic components. Even in this situation the information is the main term. The saved information here are the results of landscape history and particular place. Land changes in the past determine nowadays local basic characteristic. Each change creates and saves this information. Afterwards they influence possibilities of particular place and limit its usability. Landscape memory is comparable to the mechanical system that reacts to stimuli from external environment without changing inner organization. This information is written down as a palimpsest with the whole history of the place. The specific place „remembers" the history and the present, tolerates only specific land use and returns landscape to the previous conditions or trends after the wrong usage.

Suitable land use provides a good basis for ecosystem services. The example could be meandering and subsequent straightening of rivers, deforestation, relocation and change in soil layers. These changes in the past affected the present management and it is important to identify them. We can use these archival materials: the maps of the 2nd and 3rd military mapping, basic maps and other maps and historical aerial photographs. Landscape memory is needed to be

respected during the landscape planning and we have to learn the landscape history, the saved information and the memory of particular place thoroughly.

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Meta-landscape ecology as a new ecological science (selected meta-scientific aspects)

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The ever more frequent and complicated socio-economic and ecological / environmental problems in the globalizing world represent a great challenge for science. One of possible approaches to their solution is the meta-scientific one. Such approach is based on the cognition of science itself and its individual disciplines, their inner structure, organisation and communication with the surroundings. The aim is to find out to what extent they are able to generalise their time-spatial contextual, comprehensive as well as integrating entities and experience into universal regularities and laws, which may help solve these problems. The meta-scientific approach presented in this paper deals for the first time worldwide with meta-landscape ecology as a new ecological science which foundations were laid by the author of this abstract.

Meta-landscape ecology dealing with landscape ecology as a science, represents the most generalized and most integrated form of meta-scientific superstructure of landscape ecology, lying in penetration of meta-scientific and landscape-ecological entities, approaches, principles and general laws.

The key topics and issues of meta-landscape ecology are:

- *preservation* of authenticity and determination of identity for landscape ecology,
- time-spatial contextuality, complexity and integrity of landscape ecology,
- social-scientific relevance of landscape ecology,
- position and cooperation of landscape ecology among sciences involved with the study of relationship between humans and landscape,
- scientific-managerial marketing of landscape ecology (landscape ecosciencing, landscape ecobranding, landscape ecolabelling),
- meta-scientific synthesis and principles of landscape ecology,
- landscape ecology as a scientific system,
- research efficiency of landscape ecology and
- prognosis of development of landscape ecology.

Fresh meta-scientifically oriented knowledge of landscape ecology is not only epistemologically important for the theoretical, methodological, educational, and applied development of landscape ecology itself but also for its generalising nature for broader universal validity for other scientific disciplines with idiographic regional entity involved with landscape research and its relationship to human society.

Section 2: Methods in landscape research

Post-industrial landscape: its identification, typology and value

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The post-industrial landscape is an industrial heritage. Such landscape was directly made by industry or implicitly influenced and now it's abandoned. This landscape is characterized by specific physiognomic, structure and function attributes, which constitute relicts of the last industry period. These parameters are „recent" in industrial landscapes, but they are characteristically „fossil" in post-industrial landscapes. The characteristics are connected with all present landscape structures: natural, economic, social and spiritual.

A number of cases of post-industrial landscapes (more than 100) with following indications – allocations of brownfields, old environmental burden, dumps, stacks and embankments, mining areas and areas with human-made land forms on territories bigger than 5 km^2 were allocated by using digital geo-data obtained from all over the Czech republic. Each of landscapes was screened during a field research and details of their creation were collected. Then such information was used for classification of identified post-industrial landscapes to a lot of types.

The knowledge obtained serves solutions to various revitalization, funding and reconstruction programmes. The decision-makers are provided with clear information about the extend, contents, quality and topic problems of each identified post-industrial landscape what makes the starting point for planning their future.

Acknowledgement
Definition, classification and typology of post-industrial landscapes of the Czech Republic was the main aim of the grant project "The Fate of Czech Post-Industrial Landscape" number IAA 300860903 supported by the Grant Agency of the Academy of Sciences of the Czech Republic (2009-2011).

Habitat Diversity: A Key Category in Landscape Analysis for Spatial Planning in Mountain Conditions (A Case Study of the Banite Municipality, Bulgaria)

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The main objective of this study is to increase the objectivity and relevance of spatial analysis at regional to large-scale landscape research. The results provide argumentation that supports the introduction of habitat type information in complex landscape analysis, which allows for elaboration of landscape indicators for assessment of the degree of anthropogenic pressure, as well as for designing of adaptive forms of land use planning. The approach is applied in the

area of the Banite Municipality, Smolyan Region in the Rhodope Mountains of Southern Bulgaria. Concurrent analysis of habitat diversity in the area with the peculiarities of contemporary land cover is used; the latter being applied as a criterion for analysis of the landscape systemic character.

Habitat diversity in mountain areas is essential for a variety of landscape taxa which are the basis of landscape planning. Habitat diversity and landscape diversity are the most important categories that reflect the functional nature of the biodiversity category. In the context of the sustainable development paradigm, the existence of modern societies very much depends on spatial analysis and spatial planning, where the scientific categories of habitat and landscape diversity are of increasing significance.

This study attempts to integrate habitat diversity as a criterion in the landscape differentiation processes, including landscape mapping in GIS environment and subsequent analyses of the structure - function relations. Such an approach is prompted by the high natural heterogeneity of mountainous areas and the determining significance of habitats as an information indicator for major natural relationships in small areas.

Vegetated areas in relation to formation of local climate – an example of the city Nitra

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Trend of nowadays is decreasing of green areas related to increasing urbanization and spatial requirements of urban population. One of the factors that influences the local climate conditions in relation to environmental risks are vegetated areas in urban environment. The aim of this study is to specify the relation between functional areas with vegetation in the central city zone and categories of climate in the city Nitra. Climate as a significant environmental factor is defined by categories in urban environment (e.g.: Grimmond, 2007) as: climate of the city (climatic conditions of the city Nitra), local climate (climate of selected city district– housing estate Chrenova 1) and microclimate (specific climate of small area – selected residential blocks of housing estate Chrenova 1).

The significant data source for assignment of climate of city Nitra is the numerical model supported by (Ukrainian centre of environmental and water projects, 2006), that effectively minimises the estimation error of meteorological data by using the Kalman filter. For assignment of local climate we used the method of thermal surface monitoring. Acquired data were evaluated as average values for the selected city district. Microclimate conditions were monitored by using thermal surface monitoring in six localities in the housing estate Chrenova 1 during the spring and summer session 2013.

Acknowledgement
This study is the result of the project implementation: Environmental aspects of the urban environment ITMS 26220220110 supported by the Research & Development Operational Program funded by the ERDF and the result of the project: VEGA 1/0042/12 Analysis of selected environmental factors in relation to possible health risks.

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Types of traditional agricultural landscapes and their respective representation in the Kysuce region

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The Kysuce region is a significant historical region of Slovakia known for its specific natural characteristics and values, as well as for its characteristic type of settlements that resulted from its historical colonization. In this territory we performed mapping of traditional agricultural landscape (TAL) and biodiversity of TAL since 2009. This mapping was performed with modified mapping methodology of TAL (Barančok, Barančoková, 2012).

Almost 12% of the land area out of the total area of Kysuce region can be now characterized as areas with TAL. The largest representation, almost 10% of the total area, is attributed to the typical types of TAL with typical forms of anthropogenic relief (FAR), including areas with dispersed type of settlement. The largest representation of TAL can be found in the cadastral areas of Dlhá nad Kysucou, Zákopčie and Lutiše villages, where these forms occupy about one quarter of their territories. Individual types of TAL are most often found in parts of the monitored territory lying outside the main chains of settlements that stretch along major rivers such as river Kysuca and lower watercourses of Čierňanka and Bystrica. Therefore, the overall representation of TAL is greater in cadastral areas that wholly expand to or at least interfere with the surrounding mountain ranges, such as e.g. Oščadnica, Zákopčie, Nová Bystrica, Skalité villages. On the contrary, the lowest representation of TAL is in the parts of the territory with continuous forest complexes or in the lower and middle parts of the main valleys, where these forms were destroyed during the period of collectivization by land consolidation. The second most important type of TAL within the territory is the TAL with dispersed settlements. There are greater representations in the central and northwestern part of the territory, while in the eastern and southeastern part their occurrence is rare. The most typical and best preserved forms of dispersed settlements can be found in the cadastres of Zákopčie, Klokočov, Korňa and Raková villages.

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Long-term habitat changes from the 18th century in Hungary

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The past is a reference not only for understanding the present landscape, but for planning or predicting the future. Most studies on landscape change apply land-cover or land-use categories, because the available sources of cartographical and remotely sensed material support this approach. In our study besides the long-term landscape changes we detected trends of certain key habitat types typical in the Pannonian biographical region.

The pilot of the study went on a 30x60 km sample area in the central part of Hungary. We randomly selected the centre of 360 grid cells from the grid system of the MÉTA actual habitat database of Hungary (MTA ÖK ÖBI, www.novenyzetiterkep.hu). To describe temporal changes at each locality (centre of grid cells), we assembled a spatiotemporal point database. Points falling on arable land, vineyard-orchard, built-up area or tree plantation on the historical maps were characterized by the key of the map source. Localities falling on natural or semi-natural landscape were classified into habitat types following the National Habitat Classification System (Á-NÉR, Bölöni et al. 2007). We applied the change detection and the habitat-specific change trajectory analysis to analyse habitat change processes (Käyhkö and Skånes 2006).

After the pilot study we applied the same method on 5000 random point localities in the whole area of Hungary. For choosing the studied time periods, we relied on cartographical sources broadly available and cover large areas as Military Surveys, Topographic Military Maps and satellite images. ArcGIS 10.1.ESRI software was used for managing datasets and maps and performing spatial analyses. We analysed the trends of priority Natura 2000 habitats, especially wetlands and forest habitats, wooded pastures and some important dry grassland habitats.

Detected 230 years long country-wide habitat trends and the trajectories can be useful in practical management and conservation of valuable habitats and landscapes, especially the priority habitats of the European Union (Natura 2000).

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Spatio-temporal assessment of natural processes responsible for the recent deposition of sediment in postglacial lakes of the Tatra Mts.

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The study demonstrates a workflow and results of the assessment of spatial and temporal changes in landforms originated from hydro-geomorphological processes within the representative catchments of postglacial lakes in the Tatra Mts. It comprises both the analyses of

quantitative and qualitative data describing the selected landscape characteristics. The research methodology is based on the integration of miscellaneous techniques including the use of new-technology equipments for close-range photogrammetry and 3D imaging. The methods can be categorised in four main groups according to their purpose and manner of data acquisition and processing: 1) methods for new data acquisition by means of field measures and mapping; 2) methods for change analyses by means of remote sensing techniques and GIS tools for analysing orthophotos and historical aerial photographs; 3) GIS-based methods for mapping and modelling of relevant erosion-depositional processes; and 4) statistical methods for analysis and interpretation of meteorological data and spatial changes in terms of lacustrine deposit generation. New data acquisition is based on fieldwork and direct measurements using imaging and scanning portable devices. Delineation and measuring of planar dimensions of the selected landforms and land cover units are performed in GIS on georeferenced images captured by HD camera mounted on a quadcopter UAV (unmanned aerial vehicle). High-resolution digital surface models (DSM) of the sediment accumulations in the lake riparian zone are extracted from 3D point cloud data from terrestrial laser scanning (FARO Focus 3D 120) to detect recent changes in shape and volume of the deposits. The surface of lakebeds is scanned by a sonar device (LOWRANCE HDS 8) to provide bathymetric data for change detection purposes. A spatial accuracy of the data is improved using a geodetic RTK GPS receiver. Dataloggers with air temperature and humidity sensors supplement the available data from the nearest meteorological stations which helps in better parameterisation of the local climate variables in spatio-statistical modelling. A potential of erosion-depositional processes (e.g. debris flows) is estimated also by the analysis of historical data (aerial photographs and relevant precipitation data). The resulting geographic database comprises parameterised spatial and temporal attributes of the selected landscape characteristics that are used as variables entering the assessment model.

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Analysis of landscape typologies of Slovenia

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The primary goal of the paper is to analyse manually defined natural landscape types of Slovenia. Increasingly more digital data are available for natural factors in addition to an increasing number of geo-information tools. By overlapping maps of natural landscape typologies produced with different tools, areas can be determined that are frequently classified the same way, and areas that are not. Natural landscape types that were already defined in the past by geographers can thus be confirmed or rejected and attention can be drawn to any weaknesses.

Numerous landscape typologies can be found for Slovenia and we tested two of them (Perko, 1998; Špes et al., 2002). Samples of training cells were taken from each typology. Based on the training cells and the selected data layers (i.e., elevation, slope, permeability, and precipitation) we modelled natural landscape typologies. We used seven supervised classification methods (i.e., the minimum distance to means, the maximum likelihood method, the k-nearest neighbour, and four versions of the decision tree). Because seven modelled typologies were created for each original typology, the number of times an individual cell was classified into

a specific type was able to be determined. Such a sum of hard modelled classifications can be used as a general fuzzy typology that is created based on various methods and should therefore be relatively objective. We also compared the modelled typologies to the corresponding originals. The goal of this was to establish the extent to which models confirmed the originals. The analysis provided an insight into which Slovenian areas are difficult to classify into a specific type, and which areas can be confirmed with models easier. After an analysis of the results researchers can further evaluate Slovenian typologies and make eventual improvements. The tools used in the analysis can be also applied to different scales and geographical areas with adequate digital data.

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Ecology of the European silver fir *Abies alba* Mill. in vegetation landscapes of south-eastern Poland: GIS and multivariate ordination methods

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Abies alba Mill. is commonly recognized as a species declining in abundance in all geographic regions (including mountain, highland, and lowland populations) and in all types of plant communities, even in the association optimal to this species, i.e. mixed fir forest *Abietetum polonicum*, an endemic community of southern Poland uplands included in the list of EU priority habitats as the Holly Cross fir forest (code 91P0).

The studies were conducted in two areas of the Roztocze Highlands, SE Poland, at the north-eastern limit of species mass occurrence, namely in vegetation landscapes of Cretaceous hills – the Roztocze National Park (RNP) and break sections of four river valleys (RV) crossing the SW escarpment zone of the region and forming ravines of mountainous character. We aimed to answer the questions: (1) How wide is the ecological niche of *A. alba* at the limit of its geographical range? (2) Does *A. alba* expand its optimal niche (*Abietetum polonicum*; acid brown and podzol soils) for alternative niches contributing to greater diversity in the occupied habitats?

Geographical Information System has been used for studying the relationships between terrain characters of the two landscapes (primary topographic attributes – slope, aspect, planar, vertical and total curvature; secondary attributes – solar radiation and topographic wetness index) and ecological requirements of fir (ecological indicator values by Ellenberg). The analysis of the relation between habitat characters and fir abundance was performed with CANOCO (PCA analysis) and Statistica PL (Spearman's correlation coefficient and Mann-Whitney U test) software. The analysis was based on 222 phytosociological relevés taken in forest communities with a fir component: 123 from the RNP sites and 99 from the RV sites. Data on soil properties (pH, organic matter/C org., Ca and Fe content) were available for 39 and 33 of the analysed forest patches, respectively.

In the RNP, upland fir forests and other forests with fir are present on plain/plateau forms of terrain, while in the RV sites they occupy mainly steep slopes. Generally, in both vegetation landscapes, fir prefers mineral soils – from oligotrophic to mesotrophic, which are too leachy for leaf species and even spruce. In the RV sites, *A. alba* seems to have a much broader ecological scale as for soil types and forest communities, and colonizes organic soils in wet mixed coniferous forests with spruce, riverside ash-alder, and bog alder forests.

Quantitative and qualitative structure of the soil seed bank in basins without outlets in relation to microhabitat conditions

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Changes in the degree of habitat moisture are one of the major factors affecting the variability of plant communities and their constituent species populations. Investigations of the seed bank in hydrogenic habitats generally involve a large spatial scale and disregard the specific microhabitat conditions that can affect seed viability and survival of individuals recruited from the seed bank. Analysis of habitat heterogeneity in a microscale reveals area fragments that can serve a function of specific microniches referred to as safe germination sites. The aim of the study was to find answers to the questions: (i) does the quantitative and qualitative structure of the vegetation cover and seed bank exhibit variability in relation to selected habitat factors, mainly the degree of substrate moisture and selected physico-chemical soil characteristics? (ii) what is the quantitative and qualitative similarity between taxa recorded in the vegetation cover and seed bank along the soil moisture and fertility gradient?

The investigations were carried out in basins without outlets, i.e. small isolated hydrogenic objects located in the agricultural landscape of the Lublin Upland, Eastern Poland. The absence of a hydrological link of these objects with watercourses and other water bodies as well as the agricultural character of the catchment significantly limit the possibility of transport therein of seeds of species characteristic of moist habitats. In each basin, a transect was established, along which floristic inventories were made, soil was sampled for analysis of the seed bank with method of seedling germination and for assessment of the physico-chemical properties, and the levels of groundwater and surface water were monitored regularly.

The results indicate that the flora of the analysed objects is characterised by a very broad spectrum of ecological tolerance. The vegetation cover and soil seed bank resources are to the greatest extent influenced by habitat moisture, the gradient of which determines the occurrence range of many species. The results obtained also emphasise the role of small hydrogenic habitats in increasing the biodiversity of the agricultural landscape; they can be helpful in formulation of protection recommendations for sustainable management of agricultural land, which ensures maintenance of the mosaic of habitats.

Landscape and faunal diversity in middle-taiga landscapes

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The study hypothesized importance of the landscape spatial structure as a factor of fauna diversity differentiation. It is assumed that the spatial structure of the landscape contributes to the needs of animals in different habitat types, combinations of different types of forage bases and in providing favourable conditions for daily and seasonal migrations. The spatial structure of the landscape is quantifiable in the form of a series of indicators, each of which, or the combination of which is tested as a possible predictor of quantitative and qualitative indicators of faunal diversity.

The main subject of the study is the viability of populations of zonal boreal species in the middle-taiga landscape of European Russia highly fragmented by farmlands. Some of the species from groups of rare species (*Clethrionomys /Myodes rutilus, Myopus schisticolor*), game species (*Vulpes vulpes, Sus scrofa*) and key species (*Clethrionomys/Myodes glareolus, Sorex araneus, Microtus ardalis obscurus*) of mammals were selected as indicators. As hypothetical factors affecting the viability of indicator species and total fauna diversity the following effects were examined: 1) isolation of forest patches from primary forest landscape by cultivated fields; 2) the influence of different types of adjacent treeless patches providing part of forage reserve for forest species; 3) the influence of a size of isolated forest patch on occurrence of core and edge effects; 4) high original abiotic mosaic structure of landscape.

To assess the diversity of land cover of key areas and their surroundings classification of multispectral satellite image SPOT 5 with a resolution of 12 meters per pixel was performed. Different types of land cover were identified: mature coniferous forests, mixed coniferous-leaved forests and young pine forests, young deciduous forests, thin forests, shrubs and undergrowth, natural grasslands, fallows and cultivated fields. Then for the classified image landscape metrics that determine the diversity (Shannon index), edge density and isolation of key habitats were calculated in different surroundings. As an indicator of an isolation the proximity index was used, which takes into account the distance to the nearest similar type of land cover as well as its size. Then the obtained results of the landscape diversity analysis were compared with data on the general faunistic diversity and occurrence of indicator species in key areas.

Small carnivores in urban and agricultural landscape of south-east Poland – case study of the weasel (*Mustela nivalis*)

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Faunistic and ecological consequences of the transformation of the agricultural and urban landscape are still debated issues among ecologists, vertebrate zoologists and practitioners. The study included three cities of different sizes from the South-Eastern Poland (Lublin, Chełm and Łęczna). Agricultural landscape was selected as a control area. The data on the occurrence of weasel in urban and agricultural sites were derived from live trapping of small mammals. Overall,

18 060 trap-days were completed and 56 individuals of weasel were caught. Despite the excessive trap effort the number of weasels found in urban areas was very small. Weasels were not observed in traps located in the downtowns of large and medium-sized cities. Instead they were found only on the suburbs, whereas abundance of weasels in agricultural areas was relatively high. The fact that urbanization can be a barrier to colonization of the weasel has its ecological consequences for the phenomenon of biotic homogenization and the theories of natural enemy escape (for small mammals).

Forecasting of landscape dynamics using computer models: a case study at Roztocze Wschodnie (Eastern Poland)

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The study was performed within the border zone between Poland and Ukraine, at the region of Roztocze Wschodnie. The main aim of the study was an assessment of post-war changes in the landscape structure of the area that became a border zone after the change of national borders after World War II in Eastern Poland. The second aim was an assessment of possibility for forecasting landscape changes using CELLAUT model. Maps were analysed from the period before World War II (1936), some 30 (1965) and 60 years later (1996). Changes in the landscape were determined with ArcGIS 10.2.2 and Fragstats 4.1. The main land cover types analysed were: forests, settlements, rivers and roads.

Components of landscape mosaic were elaborated with ArcGIS. Then they were transformed to ASCII files to be used in the Fragstats programme and subsequently in the model CELLAUT that was created for an improvement of the analysis of landscape dynamics. The model, based on the theory of cellular automata, was verified in selected landscapes within the border zone. The main assumption for creation of this type of the model was the development of the potential provided by cellular automata, to predict changes in the landscape (He et al., 2011; Mitsova et al., 2011). Structural changes in this area were reflected in a decrease of settlements' density, distribution changes (deviational ellipse), and shift towards the west. Other elements of landscape structure underwent transformations, significantly changing the productive and cultural function of a landscape. Forecasts of possible changes in landscape dynamic obtained in the CELLAUT model, were compatible with trends found from the comparison of historic and current maps, and indicated most probable directions of future changes. Perspectives for the development of the model CELLAUT, in its application for forecasting of the dynamics of landscape mosaic within Polish-Ukrainian border zone, are presented.

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Extinction debt and colonization credit in highly fragmented forest landscapes

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In stable ecosystems, such as deciduous forests, slow dynamics in plant species populations are a common phenomenon. This often leads to time-delayed extinctions („Extinction debts") after habitat fragmentation or to a delay in the recolonization of newly established forest patches („Colonization credit"), respectively. The detection of an extinction debt or a colonization credit can be challenging because comprehensive data of the landscape history and the present day spatial configuration are needed.

We used a set of historical maps that ranged back to the year 1780 to reconstruct the historical deciduous forest distribution of the Prignitz region (NW Brandenburg, Germany). We found a forest area loss of more than 94% in combination with a substantial decrease of patch connectivity since the year 1780. The vast majority of the "ancient forests" were already cut and converted to agricultural land and coniferous plantations until the year 1880. After 1880 the forest distribution changed only slightly, albeit several small forests emerged in areas of minor agricultural value ("post-agricultural forests").

We surveyed the herb layer species richness of 104 ancient and 110 post-agricultural forest patches in two adjacent studies and fitted statistical models of species richness with land-use history and historical patch configuration as explanatory variables. In ancient forests the results indicated a small effect of historical patch connectivity on present-day forest specialist species richness. However, models with present day patch area and connectivity were always the overall better models in explaining present day species richness. This leads to the conclusion that the extinction debt in ancient forests of the Prignitz now has largely been paid since the main fragmentation occurred 150-200 years ago. In post-agricultural forests, however, we found an average colonization credit of 4.7 species; even in forests that were established 130 to 230 years ago. Hence, our results indicate that in highly fragmented landscapes the recovery of the forest species diversity in post-agricultural forests may take several centuries; if it ever will happen.

Application of Complex Profile Method in Coastal and Insular Landscape Studies in Estonia

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The coast of Estonia (4,010 km) has over 1,500 islands. The coastal landscapes are young (less than 10,000 years) and developing rapidly in an area of tectonic uplift. Due to geomorphic variety of the coast, different exposure to the open sea and the character and duration of land use, the landscapes vary greatly from site to site. The greatest changes in landscape during the last century have been caused by abrupt socio-political and economic changes.

The formation of landscape diversity on small islands is strongly influenced by topography and vegetation. The character of contemporary shore processes (erosion, accumulation) and water regime, including the extent of the influence of saline sea water, are critical in the formation of insular landscapes and their vertical structure (Turner et al., 1996). The reduction of human impacts and the development of vegetation lead to the unification of the landscape. The former meadows tend to overgrow with bushes and finally with forest, changing the properties of soils and matter cycle associated with a loss of valuable habitats, in general.

The complex or landscape profile method is among the best ways to analyze the complete spatial structure of a landscape, and to reveal mutual relationships between natural components of the system (Ratas et al., 2014). The method is preferred in specific comprehensive studies of two or three landscape components, most frequently describing the relations between soil and vegetation. A number of geomorphic and soil pits and vegetation sample plots are quantitatively analysed along topographic and water regime gradients on transects. The analysis can be repeated with 5-10 years interval depending on the velocity of changes in a particular study site. The method is well suited to the assessment of the rate of both natural (frequent strong storms and higher storm surges, fluctuations of groundwater table) and human (cessation of traditional land use, urban sprawl, high recreation loads) impacts on landscape changes.

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Forecasting of the dynamics of beech and fir forests of the Polish Bieszczady and the Ukrainian Beskidy Mts. under the influence of climatic changes

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The study concerned forecasts for the dynamics of beech (*Fagus sylvatica* L.) and fir (*Abies alba* L.) stands in the Polish Bieszczady and Ukrainian Beskydy Mountains. Study plots were set in the forestry area Procisne of Stuposiany Forest District (49º11'23''N, 22º38'39''E) in Poland, and in Jabloneckie forestry area of Nadsiansky Landscape Park (49º09'47''N, 22º45'15''E) in Ukraine. Beech and fir stands in these regions were actively managed in last several centuries. After the World War II, tree stands at Bieszczady were less intensively exploited due to resettlement of local inhabitants, but in the Beskidy part, belonging at that time to Soviet Union, the management of the forest was very intense. Therefore, neighbouring areas with the same ecological conditions have now different structure of tree stands and different accumulation of biomass.

Potential changes in the biomass and the number of trees per area unit were forecasted for next 500 years with software FORKOME (Kozak et al., 2003; 2012). There was analysed a control scenario without climatic changes compared with four variants of changes: 1- warm and humid, 2- warm and dry, 3 – cold and humid and 4 - cold and dry. Obtained results confirmed a cyclic tendency for changes in the structure of tree stands, i.e. an exchange of proportions between beech and fir biomass. Temperature variation will not affect the direction of those changes. However they may disturb their rate and the proportion of admixture species. According to this prognosis, lower tree biomass can be expected at Beskydy comparing to stands of Bieszczady. The output of those simulations is supported with field and literature data. Results of this study can be applied in long term planning the forest management in this region.

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Ukrainian part of the Danube Delta: Landscape Changes Issues

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The Danube Delta is the major Europe's wetland. About 20 % (1,128 km^2) of the Delta is situated in Ukraine. High richness of the Delta's wildlife, the natural state and processes which still take place at a large scale have a significant importance for nature conservation.

However, between the 1950's and the mid-1980's, large areas of the delta floodplain on the territory of the former Soviet Union were heavily drained for industrial farming. Natural hydrological processes and retention areas of the Delta were interrupted. This, among others, has led to changes in landscape pattern.

The goal of this research is investigation of landscape changes within the territory of the Ukrainian part of the Danube Delta for the period from 1985 to 2014.

We set out to investigate the pattern and changes in the landscape using satellite images from Landsat different missions [1]. Multi-angle hyperspectral Proba-1/CHRIS data was applied to fill up the gap in ground-truth data. Observations of wetland and floodplain areas are taking advantage from the PROBA acquisitions due to the CHRIS spectral and spatial resolution features [2].

In the present study the Landsat-TM (acquired on 8 July, 1985) and Landsat-OLI (acquired on 8 July, 2014) multispectral images were used to obtain spatial distribution of the main landscapes of the Danube Delta. Two landscape maps were produced by performing a supervised classification using the software ENVI (Environment for Visualizing Images 5.1, ITT Visual information Solutions) and applying a Support Vector Machine algorithm. These thematic maps outline development of the Danube water course, lakes, emergent wetland, inland marshes, deciduous broadleaf forest, croplands / natural vegetation, sparsely vegetation, and open soils. As a result, a map of landscape changes was also made.

The further research is meant to be directed at analysis and comparison of the landscape changes for the purpose of anthropogenic impact assessment in the Ukrainian part of the Danube Delta.

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Landscape changes in selected suburban areas of Wroclaw (Poland) and Bratislava (Slovakia)

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An excellent example of high-intensity changes in the landscape are the suburban areas of big cities, especially those parts located in close proximity to areas of protected landscape. The biggest changes in the landscape structure can be observed there mainly due to location of new building areas. The main objective of the study is to determinate from the local-scale case studies of Polish and Slovak cities the level and nature of current and planned changes in the landscape of suburban areas. The area of the study is divided into two parts. The first one is located in the suburban area of Wroclaw in directly adjacent to the Landscape Park of Bystrzyca Valley, and the second one is located in suburban area of Bratislava near Protected Landscape Area of Malé Karpaty.

On the basis of the identification and evaluation of changes in landscape structure in different time periods the index of landscape changes is determined and the nature and intensity of changes in the landscape in selected suburban areas of Wroclaw and Bratislava compared. The comparison is based on the changes of percentage of main elements in the secondary landscape structure manifested by extent of urbanization level, resignation from land cultivation, forestation and other changes in the landscape. The second part of the research is identification of main spatial conflicts and analysis of spatial planning documents of both research areas in terms of planned changes in secondary landscape structure. It helped to determinate the level of threat to the landscape described by changes in index of landscape synanthropisation.

The research of methods for ecological models of tourism development using quantitative (qn) and qualitative (ql) techniques

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The tourism is legitimately considered as the major branch of global economy and its global dimension is confirmed by the UNWTO (United Nations World Tourism Organization). It helps solve the problem of unemployment by creating new jobs, it contributes to an increase in gross domestic product and generates foreign exchange reserves. It also contributes to saving of historic building monuments, protection of cultural values created by human generations and also

treasures of nature. Research of the tourism development is currently moving towards methods with the appropriate quantitative (QN) and qualitative (QL) techniques, based on strong theoretical principles.

By the research of extension and structures of tourism we meet with relatively broad range of factors that affect different ways of development opportunities. Generally, these factors represent sources and assumptions such as location of recreational places, relief, climate, hydrology, fauna, flora, cultural and historical conditions, demographic and settlement conditions, economic situation, infrastructure, material and technical conditions of tourism development. The attempt to identify selected characteristics that at the best express the spatial aspects of tourism, necessitated to consider practical aspects in professional areas.

For the marketing and selected economic evaluations of tourism it is appropriate to use QN techniques because they require careful, objective measurements, such as number of visitor days spent recreation costs, etc.

Use of QN-techniques is suitable for quantitative assessment of objective functions of a selected landscape for tourism development, such as landscape-ecological significance, attractiveness of georelief, landscape scenario, etc. For an integrated approach taking into account geographical aspect in spatial menu layout evaluation (location and feasibility preconditions) and the demand for tourism development it is appropriate to use a combination of QN- and QL-techniques.

The presented case study is an example of using quantitative (QN) techniques in the evaluation of natural assumptions for tourism development.

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Physical accessibility of landscape and its relationship to landscape development

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Physical accessibility is recognized as an important driver of the landscape development in increasing number of studies. However, in most of the studies the accessibility is analyzed in simplified form as a direct Euclidean distance, with no regard to existing road network, land-cover or terrain that fundamentally affect the physical accessibility. This contribution is focused to advanced methods for analysing the landscape accessibility as the time needed to access the landscape. We present the usability of advanced GIS algorithms, input data sets and the friction coefficients needed for the analyses.

The use of analyses is presented in three case studies. The first one, from historical ages, presents the effect of landscape accessibility in relationship to the location of the settlements. The second one, from the second half of the 20th century, analyses the accessibility as important factor in preservation of traditional agricultural landscapes of Slovakia in time of socialistic

collectivization. The third one, from the present time, shows the accessibility as a driver for abandonment of traditional agricultural landscapes.

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Remote Land Degradation Assessment in the vicinity of Boryspil Airport

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The aim of this research is preliminary assessment of land resource degradation within a radius of approximately 30 km around the international airport Boryspil using a two-level model for land degradation mapping on multispectral satellite imagery of low and medium spatial resolution.

The Boryspil area landscapes belong to forest-steppe zone, forest and marsh meadow floodplains and wetlands. They developed as a result of climate aridity increasing and deeper groundwater occurrence on medium-loamy loess rocks. The soil types are soddy-podzolic, ashed, turf gley sandy, meadow, slightly salty at surface chernozem.

To assess the level of land degradation the authors performed preliminary processing of Landsat-5/TM and Landsat-8/OLI multispectral satellite imagery for the period from 1993 till 2013 obtained from the United States Geological Survey archive through the EarthExplorer data access portal (http://earthexplorer.usgs.gov). For the first model level two land degradation indicators – vegetation cover change and soil erosion – were mapped. Vegetation cover was evaluated using MSAVI vegetation index, and water and wind erosion were modelled using climate data from World Climate (http://www.worldclim.org) and soils specifications developed in the region: granulometric and hydrological numbers, average soil density, equivalent soil particles size, erodibility factor. Second level gives data fusion of specific thematic classifications of the first level into final thematic map to improve accuracy and reliability owing to joint interpretation. Algorithm for land degradation mapping was borrowed.

The areas of low, average and high degradation level are shown at the obtained map. More than 30% of the territory in the vicinity of the airport is subjected to anthropogenic impact of average and high level. The data demonstrate correlation between long-term agricultural and industrial impact and land degradation in the vicinity of Boryspil Airport.

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The application of landscape ecology to the prediction of changes in climatic conditions for growing agricultural crops. A case study from the Czech Republic

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Landscape ecology delimits vegetation zones in the Czech Republic using the method of bio-indication. Vegetation zonation in Czech landscape is the expression of the dependence of potential natural vegetation on the long-term effects of altitude climate, which is determined by the combination of average and extreme air temperatures and the amount and distribution of atmospheric precipitation. Global warming will probably manifest itself in a gradual shift in vegetation zones to higher altitudes, and thus the overall change in vegetation zonation. A mathematical model of changes in vegetation zonation in the Czech Republic depending on predicted climate change allows the evaluation of possible climate change impacts on the growing conditions of agricultural crops in the Czech Republic. It is a correlation model, which can serve as an example of the application of landscape ecology in dealing with practical problems of landscape management. The model can be used as one of the tools supporting the development of strategies and adaptation measures to climate change. This contribution demonstrates the application of the model on the example of analytical prediction of future temporal and spatial changes in ecological conditions for growing sugar beet, which is a major and traditional agricultural crop in Central Europe. Predicted climate change will have a positive effect on growing conditions of sugar beet in the Czech Republic – the areas suitable for growing sugar beet will become larger within the study area.

Trends in inter-component relationships during the recovery of disturbed landscapes

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The research focuses on the degree of mutual adaptation of landscape components (vegetation, soils, rocks, landforms) and the hierarchical organization of the landscape (i.e., the degree of subordination of the local geosystems to a higher-order geosystems). We elaborated the approach to identify changes in hierarchical organization during the recovery succession after anthropogenic disturbance. The object of the study is the middle-taiga landscape of European Russia. We discovered clusters formed by correlated properties of the landscape components, evaluated the strength of between-components relationships at various stages of recovery as well as the stability of relationships at different hierarchical levels.

To identify the relations between soil and vegetation properties and the relief of surrounding geosystems for forest landscapes after felling or agricultural use we used nonlinear multiple regression models separately for units disturbed less than 30 years ago, 30-45 and over 45 years ago. In the models vegetation and soil differentiation factors values (derived by multidimensional scaling) are used as response variables. Morphometric characteristics of

landforms derived from digital elevation models (DEM) with resolution 30 m and 400 m for varying environs serve as predictors. Comparing determination coefficients for three age models provides knowledge of how geosystem structure changes during the recovery succession. The results show evidence that relationships between vegetation and the relief characteristics become weaker as phytocenosis recovers after disturbance.

Similar response of vegetation and soil indicators to changes in environmental conditions enabled us to reveal the clusters of interrelated properties of landscape components which are sensitive to 1) humidity, 2) swamping process and 3) nutrients supply. To assess the stability of clusters during the recovery nonparametric Spearman correlations were calculated for the different stages of succession. Some properties of components vary more coherently in accordance with ecological gradients as the recovery of natural landscapes goes on. On the contrary, for certain properties coherence of response to environmental conditions decreases at the later stages of succession. Overall, interdependence of vegetation and soils properties usually increases as natural landscape recovers.

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The landscape and historical preconditions of Moscow's origin

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The main purpose of the study is to determine the role of a landscape factor in the history of origin and development of Moscow. The methodological basis were the landscape and historical approaches that take into account the regional and local physical and geographical differentiation of the territory and combines both space and time.

A diversity of landscape conditions on the territory of Moscow is caused by, mainly, features of lithogenic basis (geological constitution and relief) and distinctions in local climate of landscapes. Moscow is located on a joint of three physical and geographical provinces, namely, Moskvorecko-Okskoya, Moscow and Mesherskaya, that largely follow the relief of the Russian plain that includes Moskvorecko-Okskoya erosional plain, Klinsko-Dmitrovskaya ridge and Mesherskaya lowland (Annenskaya, etc., 1987). The territory of modern Moscow has nine different landscapes, the majority of which reach far beyond its limits. It is a unique fact that eight of them practically converge in the central part of the city.

Moscow, as well as other cities near the Moscow region, has arisen, first of all, as the centre of development of an agricultural area. The choice of a place for construction of Kremlin is not accidental. It is difficult to find a better place other than Borovitsky hill in the modern borders of Moscow. This place combines the control over the routes of the communication with excellent defence opportunities. Kremlin is located on a plot of low out-washed plain, which is protected by water barrier and natural coastal slopes. It is more correct to name it a cape near junction of the rivers.

The use of field methods (such as landscape, archaeological, paleopedological, paleontological and other natural scientific methods) with off-site methods (such as an analysis of archival, cartographic and stock materials using GIS technology) has let reveal the landscape

patterns of settlement and economic development of the Moscow territory in the early stages of the city development.

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Slovak cultural landscape and its recent transformation

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Development of cultural landscape is a continuous long lasting process combining both natural conditions and human society activities. Modern approaches to land use changes focus on very recent time horizons using automated, semi-automated or manual interpretation of satellite images on various geographical coverage (from regional to global). The analysis of historical cartographical data and lately aerial photographs revealed three distinct socioeconomic periods in the development of Slovak cultural landscape: (i) transformation from feudal to capitalist system in the 18th–19th centuries, (ii) rapid change from capitalist to socialist system (1948-1989), and (iii) return to democratic system based on free market principles since the 1990's. Each of these periods was characteristic for certain land use changes depending both on the landscape character or the socioeconomic situation. Land use changed significantly during those periods. These changes were driven by changed political and property situation and technological development. In recent decades, main driving forces of land use change, especially in post-socialist countries, are economic situation and social pReferences:. These drivers are often combined with unexpected natural disturbances triggered by climate change.

The paper describes changes in Slovak cultural landscape that underwent three stages of different social and economic development in its history. These were the transformation of a feudal society into a market society in the 19th century and the first half of the 20th century. After 1948, the capitalist system gave a way to a central planning system that was replaced again by a market system after 1990. These vital changes have been translated into a varying development of landscape structures and land cover also when the years 1990, 2000, 2006 and 2012 are evaluated by means of CORINE land cover and land accounting method. The paper deals with the assessment in four landscape types: lowlands (27% of Slovakia's area), basins (14%), valleys between mountains (7%) and mountains (52%). A detailed analysis of several model areas of different locations and development of landscape is added to this general look at landscape changes in the whole Slovakia.

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Combining remotely sensed data with ground penetration radar methods for bog structure detection (the Belomoro-Kuloyskoe plateau case study)

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Wetlands are the key landforms for estimating the carbon storage and the intensity of gas emission. A wetland's type and pattern are the main parameters for potential human activity assessment, as well as for the forecast of the wetland's response to the anthropogenic impact.

Bogs and fens are wide spread across the Belomoro-Kuloyskoe plateau (Arkhanglesk region, Russia). Local people use wetlands for berries harvesting. Migrating birds use pools for rest. Two diamond deposits with open exploitation produce main human impact.

Bogs and fens have a complex inner structure. A seemingly uniform peatland landscape can include multifarious micro-landscapes. The aim of the research was developing the algorithm for the identification of a peatland type, peat layer depth, and the shape of the peatland bottom, using available remotely sensed data (Savelyeva, 1991) combined with minimally required field work.

The data we used were: Landsat-8 image (06.08.2013, 15-30 m/pix); GeoEye image (14.08.2006, 0,5 m/pix); ground penetration radar (GPR) profiling data; peat drilling data; landcover descriptions.

We used a neural network approach (Schowengerdt, 2007) to classify Landsat image, while the very high resolution GeoEye image was expertly classified. We also performed the GPR profiling for key sites by means of the Zond 12e, 300 Mhz (Vladov, Starovoytov, 2005), which was subsequently verified by on-ground peat drilling.

The main types of peatlands were considered as followed (Boch, Mazing, 1979): ridge-hollow, ridge-depression, large ridge-hollow, flat, hummock. Within the study area we determined the two following peatland types: narrow peatlands with distinct orientation and wide peatlands with no apparent orientation.

Peatlands of the first type have a complex spatial pattern so they may even include the peatlands of the second type. We have also determined the combinations of the Landsat and GeoEye image samples and GPR profiles required for the successful peatland structure identification.

Suggested approach can provide a good spatial base for many types of ecological assessments and forecasts.

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Landforms and the shaping of cultural landscapes in mountain areas: Analysis of permanent pastures landscape of *Alto Barroso* region (Northern Portugal)

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Alto Barroso develops in a transitional strip located between the mountain ranges of North-western Portugal and the plateau of "Trás-os-Montes". At a macro-structural scale, this upland corresponds to a tectonic step. It contains a succession of uneven highlands, divided by the entrenchment of the valleys of the main watercourses.

The characteristics of the cultural landscape of *Alto Barroso* are clearly connected to its functional dimension, being mostly shaped by ancestral agro-silvo-pastoral systems and techniques. They are the outcome of the conjugation of hydrogeological and climatic constraints with the soil use options and technical solutions adopted by communities.

This research aims to contribute to the understanding of the landscape of *Alto Barroso*, explaining why the land use distribution closely depends on medium scale landforms and of its relation with the climatic pattern.

The methodology to assess the relation between landforms and the organization of the landscape mosaic was based in the development of a geographic information system that allowed conducting a correlated analysis of the geomorphologic map with the following cartographic levels: lithology, soil, hydrography, land use and built heritage associated to agro-silvo-pastoral activity.

The results achieved enabled to:

- define the conditions of the distribution of permanent grasslands, specific water-meadows and agricultural uses, including the morphostructural, pedologic and climatic factors;
- classify the different types of evergreen pastures – water-meadows sustained by a specific watering practice that consists in the maintenance of a permanent surface flow.
- identify and classify the landforms with major interest for landscape interpretation, as well as those with remarkable heritage value, considering the scientific, ecological, economic, cultural and aesthetic criteria.

This research proved the relation between the geomorphological features and the landscape mosaic. Landforms play a crucial role in the soil use pattern, particularly in the case of the permanent grasslands that are a key resource of the regional economy.

The simplification of geomorphological cartography, translated into a landforms map, is a methodological strategy to promote the use of geomorphological knowledge in landscape analysis. Moreover, the identification of the landforms that grounds the landscape organization may support the selection of meaningful geomorphosites to the narrative of the territory.

Using the Laser Technology in Designing Land Functions

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This article presents the possibilities of using computer scanning to design a location for a sewage treatment plan taking into account its impact on the landscape. The land research consists of scanning the area for the sewage treatment plant using the 3D method. The used automatic laser measurement technology allowed measurable, fully objective point models to be obtained in a short period of time. The resultant scan was processed by superimposing a texture to obtain a spatial model, and then land development elements were inserted in their natural environment. Visualizations can be helpful in selecting the most advantageous land development option, and can result in protecting land before it is developed or in leaving it unchanged.

The collected data will constitute the basis for the possibility of using computer scanning to visualise the development in an area of high landscape value. The study described in this paper was intended to present the possible application of the laser scanner to protect the environment at the stage when spatial planning decisions are made.

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Landscape degradation and its effect on the soil-vegetation relations within juniper forest in the Fann Mountains (western Pamir-Alay)

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Juniper woodland landscapes here are degraded as a result of mass cutting for economic needs. This causes erosion and changing the chemistry of the soil environment that will lead to the degradation of the landscape as a whole. The relations between soil and landscape vegetation differentiation with respect to their functioning under influence of human impact was investigated. Particular attention is paid to the change of mountain juniper forests, which is a consequence of soil degradation, depletion of floristic composition and their functioning. At higher and inaccessible parts, the landscape area has a more natural character than the areas available for human activity. This is evident mainly in the vegetation and soil cover. Vegetation is represented by juniper forests and the main species are *Juniperus semiglobosa* Regel. and *J. seravschanica* Kom. Both species are long-lived (they can often live for over 1,000 years) and have different habitat requirements. They are useful for determination of landscape memory and also have dendrochronological potential.

The analyzed soil is characterized by varied granulometric composition. At the highest altitudes strongly predominates material of gravel-stony fraction > 2 mm in the form of limestone debris of different edges. The contribution of sand and smaller particles < 2 mm is much smaller. At lower altitudes thick material > 2 mm makes about 60%, while the finer (< 2 mm), about 40%, and in first floor elevation – respectively 55% and about 45%. Soil pH in all the investigated samples is neutral or close to it, which undoubtedly results from the nature of the geological substratum. In all test samples to a depth of 10 cm the available phosphorus (avail. P) predominates, which content varies in the range 3,4–14 $mg.kg^{-1}$, in contrast to the lower depths, where it is almost two times less. A significant and comparable contribution in the profiles has available potassium (avail. K), representing a wide range of 39–83 $mg.kg^{-1}$. OC (organic carbon) content is clearly dependent on the amount of NT (total nitrogen) and vice versa. The greatest amounts of OC (10–25 $g.kg^{-1}$) and Nt (1.2–2.0 $g.kg^{-1}$) occur in the upper soil horizons. A similar dependence is observed in cation exchange capacity. In all studied points the C/N ratio is narrow and points to the rapid mineralization of organic matter, which in these ecosystems it is generally low.

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Urban heat island vs. flora features in the Lublin city area, SE Poland

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The process of urbanization transformed the European landscape during the last century and created new environmental conditions for plants. In big cities, the various forms of human activity, concentrated in a relatively small area, contribute to creating a specific climate (Sukopp, Wurzel 2003). One of the most important effects of urban climate studied is the air temperature increase in the city in contrast to the surrounding areas. This phenomenon is called the urban heat island (UHI). A great number of factors are involved in formation of the UHI: general climate features depending on local factors, e.g. relief, urban structure, density, and type of settlement (Oke 1982).

The aim of the paper was to analyse the flora features with special emphasis on thermophilous species on the background of thermal conditions prevailing in the city centre and suburban areas.

The study area was located in the Lublin city and its nearest surroundings. Distribution of species was noted in the grid composed of squares 1 × 1 km. Where possible, thermal requirements of species were defined on the basis of Ellenberg's ecological indicator values (1991). As the thermophilous plants were recognized species with T value 6-9. The analysis of the mean monthly, seasonal, and annual values of temperature was based on data from meteorological stations for 2000-2010.

The investigations revealed a significant effect of the area of the city on thermal conditions and flora quality. In the study period, the mean temperature in the city centre was by 0.4°C higher than in the suburban areas. No cool years were noted in the city, and eight were fairly warm, warm, or very warm. In total, 548 species were recorded in the study area including 272 thermophilous species. They are concentrated in the city centre, where they represent over 55% of the flora, whereas in suburbs they account for up to 34%.

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Multidisciplinary approach to research on historical landscape structures

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The area investigated around the Deserted Castle is covered by forests and is nowadays a popular recreational zone for the town of Zvolen. Comprehensive archaeological research of the medieval castle was supplemented by the investigation of lesser-known historical landforms in the vicinity of the site. We focused on historical landforms with communicative functions. These are not topical for archaeology, but are closely interconnected with archaeological sites and could be very interesting for tourists. We applied regular landscape-ecological approaches in the study: the positioning of landforms in the field (GNSS, 2012), and the interpretation of historical communications within historical military maps (1810-1866), historical topographic maps (1957-1971) and actual ZBGIS maps (2012). The comparison of data in GIS applications demonstrates the inaccuracy of data obtained from historical maps as well as from GNSS. Consequently, we used modern contactless technologies - aerial laser scanning (Riegl LMS-Q680i, 700 m, 2012) - for the identification of historical landforms amongst the terrain. We interpreted the data accuracy and evaluated morphometric parameters and morphographic attributes of landforms in the representative locality. The data obtained and interpreted through modern technologies could be implemented in an attractive application available on websites for the public as "a virtual guide to the historical landscape".

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Land use changes and its reflection on landscape architecture landmarks

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Natural development processes bring remarkable changes to the landscape, namely to its geography, climate and vegetation components. The anthropogenic influences and changes are provided by different forms of human activities according to individual economy branches as forestry, agriculture, settlement activity, transport, industry and production, energy power production and distribution, water management, military and defence constructions and others.

This contribution develops a methodical approach where attention is focussed on agricultural land-use forms and their reflection on the architecture of landmarks. Agricultural land-use forms depend on the type of property ownership, stage of technical progress, production and management technologies, and social background of the human society. Those are reflected in landscape architecture that means space composition and characteristic features of natural and anthropogenic elements. As a study territory we chose lowland and hilly landscape types of Slovakia with an accent on production of various sorts of corn, and on fruit and vineyard cultivation. We have divided the architectural landmarks to horizontal and vertical group elements. Among the horizontal macro-landmarks there belong landscape structure elements as a reflection of land-use forms, with their shape, surface area and colour of plots, often in a form of mosaic and line elements. Among the micro-landmarks there should be ranged the land-surface pattern and pictograms of the farm products, shape and colour of elements related to cultivation technologies of cultural plants and fruits in the orchards. To the group of vertical landmarks related to agricultural activities there belong predominantly individual human artefacts and technical works, as well as rural urbanized and production areas. Elements of both the horizontal and vertical landmark groups should be categorised according to their time of origin to historical and current ones. All landmarks that are perceived as a representative regional 'agrodesign' will be classified, particularly described and documented by sample figures.

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Quantifying Landscape Changes through Land Cover Transition Potential Modelling (on the example of the Black Tisza river basin)

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Understanding landscape changes driven by multiple complex factors in space and time raises an important challenge to landscape ecology. These changes are imprinted in spatial landscape pattern dynamics which in turn can be recognized and measured through land cover changes modelling (Baker, 2009, Kolb et al., 2013). The aim of the study is to analyze and understand the drivers of land cover changes, simulate their transition potential maps, and quantify predicted landscape changes through the set of landscape metrics.

The Black Tisza river basin (48.07° – 48.40° N, 24.14° – 24.55° E) in the Ukrainian Carpathians was chosen as a study area. The watershed area is 567.72 km^2 with absolute heights range from 447 to 2 004 m a.s.l. The basin is characterized by heterogeneous relief, different local climates, and resulting soil and vegetation types. The study area covers landscapes with the different types and intensity of disturbances: (1) highly transformed foothill area with secondary grass- and croplands; (2) medium height hills with mixed forest landscapes and secondary grasslands; (3) high hills with coniferous forests alternating with clear-cuts of different recovery degrees; (4) highlands with subalpine and alpine meadows.

The landcover maps were obtained from classified Landsat TM (1989, 1998, 2009) and OLI (2014) imagery. Global Forest Change 2000 – 2012 dataset was used for controlling the

classification accuracy and calculating of some intermediate landscape metrics. The dataset of explanatory variables included SRTM DEM altitude and slope, WorldClim bioclimatic variables, road network and settlement boundaries extracted from the OpenStreetMap database.

QGIS Modules for Land Use Change Simulations have been used to reveal and analyze driving forces of land cover change and model transition potential as the plug-in is specially designed to analyze land cover changes between different time periods, model land cover transition potential, and simulate future land cover changes using few algorithms. Simulated land cover change scenarios were analyzed in FragStats to quantify and interpret changes in spatial patterns through landscape metrics.

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Determination of hydric significance in the Poprad river basin for the needs of an integrated landscape management

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Land use affects the quantity and quality of the water within the river basin significantly. The river basin represents the spatial unit in which the water quality improvement, water management and flood protection measures take place. This could be achieved by proper landscape management, which requires an integrated approach. Thus it is necessary to consider all aspects of the landscape, as well as society demands and landscape potential as a whole.

In relation to current flood problems, the basin landscape structure and utilization analysis represents the crucial step in flood protection. Thus flood protection measures should be projected based on the assessment of the specific landscape features related to water runoff and retention.

In following contribution we deal with determination of hydric significance, representing the ability of the landscape to retain water, slow the runoff and encourage infiltration. Hydric function (as the attribute of the river basin) represents the complex attribute reflecting such processes. The main input parameters into evaluation process are represented by geomorphology, hydrogeology, soil and climatic conditions, the current landscape structure and forest ecological status. Each attribute is assigned to specific score and weight value according to its significance. Based on these input data we have calculated a distributed hydric significance value for the whole basin. The whole basin was then divided into four categories of hydric significance, from excellent, to good, average up to limited. These categories express the landscape water retention capacity. Areas of low hydric significance are than the subject of land use optimisation. A new landscape arrangement should then reflect the flood protection and water retention enhancement.

Analysis of the spatial and temporal distribution of selected landscape diversity indexes in detailed scale (Example of the viticultural landscape Svätý Jur)

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The aim of this study has been to assess the temporal and spatial changes of landscape diversity (LD) by means of Shannon and Simpson LD diversity indexes in a detailed scale on example of a part of the vine-growing landscape at Svätý Jur in two periods. Regarding the present profoundly changed landscape of the study area this is the reconstruction of LD values in viticultural historical cultural landscape.

Landscape diversity (LD) values were set for each individual square (side 25 m) of rectangular grid for the years 1896 and 1949 respectively in the prevailingly viticultural landscape in a part of Svätý Jur cadastre with an area 66.16 ha. Shannon landscape diversity index (SHDI) and Simpson landscape diversity index (SIDI) were applied as a LD metrics. Viticultural landscape land cover has been interpreted in a more detailed way. Two basic levels were set: large-block and small-block narrow strips of vineyards. LD of the area in 1949 has slightly increased compared to 1896. On more than a fifth of the area (22%) there were no changes of LD, 47% of the area had a larger SHDI in 1949 and while 31% of the area had its SHDI larger in 1896.

Presented methodology facilitates a detailed assessment of LD changes in a small area or in the whole study territory. Expectations concerning relatively small changes of LD in the quoted years attributable to stable land property status have been mostly confirmed. The use of two most popular LD assessment indexes, that is, SHDI and SIDI pointed to some differences in obtained results in case LD values were classified into size categories. The method used appears to be one of useful and operative tools of landscape attributes identification and management improvement performed in a detailed scale.

Remote Sensing (UAV) for torrent inspection/survey in the alpine municipality of Weng im Gesäuse (Austria)

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The Austrian Forest Law (Forstgesetz) from 1975 committed municipalities to annual torrent inspection/survey. Torrents should be controlled together with their tributaries to various so called mischiefs (e.g. crossing barricades such as fallen trees or branches, silted culverts etc.). Subsequently, these barricades must be removed to reduce the flood and debris flow hazard (floods and mudflows) downwards.

Within the presented pilot study different Remote Sensing data were tested to support larger alpine communities with many torrents. The main research question was to what extent Remote

Sensing data can be utilized for the detection of mischiefs. High-resolution UAV images, aerial photographs (UltraCam data and conventional ortho-photographs), high resolution satellite imagery (IKONOS) and laser-scanner data for two relevant streams in the alpine municipality Weng im Gesäuse (Styria) were analysed and compared with the results of the torrent field survey.

In addition to different methods for the detection of mischiefs, the data availability, actuality and acquisition (weather and seasonality dependency) as well as the processing and the cost estimates for municipalities were taken into account, in order to point and determine out the actual utility/effort of Remote Sensing based torrent control. One focus of this work was on the high-resolution UAV recordings, which are cost effective, allow flexible scheduling and have gained importance within the area of Remote Sensing over the last few years.

The result of this study shows that, contrary to some weaknesses in the acquisition, processing and analysis, Remote Sensing data can be used to assist the torrent inspection. The greatest utility is proofed in the application of high resolution UAV images at the beginning of the vegetation period for steep and inaccessible mountain streams with low bank vegetation.

An example of the application of the methods in landscape history – a case study from Southern Estonia

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It is necessary to obtain data on landscape history in order to understand the current patterns in rural areas and develop appropriate policies for conservation. It is also important to explain to the public how modern landscapes are the product of centuries of interaction between man and his management practices such as slash and burn agriculture.

The aim of the study is to develop suitable methodology for identification the former slash and burn sites in modern landscape and examine the contemporary features of these sites. The study areas are in the Karula National park and in the Haanja Nature Park in Southern Estonia.

Maps from the Nineteenth Century were used to identify the former slash and burn fields. Comparison historical maps with contemporary maps and databases were carried out to describe the character of slash and burn sites. Using these maps was selected sites for fieldworks both in former slash and burn sites and old forests. Landscape elements and soil profiles were recorded in 67 sites with different history and the results were treated statistically.

Most former slash and burn areas are now covered by forest. The field studies show, that bigger area was used for slash and burn as the Nineteenth Century maps indicate. The landscape elements show better correlation with slash and burn history: presence of field margins and large relict trees in the forest. Also these features are not perfect because in the flat land the terraces does not form and the large relict trees could miss.

Particles of charcoal can be found in soil profile in forests but these could origin both from slash and burn cultivation or wildfires. In slash and burn sites charcoal usually is located in the lower part of humus layer and the humus layer is homogeneous because of ploughing. In original forests the soil profiles have been disturbed by natural processes.

To identify the former slash and burn areas complex features must be considered. The paper will conclude with description of local landscapes and how they have been derived. For example the tops of hills were usually used for slash and burn and they are now forests which are up to 150 years old.

Quantitative analysis of rural settlement pattern of the North of Russia

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The aim of our study was to develop technique of quantitative analysis of rural settlement pattern in different nature environment. The research was done in Kargopol area, one of the northernmost agrarian regions of Russia. The region is interesting for its long agrarian development, geological variety, but uniform socio-economical situation and climate. The spatial pattern of agricultural lands and corresponding rural settlement pattern is essentially determined by the landscape pattern.

The majority of the region is occupied with Carbon karst plateau coved by thin (to 5 m) moraine clay. The settlement pattern here is characterized with location of village clusters around rather large and shallow karst lakes, which in turn obey the Poisson law according the theory of mathematical morphology of landscape suggested by Alexey Victorov (1998). It was empirically tested that the centres of the village clusters obeyed the Poisson law and empirical vicinity coefficient proves the random distribution of villages, which is not usual for other settlement patterns.

The second settlement pattern occurs within river valleys. This type of rural settlement pattern is widely spread in taiga zone. The valley settlement pattern is often characterized with pair symmetry of villages on two banks of the river. Every valley can be characterized with its own symmetry coefficient, which shows closeness of real settlement pattern to ideal symmetrical location. Other parameters of the valley pattern are settlement density along and across the valley, distance distribution from the river and others.

The third type of settlement pattern is within glacio-lacustrine depressions with rather rich soil and the lake in the centre of depression. The empirical parameters of this pattern were found, including settlement density within the depression and its dependence on the distance from the lake.

Our research shows that every type of historical rural settlement pattern can be described with certain quantitative parameters depending on the landscape pattern of their environment. Our goal is to find appreciate quantitative parameters for every rural settlement pattern in taiga zone and prove their relations with corresponding landscape patterns using landscape metrics.

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Mathematical morphology of landscape: new trends and results

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The aim of the presentation is to show new trends of the mathematical morphology of landscape. The mathematical morphology of landscape is a new branch of landscape science studying quantitative laws of mosaics formed by land units on the Earth surface, including mathematical analysis of these mosaics (Victorov A.S. 1998,2006, Kapralova V.N. 2014). Mathematical models being the theoretical kernel of the mathematical morphology of landscape are the general base for a many task decisions. The models are based on the random process theory.

The new trends of the mathematical morphology of landscape are the following:

1. Using the mathematical morphology of landscape for dynamic balance analysis in landscape morphological pattern development.
2. Using the mathematical morphology of landscape to natural risk assessment for engineering constructions.
3. Using current landscape metrics for searching dynamic landscape parameters.
4. Landscape metrics optimization.

The first trend can be demonstrated on the example of the morphological pattern of alluvial plains. It is proved that this type of area is characterized by a state of dynamic balance. The relationship between probability distributions of package size and duration of cycle of meander development was found as an exponential distribution with a shift.

The example of the second trend is an analytical decision for probability of influence of thermokarst on energy infrastructure (a pipeline). The decision was empirically tested.

The third trend is used for studying morphological pattern of areas with landslide hazard. The analysis of the mathematical model proves that this territory reaches the state of dynamic balance. The relationship between parameters of this dynamic balance state and probability distribution of landslide activation time was found.

An optimal set of landscape metrics for plains under soil subsidence is an example of the forth trend.

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Quantifying Landscape Fragmentation

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The provision of tools for monitoring and especially quantifying the impact of human activities on forest landscapes facilitate the design of efficient and assessable forest resource policies and risk assessment studies. Status and trends of land cover objects can be described by their pattern, connectivity, and fragmentation. While there are many quantitative measures for pattern and connectivity, fragmentation is usually provided as a qualitative description for a specific species living in the landscape under study. Yet, a meaningful understanding and interpretation of landscape dynamics in general requires a generic, reliable and especially quantitative assessment of fragmentation. This presentation will illustrate the concepts of normalized, quantitative fragmentation metrics describing the overall degree as well as the spatial distribution of fragmentation of any land cover type in digital image data. The proposed indices apply the holistic approach of spatial entropy instead of addressing and summarizing the many different aspects of fragmentation individually. Such normalized indices permit not only a concise state assessment on a given site but also the inter-comparison of fragmentation for different sites. In addition, temporal changes can be localized and quantified. The reliable quantitative assessment of fragmentation is a prerequisite for any statistical analysis. Besides highlighting hotspots of changes it permits measuring, and thus evaluating the progress in biodiversity and landscape planning projects.

Methods and tools for pattern, connectivity, fragmentation, change analysis and more are summarized in the free software collection GuidosToolbox available at: (http://forest.jrc.ec.europa.eu/download/software/guidos).

Landscape diversity of the Danube plain – exploring the peculiarities in Lom municipality, Northwestern Bulgaria

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In the ongoing process of global natural changes and socio-economic adaptation, we cannot discuss sustainability without taking into consideration the natural conditions and their impact over the environment. Coupling the broad scale of natural and human factors, the landscape diversity of a particular area creates favourable conditions for various scenarios in the landscape ecological planning. The Danube plain provides such conditions with its landscape diversity and related potential.

The present research brings into focus the municipality Lom - moderately populated area, situated in North-western Bulgaria, bordering with the Danube River to the north. The case study area encompasses different general landscape units – plateau planes, lowlands, river valleys. Only by analyzing the landscape characteristics of the research area, the potential of the territory could be revealed and the further analysis could be successfully integrated in the land use management plans and decision making with high socio-natural and economic outcomes.

This paper reviews the landscape diversity into fragmented landscape units, defined by the analysis of the unique liaison of the landscape components *in situ*. The results are illustrated in landscape map which combines both the natural and anthropogenic aspects of the research analysis and is also well implemented as a visualization tool. The identified landscape units are arranged into a classification system that presents the deterministic role of the different components.

The discussion pillars step on the landscapes' diversity that gives opportunity for landscape and ecosystem services' evaluation and also - a detail analysis of the region's potential. Moreover, this approach could be successfully implemented into the environmental management process, policy implementation and development scenarios.

Landscape Diversity and Spatial Modelling of the Wetland Natural Systems in the Rila Mountains

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Investigation of landscape diversity and functions of wetland systems has been a basic issue of geographical researches during the last decades. Understanding of dynamics of the processes and evolution of the wetland systems are key elements for understanding of problems connected with the impact of global change in the mountain regions of the South-eastern Europe.

Wetland natural systems are one of the most dynamic natural structures. Minor changes in natural conditions reflect the status of wetlands. Wetland systems in high Bulgarian mountains have glacier origin. The Rila Mountains are the highest mountains on the Balkan Peninsula and a significant mountain system for Bulgarian nature and the protected area.

The investigation observes the present status of the landscape diversity in the regions with wetlands in the Rila Mountains. The other aspect of the research is the spatial modelling of the wetlands and landscape diversity. The classification of the landscapes diversity is based on the Classification of the landscapes in Bulgaria in scale 1: 500 000. A head-up digitizing technology has been applied in generating of the spatial models for the regions with wetlands.

The research results can be used for optimization of management plan and zones in the protected area. There is an opportunity to apply the investigation in different strategies for development of mountain regions.

Landscapes of Arctic areas newly abandoned by glaciers: identification, differentiation and transformation

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Extensive areas with completely new landscapes have been abandoned by Arctic glaciers due to their recession under climate warming after the Little Ice Age (from 1901 to 2014). Remote sensing (based on aerial photos and satellite images) is very useful but insufficient for identification of these areas, e.g. it is difficult to distinguish glacial ice from a deglaciated or periglacial area under snow. Field landscape mapping is necessary for precise recognition of glaciers' extents and internal differentiation of newly deglaciated areas which become very differentiated, contrary to their previous high homogeneity.

New marginal zones, at fronts and around lower parts of glaciers, have the most varied landscape structure due to origin of numerous types of deposits, landforms and water bodies. Deglaciated areas around the upper parts of glaciers are less varied due to a common lack of glacial deposits on mountain slopes there. These new landscapes undergo different geomorphic and hydrological processes (both superficial and underground), animal colonization, plant succession and soil formation. Hence, the landscape transformation is very quick there.

Until the 1980s, this research field belonged to geomorphology. Afterwards, with a progressive widening of deglaciated areas and development of their biota (intensified by a significant current warming), a landscape-ecological approach has become particularly effective there due to a high complexity of these landscapes and a quick rate of their transformation. Such an approach has been used in Svalbard (Zonneveld et al. 2004, Ziaja 2004, Ziaja et al. 2009).

Summarizing, this research field widens quickly because a volume and extent of glaciers are far too big in relation to the current climate and components of landscape mosaics are becoming smaller. Hence, a lot of virgin areas wait for investigations based on the landscape-ecological methods.

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Section 3: Landscape and ecosystem services: concepts and applications

Ecosystem and landscape services: development and challenges of disputed concepts

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Over the last years, the ecosystem services (ES) concept is strongly growing in popularity, primarily to overcome the long-term neglect of biophysical and ecosystem functions – often considered gratis – in our economic cycles and the societal system as such, and as a reaction to the increasing degradation of ecosystems providing these services. Meanwhile, an avalanche of research and political documents is referring to ES, large-scale research projects were implemented and an exponential growth in the number of published papers related to ES took place. At first, the presentation will briefly recapitulate the development and important milestone of the ES concept.

The idea of ES may enhance the awareness for ecosystems as a basic condition for human life, and it can be used as a stimulus and tool to find appropriate solutions for land use to balance economic interests with ecological and social requirements. However, we should not overlook critical voices. The debates refer to elementary issues such as definitions, classification and measurement, the complexity of ecosystems, or the appropriateness of frameworks and valuation tools. There is still a lack of established ways of integrating ES into policies and decision making processes. More fundamental is the criticism that the concept would favour a pure anthropocentric focus, prioritize markets, and promote a "commodification" of nature. Non-market governance structures would be threatened, and the multi-layered relationships between man and nature might be reduced to economic issues. ES may conflict with some biodiversity conservation objectives. Several critical arguments will be addressed, and it will be emphasized that the ES concept should move beyond the narrow utilitarian and monetary focus, also to improve its capacity to deliver scientifically sound assessments and practical solutions.

Finally, some points of criticism will be weakened, namely by broadening the focus from ecosystems towards landscapes and by the definition of landscape services (LS) as "the contribution of landscapes and landscape elements to human well-being." On several examples it will be shown that there are important reasons for LS: the prominent role of spatial aspects, the reference to landscape elements and the landscape character, the perception of the environment more as landscape than as ecosystem, and the relevance for planning.

Research of vegetation changes in intensively used areas of the Chopok Peak (the Nízke Tatry Mts.)

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Locality of the Chopok Peak in the area of the Nízke Tatry Mts. is intensively used for sports and recreational purposes. In connection to the development and modernization of Chopok - south and Chopok - north centres, there is currently a fairly extensive intervention in natural environment. Significant interventions and changes relate to the flora and vegetation of the area.

In the study area of southern and northern slopes of the Chopok Peak (including high-mountain, sub-alpine and alpine belts) we conduct long-term and periodical research of vegetation. The aim of our work is to capture all changes that occur in abundance of vegetation units, in the species composition of plant communities, in the occurrence of dominant species of the flora, in the spread of non-native or invasive species etc. Research of flora and vegetation is performed in the full-area, for example in mapping of occurrence of endangered and rare species of flora and in the vegetation mapping, respectively habitats of the area or the research is carried out on the permanent monitoring plots (PMPs), where we tracked changes in species composition of vegetation units, also, the dynamics of changes in the occurrence of dominant species or impacts of specific human activities (construction, trampling, using of technical snow etc.). For the purposes of our research are used well established methodologies that are modified due to the nature of the studied site, or vegetation and the nature of the monitored natural or anthropogenic effects (stress factors).

The data and knowledge are used for evaluation of changes in vegetation that we have gained in this area before the start of intense construction activity. From the southern part of the study area was processed complete map of the spread of dominant species of flora; there have been mapped distribution of habitats and processed data on grasslands vegetation of ski trails and permanent monitoring plots. From the northern part of the area were processed only smaller sites, which were most affected by human activities. All data will be assembled in the following time period using data from full-area research and data from permanent monitoring plots (PMPs), which have been established for this purpose.

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Water retention in traditional agricultural landscape in the cadastral area of Liptovská Teplička village, Slovakia

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At present, problems of frequent storm rainfalls and the resultant floods as well as droughts as a consequence of climate change are very topical in Slovakia. Over the last decades the flood-protection measures in landscape were aimed at the maximum outflow of rain water from the territory. They were oriented to the landscape protection in time of floods and to the transformation of flood flow. However such technical concepts cannot be effective sufficiently. It is important to deal with revitalization of damaged parts of landscape as flood prevention. It is closely associated with water retention in landscape which depends on landscape diversity and biodiversity. Such diverse landscape character is typical for traditional agricultural landscape (TAL). The pilot area Liptovská Teplička belongs to the best preserved TAL's in Slovakia. It is situated in the eastern part of the Low Tatra Mts. in the altitude from 846 m to 1,429 m. It belongs to the highest situated agricultural villages in Slovakia and has extreme relief-climatic conditions for agricultural production - steep slopes with rocky soils located in cold climatic region period. The village during its historical development was characterized by the high level of division of agricultural land into parcels. Due to this division and steep slopes, there were created plenty of long and narrow parcels with field margins (balks) – forms of anthropogenic relief (mounds, heaps, terraces and their combinations). Despite of agricultural intensification in the last century there have been preserved a great number of such unique landscape elements.
Our contribution is dealing with assessment of water retention function of field margins as important flood protection landscape elements. Geological bedrock, primary relief inclination, balk type and its height, slope, skeleton content, position of the balk towards the relief curve, land-use and management of balks and adjacent productive plots as well as climatic data in relation to root biomass have been studied as indicators of water retention function. The first results show that the elements with the best water retention capacity are the rocky-muddy linear mounds on the dolomite bedrock which are regularly mown and occasionally grazed and have a diagonal orientation to the relief curve. The results can serve as a proposal of flood-protection measures in intensified large-block agricultural landscape situated predominantly in mountain areas.

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Ecological and social functions of plant communities and ecosystem services in rural landscape

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Rural landscape is a mosaic of ecosystems in which natural and semi-natural communities predominate. The concept of ecological and social functions of vegetation (Eliáš, 1983) and inductive (bottom-up) approach to identifying and valuation of ecosystem services (Eliáš, 2012, 2014) were applied in a microregion Tribečsko, SW Slovakia, Central Europe. Methods of ecological and social-economic valuation of vegetation (Jurko, 1990) are based on semi-quantitative analysis of species diversity (specimen vegetation relevés) and other parameters characterizing plant communities. Ecological functions are considered within a system of ecological relationships and they are important for existence of natural ecosystems. Social functions of vegetation are considered in the system of social/socio-economic relationships. They are products of the society's needs and make use of the properties and effects of the vegetation. Usability of the socio-economic functions depends on local environmental and economic (market) conditions as well as externalities (Eliáš, 2013). Field studies of ecosystem functions and/or services are needed to assess/estimate the capacity/potential of ecosystems and quantify the ecosystem services in the countryside. In the microregion, provisioning and regulating services are better recognized in forest ecosystems, while provision of food in agro-ecosystems. Many of the semi-natural grasslands and vineyards were abandoned which has resulted in degradation of the ecosystem services provided.

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Upscaling carbon fluxes from chamber measurement to the landscape-scale in Norway spruce forest disturbed by windthrow and bark beetle in the Tatra Mts.

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Windthrows and bark beetle attacks are among the most important disturbances of forest ecosystems in Europe. Increasing frequency and intensity of damage is forecasted due to expected climate change. Carbon sequestration, as one of the key forest ecosystem services, might be notably reduced under changing environmental conditions. Surprisingly, little is known about carbon dynamic following disturbances, especially in mountainous landscapes.

After a large-scale windthrow and bark beetle outbreaks which hit the Tatra Mts. during the last 10 years, we established a network of monitoring sites to study soil carbon stock and soil-vegetation-atmosphere CO_2 dynamic. Using the chamber method we estimated the main ecosystem carbon fluxes: 1) ecosystem carbon efflux (respiration - Re) and 2) assimilation (gross photosynthetic production, GPP). We identified soil temperature, soil moisture and photosynthetically active radiation respectively, as the controlling factors for ecosystem CO_2 fluxes. Statistically sound regressions among CO_2 fluxes and instant microclimate values were extrapolated across the season using continuously measured values by on sites located automatic weather stations. Spatial upscaling from point-wise to landscape-wise scale was based on regressions between C fluxes and microsite and/or vegetation conditions. We interpreted the landscape-scale carbon sequestration as a difference between GPP and Re. In 2012 the forest damaged by the 2004 windstorm was a carbon source, but in 2013 it turned to carbon sink. Forest destroyed by bark beetle in 2007-2009 was still a large carbon source. Soil organic carbon (SOC) stock controlled by forest disturbance history, present weather and vegetation, seemed to be the key factors for carbon sequestration in the study region.

We emphasise the need for further carbon dynamic monitoring to estimate the soil carbon fate in long-term after different type and intensity of large-scale disturbances.

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Landscape heterogeneity as a tool for enhancing biodiversity

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One of the main functions of cultural landscape is preservation of biodiversity. Around 75% of the European landscapes are the result of agricultural use, and they support 50% of all species (Tscharntke et al 2005, Lomba et al, 2014, Duflot et al., 2014). This is especially true for the landscapes with prevailing traditional agricultural practices and extensive technologies. Rapid changes in the last few decades have caused the „vanishing" of these landscapes, mainly driven by two opposite trends: abandonment on one side and intensification of agricultural production

on the other. In reaction to these trends, several conservation instruments have been proposed as a part of EU and national nature conservation and agricultural policies, for example, a designation of High Nature Value farmland areas, which cover around 30% of European agricultural landscapes (EEA 2004, 2009). For the preservation of high heterogeneity of cultural landscapes and their dependence on socio economic context, EU member states should define these areas and develop measures to protect their biodiversity. While evidence of the positive interrelation between landscape heterogeneity and biodiversity has been reported in the literature (Duelli, 1997, Fahrig et al., 2011), the elements and characteristic of landscape which are important for the maintenance of biodiversity need to be determined in the regional context. In the presented case study for Slovenia we developed a model of the interrelation between landscape heterogeneity and biodiversity which is to be tested on a selected nature protection area. The guidelines for the management of agricultural landscapes will be developed and verified among the stakeholders.

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Functional vegetation assessment in landscape ecology

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In the last years we can observe the boom of interest in ecosystem services and their assessment as well as attempts to quantify and map the ecosystem services. However, many recent approaches are quite schematic, semi-quantitative, often based on expert opinion or estimations. On the landscape level, the re-classification of land cover maps is often used ignoring the spatial and structural variability of abiotic and biotic parameters. This situation induced a need for suitable methods that 1) are based on an ecological theory; 2) link structural and functional aspects of ecosystems; 3) could be applied on landscape level in a spatially explicit way. This paper aims to contribute to the search for such methods using plant functional attributes and their assessment.

In the introduction we shortly review approaches to the vegetation assessment that could be or are being used in the landscape research. The main part of the paper is focused to utilisation of plant species attributes for vegetation assessment, especially in relation to vegetation functions.

Our approach is building on theoretical and methodological work of Jurko (1985, 2000) and the concept of plant functional types (e.g. Lavorel and Garnier 2002). We gradually developed the database of plant species attributes that could be used for rapid assessment of different properties of vegetation, in total 36 parameters could be assessed currently. In this paper we discuss individual parameters and their usefulness for functional assessment of vegetation. We demonstrate assessment methods, including multi-criterial evaluations. The results of assessments we present in three different case studies: functional assessment of selected vegetation units (phytosociological associations and alliances), assessment of grasslands of two different regions of Slovakia and assessment of vegetation on the cadastre level. The last case study represents an assessment of vegetation of a compact area that allows us to produce maps of vegetation functions, mostly interpreted as ecosystem services.

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Landscape biodiversity changes of the Morava river alluvia in the context of economic development

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Alluvia of all bigger rivers have been almost destroyed by melioration and hydrological works and often changed into networks of simple agroecosystems. Excessive use of artificial or natural fertilizers, insecticides and other chemicals also contributed to the extinguishment of some unique biotopes. Meanwhile, use of some pesticides was often ineffective. This also was the case of the Morava River.

The Morava River is among the most important streams of Central Europe and one of the biggest tributaries of the Danube while the biggest tributary of the Morava is the Dyje River. The Morava is a border river flowing through three countries: the Czech Republic, the Slovak Republic and Austria. Its lower and middle reaches coincide with the frontier between the Slovak Republic and the Austria and between the Slovak Republic and the Czech Republic respectively. Alluvium of the Morava is a territory with valuable biological and ecological assets.

The alluvia on the river with an area were included among the territories protected by the Ramsar Convention. Besides the flood territory delimited by the stream and the dike, the Ramsar territory also includes the forest and grassland beyond the dike and outside the inundation area. The alluvium of the Morava is part of the protected territories NATURA 2000 including the Protected Bird Territory of the Morava and several territories of the European significance.

Recently, another new phenomenon emerged. Presently, in the consequence of economic pressure many cooperative farms close down and in some areas farming disappeared altogether. The meadow ecosystems which depend on extensive farming are most affected. Development of ecotourism and extensive farming oriented to ecofarms and the return to the traditional farming practices represent a certain hope that the trend can be reversed. The alluvium of the Morava River offers ideal conditions for such activities which will have to be realized taking into account the territory on both sides of the frontier, the Slovak and the Austrian. Only an adequate and bilateral cooperation between these two countries can guarantee observation of nature conservation and ecological land use principles.

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Assessment of ecosystem services and their perception in the context of intrinsic value of habitats

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Ecosystem services are defined as the benefits people obtain from ecosystems (MA, 2005). However, although the tools for rapid assessment and monetary valuation are being successfully developed, the intrinsic value is still not clearly understood and accepted. Ecological functions and services of nature are irreplaceable and there is no sense to make a monetary valuation, however it is possible and purposeful to value their holders – habitats as a complex of suitable niches for plant and animal species (Seják, 2005). The intrinsic values of natural system features and processes within the natural system itself may possess different abundance and functional value properties than their corresponding economic values. Several ecosystem services are not going through the market and thus there emerges a permanent structural underestimation of the economic aspect (Mertz et al., 2007). As methodological background the Hessen school structural parameters and evaluation procedure were chosen, supplemented with the Article 17 Habitats Directive parameters reported regularly by the member countries (the last reporting period 2007-2012). The habitats of European and national significance were selected for this purpose. The results show unsatisfactory sensitivity of such evaluation for this type of habitats. The aim of this contribution is to look deeply to the intrinsic value of ecosystems and to outline the possible both conceptual and practical connection with the ecosystem services.

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Socio-economic functions of abandoned ameliorated peatlands at Meschera lowland, Russia

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Abandonment of formerly cultivated land can generate different landscape evolution models. Some of them are connected with the changes that improve landscape characteristics, others entail evident loss. Abandonment of drained peatlands is considered to be a benefit for the environment owing to wetlands contribution to carbon sequestration and their important role in maintaining water quality as well as providing dwelling and a source of supply for wildlife habitats (Jenkins et al., 2010; Peatlands..., 2008). On the other hand unregulated desertion of cultivated lands brings damage and loss to biodiversity and soil fertility (Franz, 2011), not to mention the reduction of agricultural land.

The research study was conducted at Central Meschera lowland (55,3N, 40,2E) on the peatlands which have passed tree periods in the management and modification of natural environment:

- pristine state;
- drainage and intensive farming in 70-80's;
- the state of 20-year abandonment.

Comparison of socio-economic functions of observable landscape give grounds to suppose that landscape have gained small benefits and obvious losses due to the land abandonment.

- Biological production of herbaceous ecosystems either decreased or has not altered.
- Cereals have been substituted by less nutritious grasses.
- The contrast of moistening between upper and lower sites has risen.
- Ameliorated histosols previously neutral and nitrogen-rich have transformed into acidic soil short of nitrogen.
- Slow water logging does not provide new peat formation.
- Surface waters contain less nitrogen, but are enriched in organic carbon compared to the period of farming.
- The territory has become overgrown with shrubs and is inhabited by numerous blood-sucking insects and because of that has no recreational potential.

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Evaluation of Microclimatic Factors in Different Layouts of Built-Up Areas and Vegetation Cover of Urban Areas of Nitra Municipality

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Many studies highlight altered climatic conditions of urban environment resulting from the presence of artificial materials at large active surface areas. These areas radiate heat (accumulated from direct solar radiation) in the periods of a negative energy balance, which occurs already during the daylight but especially after sunset. Urban vegetation affects the urban climate not only by its structure but especially by its functions. Research on microclimate dealing with relationships between vegetation cover and urban environment can bring benefits to land-use planning, as well as maintenance of urban greenery and appropriate design of its layouts, resulting in healthier environment for urban population. Our poster aims at comparing four selected layouts of urban built-up areas of the Nitra municipality in relation to microclimatic factors of air flow, surface temperature, relative air humidity and air temperature. Data on microclimatic factors were obtained by the method of surface temperature monitoring by TSI Veloci Cale 9565 – P device in 2014 (April - September). Individual built-up area layouts include *Street compact built-up areas* (historical), *Street scattered built-up areas* (houses with gardens), *Scattered built-up areas* (industrial zone of the town), and *Mixed built-up areas* adjacent to a town park. Each built-up area layout is represented by a street with a vegetation cover surface and an uncovered surface.

Different air flow in scattered built-up areas (i.e. an industrial zone of the town) on monitored surface without vegetation results from the open space of a broad street. Air flow in the street compact built-up areas is restricted to its orientation. Irregular values in air flow predominantly occurred in monitored areas without vegetation. The highest values of the factor of surface temperature were recorded in scattered built-up areas. Air temperature medians in the street compact built-up areas in the historical town centre were higher in monitored area with vegetation cover, in which lower air flow medians were recorded.

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Evaluation of soil retention potential as an important factor of water balance in the landscape

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Water balance of the country is divided into three approximately equal volumes: water soaking into the soil, evaporation and water runoff from the land. The amount of water retained in the soil and its spatial distribution in the country depends on the retention capacity of the soil and the nature of the soil water regime. To mitigate water runoff it is necessary to know the potential retention capacity of soils and propose management measures for its optimization.

In the study, we focused on creating an algorithm of hydrological balance, which takes into account the parameters of soil-ecological units (*SEU*) and morphometric conditions of the landscape (*DMR*). The result is a cumulative index to quantify the potential retention capacity of soils (*PRC*), as the basic feature of abiotic components of the landscape for understanding the dynamics of surface runoff.

The output is a special soil classification of soil-ecological units (*SEU*) of Slovakia, representing an elementary evaluation database of the retention potential of the country linked to the hydrologic balance of water in the agricultural landscape. The case studies present a potential retention capacity for the model landscapes of the lowland (Svätý Jur), hilly-land (Hriňová), piedmont area (Liptovská Teplička) and mountains (Osturňa, Malá Franková, Veľká Franková). The proposed solution may be a key contribution to mitigating the impacts of climate change on water regime in the open-soil areas.

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Floodplain functions and rehabilitation potential

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The perspectives of rivers and riparian areas to regain seminatural conditions are described by different concepts. Recovery potential usually means that after human intervention seminatural conditions potentially develop within a time-span of 50–100 years. This is obviously

not relevant for regulated rivers. Strictly speaking, restoration potential means the re-establishment of natural (pre-regulation) conditions. As a more appropriate term, rehabilitation potential covers the achievable simultaneous performance of widely interpreted floodplain ecosystem services/environmental functions (flood protection, groundwater replenishment, sediment and nutrient retention, water purification, resilience and recovery of river ecosystems after accidents, biodiversity/habitat, river-floodplain products (wood, fish, game, reed), cultural values, recreation and tourism, and climate change buffering capacity. The success of floodplain rehabilitation heavily depends on exploiting the rehabilitation potential.

Floodplains are well-known biodiversity hotspots. Our study area, the protected Szaporca-Drava oxbow is an assemblage of valuable wetland habitats: water plant communities, with e.g. *Salvinia natans* and *Stratiotes aloides* (potential habitats of an European red list water beetle); reed and *Typha* beds, alder mires. As part of the Ancient Drava project, a large-scale rural development programme intended to fight the general desiccation trend, extra water is provided from the nearby Fekete-víz stream. Our research is designed to assess the efficiency of this project from the aspect of water replenishment. We estimate the rehabilitation potential of the study area using the following methods: monitoring groundwater levels and soil moisture contents, surveying vegetation and soil dynamics and estimating water budget for the oxbow system.

Preliminary findings show that the water replenishment interventions will not be sufficient to maintain a healthy ecosystem throughout the year. The predictable consequences of climate change (i.e. increasing frequency of droughts) may also contribute to the deterioration of ecological conditions.

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Assessment of the ecosystem services framework implementation in Slovakia

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The concept of ecosystem services (ES) could be identified as one of the leading and most promising approaches in the field of environmental management, landscape and urban planning at all spatial levels – from the EU through national to local level. The main objective of our research in the framework of the FP7 OpenNESS project is an evaluation of current state of the ecosystem services framework implementation in Slovakia and proposal of appropriate methods for the landscape and spatial planning at local and regional level in urban and peri-urban areas – on the example of Trnava case study.

The overall evaluation of the ES concept implementation in Slovakia was based on several steps, including review of valid national legislative documents, providing list of authorities and

their competence; review of current key regional and local planning and strategic documents; and interviews with representatives of key focus groups and stakeholders.

Methodology to assess national documents included several criteria – overall document assessment in connection to ES concept, relation to the main groups of ES (provisioning ES, regulating and maintenance ES, cultural ES), impact of the document implementation, complexity and multi-sectoral approach, applicability of valuation methods. 12 key national documents were evaluated. Evaluation of key regional and local planning and strategic documents was based on similar criteria as mentioned above. The main strategic and planning documents for both Trnava town and region were considered (11 documents in total). The interviews with representatives of key focus groups and the stakeholders were performed in the town of Trnava and surrounding municipalities. The key findings confirm the overall low level of understanding of the ES concept and its weak implementation in Slovakia.

Outcomes from our research should serve as a basis for ES valuation process, decision making and the spatial (urban and landscape) planning in the case study area of Trnava. The main goal behind is not only to incorporate the ES concept into the environmental legislation and policy, but also to the most relevant sectoral policies (and to make them more harmonised) and into the territorial-planning and decision-making at all spatial levels.

Educational landscape potential versus educational landscape service. The case of secondary education in Krakow and Tarnow (Southern Poland)

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Among many different ecosystem or landscape services, the service: "environmental education", or broader – "knowledge systems" – is rather rarely considered in scientific approaches. This landscape service is based on specific characteristics of landscapes called here "landscape educational values". In this text, they are understood as both biotic and abiotic features of the natural environment (or a landscape) which can be potentially used to acquire knowledge about the structure and functioning of the current and past (on a geological time scale) natural environment. The usage of the educational values of landscapes/ecosystems for the purpose of learning is here called "educational landscape service".

The aim of the study is to compare the landscape educational potential with its usage in the scope of formal education. Two cities were chosen for the case studies: Krakow and Tarnow (both in Southern Poland, Małopolska Province). The areas surrounding the cities reachable by city public transport were delineated in purpose of the application of an assessment method. The method was based on the following criteria: (1) Number of issues which can be explained on particular place, (2) Typicality, (3) Uniqueness in the study area, and (4) Easiness to identify in the landscape. The criterion 'typicality' was defined by three subcriteria: (a) consistency of the objects features with schoolbook definitions, (b) transformation level, and (c) a stage of development. In order to measure the educational landscape service flow, the survey with teachers and students of secondary schools in Krakow and Tarnow was conducted. The respondents were asked about localities visited for educational purposes in the scope of formal environmental education.

The results show that the map of educational landscape potential based on assessment criteria only partially overlap the map of the places visited by teachers with students for the purpose of outdoor environmental education. Additionally, many teachers indicated that they do

not have enough time during school year for any educational trips with students. Therefore, the maps of the landscape educational potential of the surroundings of cities where the most of secondary schools are located may help to turn the teachers' attention to the nearest landscape elements which can serve for environmental education during one single lesson.

The influence of land use change and landscape fragmentation on selected ecosystem service provision

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The fragmentation can initially increase the landscape biodiversity, if the species-rich ecotonal communities have been created between neighbouring habitats. If, however, the level of fragmentation decreased significantly the territories of key species below the subsistence area, the biodiversity decline (above all ecosystem service providers, redundant and other key species) can be apparent because it disrupts the whole food web. This may result in reduced ecosystem function performance and related ecosystem service provision.

The aim of our contribution is the analysis of the influence of land use change and landscape fragmentation in two small catchments (Všeminka, Fryštácký potok) in the forest-agricultural landscape of the Eastern Moravia (the Czech Republic) on selected ecosystem service provision. The following set of indices, describing a structure change and landscape fragmentation rate, was analysed from Corine Land Cover data in map scale 1:100,000 from 1990, 2006 and 2012, using software ArcGIS 10.x, with the help of the extension Patch Analyst: i) length and density of edges, ii) patch size change, iii) patch area to perimeter ratio, iv) change in fractal dimension (McGarigal et al. 2002) and v) mesh effective size (Jaeger 2000). In addition, the land use/cover was verified from aerial photographs (in 2005 and in 2012 verified in the field) and habitats were identified and valuated according to Biotope Valuation Method (Seják et al. 2003).

For each period the values of Carbon Sequestration and Sediment Retention ecosystem service provision were figured out. In the case of the carbon sequestration, the model InVEST was adapted and completed by core area of given landscape segment distinguishing (McGarigal et al., 2002) and assignment of modified sequestration indices and transient zone estimation on the basis of road-effect zone (Biglin, Dupigny-Giroux, 2006); all made in a vector space. To evaluate the sediment retention, the model WaTEM/SEDEM (Verstraeten et al., 2002), allowing the incorporation of landscape structure and/or the spatial organisation of different land units and their connectivity, was applied. The water erosion component of WaTEM/SEDEM uses an adapted version of the Revised Universal Soil Loss Equation (RUSLE) to calculate mean annual soil loss values. The relationships between land use change, fragmentation and selected ecosystem service provision in the 1990, 2006 a 2012 are discussed.

Landscape diversity and current state of landscapes of the "Utrish" reserve

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The "Utrish" reserve is one of the youngest reserves in Russia. It was established in 2010 to protect the sub-Mediterranean landscapes, which exist in the extreme north-eastern position within the range of Mediterranean landscapes of Europe. The reserve is situated on the Black Sea coast that is the only place in Russia with unique Mediterranean species of flora and fauna. These landscapes before the establishment of reserve undergo various anthropogenic impacts causing the different transformation of unique ecosystems. The ecological situation is not so good nowadays due to the poaching and increasing recreation in the reserve surroundings.

The aim of this investigation is to study structure, functionality and current state of landscapes of the "Utrish" reserve and to determine plots for ecological monitoring of its territory. Large-scale landscape map (1:25,000) of the main part of the reserve with some detailed schemes on model areas within the coastal zone have been compiled on the basis of fieldwork and remote sensing analysis. Landscapes with different spatial organization were revealed. The exposition and steepness of slopes, the closeness of the sea, the altitude above sea level, the shadow effect of the nearest slopes as well as rocky compound are the main factors of landscape differentiation. The north and the south macro slopes of the main ridge are distinguished by different landscape structure more complicated on the southern slopes due to the ability of seismic rock falls and landslides of different ages. The south facing slopes are characterized by sub-Mediterranean geosystems - juniper-pistachio-tree and juniper open-lands with ability of species which are included into the Red Data Book of Russian Federation. The northern macro slope is characterized by more prolonged valleys, dissected by ravine geosystems with mesophilous (beech-hornbeam, durmast oak, lime-tree-durmast oak) forests. The sub-Mediterranean light forests with ability of shrubs appear on this macro slope only in its low part formed by carbonate rocks. The degradation of forests, including relict and endemic species, expansion of shrubs, secondary forests and meadows, reduction of biomass, productivity and floristic composition of vegetation were revealed as a result of the previous anthropogenic impact. The forest and open-land geosystems of the "Utrish" reserve are in progressive stage of plant succession nowadays.

Ecological networks in relation to selected ecosystem services

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Currently, the methods for valuation of environment and biotopes are increasingly developing particularly in the context of ecosystem services. One of the methods is the Hessian method, which is recommended by the European Union in the White Paper on Environmental

Liability, concerning the estimation of losses to the environment for all member countries. The method was successfully applied in Germany, the Czech Republic, Poland and other countries.

One of the aims of our study was to map and valuate the habitats in the cadastral area of Báhoň in SW Slovakia, by applying a modified Hessian method. As the source documents this case study used in particular the Local Territorial System of Ecological Stability of Báhoň (proposal of ecological network, elaborated under the Land consolidation project) and the Plan of Economic and Social Development of Báhoň. The analysis was elaborated for three scenarios of land use development (current state, proposals of ecological network and the planned territorial development).

Based on these documents we derived calculations of social value of biotopes in terms of a modified Hessian method and compared with the valuation of the biotopes of European importance under the current legislation in force in Slovakia.

Two local biocentres and eleven linear landscape elements were identified within the study area in the frame of the Local Territorial System of Ecological Stability of Báhoň. In addition, one biocentre and twelve linear landscape elements were proposed. The analyses were completed by the assessment of ecological network elements from the viewpoint of selected ecosystem services (maintenance of physical, chemical and biological conditions).

Evaluation of ecosystem services by stakeholders perception in the cadastral area of Hriňová (Slovakia)

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Ecosystem services introduce usefulness and benefits necessary for human being. Conservation of biodiversity is of paramount importance not only in maintaining its functionality, but also in providing ecosystem services. In order to preserve the ability of ecosystems to provide services, it is necessary to develop a proper management of the landscape. The ecosystems must not be devastated by human activity, because they are necessary to satisfy human needs.

Ecosystems in the cadastral area of Hriňová are highly diverse habitats that support a great variety of organisms, which vary in shape and function, and sustain a diverse range of ecosystem services.

Out of the available methods of evaluation and mapping of ecosystems services, in this paper the ecosystem services are assessed using the methodology of the MAES project (MAES, ET AL., 2013) and classification of ecosystem services CICES (MEA, 2003). CICES divides ecosystem services to provisioning, supporting, regulating and cultural services.

This paper presents evaluation of ecosystem services perception by a group of stakeholders and a group of experts. Particular basic differences and conflicts of perception by these groups were identified by their comparison. The result of this study is a proper management proposal for effective utilization of ecosystem services in Hriňová. We have also discussed some key issues and future directions in management of ecosystem services.

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The role of landscape structures and their ecosystem services in landscape management

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The landscape, as a combination of abiotic, biotic, and cultural components, consists of landscape structures which significantly contribute in providing designated functions and ecosystem services while, on the other hand, also increase the landscape diversity. Landscape structures are largely influenced by, and dependent on, human activities. By changing the landscape structures their functions and consequently ecosystem services are changing as well.

The paper presents a case study conducted in 3 case study sites in Ljubljansko barje (Ljubljana Marshes, Slovenia) where we identified 28 landscape structures. According to the degree of naturalness, the structures were classified into 6 categories. Based on the methodology proposed by Burkhard et al. (2012), verified through site visits and assessment of 2 external experts, the landscape structures were assigned with ecosystem services (ES) assessments. The matrix of landscape structures (classified according to the level of naturalness) and their ES clearly showed that the landscape structures with higher degrees of naturalness provide more ES. We came to the conclusion that the diversity of those landscape structures which provide more varied ES and at the same time need less energy inputs (mechanization etc.) is preferred. Furthermore, regarding landscape goods and services, we drew attention to the typology of goods (private, club, common and public goods). The typology of goods plays an important role in the classification of ES in terms of the relevant decision-making and management.

We predict that the results of what our society is losing by the loss of individual landscape structures will influence the future landscape management, particularly regarding the decisions as to where and how the landscape will be changed. However, this does not mean that the landscape should be changed back into e.g. forest, but, with consideration of natural conditions, to rather seek for and maintain those landscape structures that require less energy inputs while still providing different ES for various stakeholders. The results of the matrix are shown as a word cloud, while a representation of individual ES (e.g. the capacity of landscape structures in ensuring biodiversity, fodder for livestock, pollination, and providing recreational services) on maps is included.

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The assessment of cultural ecosystem services in traditional vineyard andscapes of Slovakia

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The aim of this contribution is to present selected research results of mapping traditional vineyard landscapes and also to suggest a framework for identification and evaluation of selected cultural ecosystem services of the mentioned landscapes through selected landscape metrics.

The use of landscape metrics is - next to behavioural methods and travel cost method - suitable for the analysis of attractiveness, aesthetic and recreational value of the cultural landscape (e.g. Weyland and Laterra, 2014).

Slovak vineyard landscapes, their localization on the northern border of wine-growing area in Europe and diverse combination of landscape-natural conditions and cultural-historical values represent a valuable landscape heritage, necessary for the development of tourism related to the wine production sector.

We created an overview of cultural ecosystem services provided by traditional vineyard landscapes and we analysed appropriate indicators for the cultural ecosystem services on different landscape scales.

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Landscape historical analyses coupling analyses of pattern and ecosystem services

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The resilience of mountain grassland human-environment system is controlled by complex interactions between biophysical processes and human dynamics. Within this study the influence of marginal grasslands on ecosystem service (ES) provision by evaluating historical land-use/cover changes (LUCC) of landscape composition and configuration is quantified. A set of landscape metrics and indicators were used to elaborate the following objectives: (1) To which extent do impacts on ES provision results from land-use related landscape dynamics? (2) Does landscape configuration and composition control the resilience of ecosystem service provision from marginal grassland?

A retrospective analysis use existing and new data to map land cover at critical dates for significant LUCC since WW2 at two study sites: (1) Stubai Valley, Austrian Alps (A); and (2) Lautaret, French Alps (F). The study sites differ significantly in term of climate and also regarding the process of transformation of coupled human-environment systems. Historical ES provision was calculated using a series of statistical- and process-based models of ecosystem services (Lavorel et al., 2011).

The results show a coherent image of the dynamics for different management types with increasing area over time and coalescence of scattered patches into a larger, less fragmented area. The impacts on ES provision are manifold and vary between different ES as well as bundles of entangled bundles of ES. We discuss the maximization of ES provision for both study sites to provide necessary information about main drivers in history. Based on the obtained results an outlook is given to evaluate the extent to which the provision of multiple ecosystem services under projected climatic and societal changes can be maintained to current high levels (Lavorel et al., 2011; Schirpke et al., 2013).

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Ecological evaluation of grasslands in the Hodrušská Hornatina highlands (the first results)

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Semi-natural grasslands, especially meadows, pastures and orchards with meadows are typical for the historical cultural landscape in our country. The new concept of ecosystem services recognises grasslands as important ecosystems for provision of agricultural and economic services. Presence of large grasslands is also crucial for development of non-productive functions (e.g. landscape-aesthetical and recreational). Despite of their high value, there has been a tendency to abandon them in the past. The evaluation of grassland functions may be important for their preservation and maintenance. Methods of ecological evaluation could be also helpful for landscape assessment and land use planning.

This contribution is focused on the evaluation of meadows from landscape-ecological point of view. The Hodrušská Hornatina highlands (western part of the Štiavnické Vrchy Mts.) were selected as a study area. We performed there phytosociological investigation on 84 differently located and utilized grasslands in years of 2013 and 2014. We have used methods based on plant functional traits for the assessment of vegetation records. The databases of plant species attributes (Halada, 1998; Jurko, 1990) were used to select the structural parameters of plant species relevant to the assessment. The forage quality, melliferous potential, species diversity and aesthetic value were chosen for evaluation. The forage quality of the studied meadows was mostly very high on 51 % of localities or extremely high on 25 % of localities. The melliferous

potential of grasslands was high (45 % of localities) or medium (53 % of localities). The diversity of local meadows was medium at 74 localities (the Shannon index of species diversity ranged between 3.3 – 4), lower at six localities (between 2.5 – 3.3) and medium-high at four localities (between 4 – 5). Based on these data we assess the production and aesthetic ecosystem services provided by local grasslands.

Acknowledgement
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Ecosystem services provided by birds in lowland agricultural landscape of SW part of Slovakia

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Birds provide many ecosystem services which are classified as provisioning services (bird products) or regulating services such as pest control, pollination, seed dispersal, scavenging, and nutrient cycling. Regulating services that birds provide result mostly from their foraging behaviour (Wenny et al. 2011). Presence of birds provides also cultural services (bird-watching tourism) (Whelan *et al*. 2008).

The main objective of our study is to analyze the effect of landscape composition on bird numerical responses in a gradient from forest to open landscape in relation to provision of ecosystem services. We examined the distribution of bird species populations, and its relationship to environmental conditions in a lowland agricultural landscape in SW Slovakia. The habitat selection and distribution of selected bird species was modelled using the Maxent software. We focused on dispersal of diaspores by birds. The best potential diaspore-disperser in the study area was *Fringilla coelebs* that spreads diaspores of 51 plant species, followed by *Emberiza citrinella* (34 plant species). Habitat–species relationships were used to estimate the spatial distribution of this ecosystem service availability.

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Section 4: Landscape governance and management

Landscape and Policy. Time for Change

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At present, the cultural landscape concepts are mostly conservative, emphasising the aspects of maintenance and conservation. Decision makers operate from different administrative sectors such as natural resources management, agriculture, cultural heritage and historic preservation, sustainable development, planning, civil engineering, tourism, economics, etc. Such an organization scheme leads to different administrative concerns. This situation results in an ongoing discussion over contrasting ideas of what constitutes the value and how to best manage it. Not only cultural landscape issues are not sufficiently considered by many economic activities and the corresponding sector policies, but also the landscape debate lacks a better understanding of the suitable economic activities as the main management engine. A more balanced future sustainable development requires a more comprehensive concept of the cultural landscape.

Based on the past lessons, future challenges are to improve the knowledge of the interrelations between regional developments and the landscape. A new approach would allow a full appreciation of the practical economic stimulus at a given site and would integrate the specialized knowledge and various interests across multiple various sectors. The co-operation between sector policies and innovative approaches should be strengthened by the clear commitment. Given what we know that is happening to our landscapes, there is an imperative to achieve transformation through a shift (JPBiCuD, 2010).

Fishing for an answer WHY to find a better balance between economic regional development and landscape concerns (Robl, Reif, 2014), it is at the same time an open and urgent question when the landscape strategies are to be launched. Seen as a massive opportunity for the very needed transformative change of the concepts (as the turnover from the government to the governance of the cultural landscape; the cultural landscape as the objective reality versus the cultural landscape as the subjective perception; the conjunction of the rational decision making and the emotional connection to the landscape and a few other ones), it could lead towards a true understanding and operating of the cultural landscape: the place of the productive and harmonious residence where the production of regional products and the use of the regional resources are based on the landscape management as a basis for the development concepts and marketing strategies.

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Rigid nature by fixation in landscape ecological processes

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Nature conservation in Europe may suffer from a drawback as a result of its fine legislation and regulation of nature parts in the landscape, in between all other functions. As a consequence of land use surrounding the last bits and pieces of nature, these appear to become rather rigid. When a goal is set as for instance 'heathland', this piece of land has to be managed as a heathland, despite succession due to ongoing weathering of minerals, leaching of these to deeper layers and consequently poorer vegetation quality for herbivores, resulting in their decline.

We investigated this dilemma by having interviews with policy makers and nature managers from different areas, combined with a literature review on the qualities during time and the ecological processes involved. Finally, we formulate some suggestions to mitigate the foreseen effects and the call to open up the landscape physically in a wider perspective.

This fixation of processes is quite general: it occurs in reed lands (where reed is gradually poisoning its own substrate), in coastal and inland sand dunes (succession of vegetation and building up of a soil profile), along rivers (due to its fixed channel), in fens (due to its fixed water table) and even on the longer run in forests. As a consequence, species that need dynamic landscape processes disappear from the nature areas that we preserve with great care.

We need low frequent dynamics to counter these landscape processes, however, nowadays habitats are locked up in their nature reserves by having managers to maintain and report on the precise proportion of each habitat and the population sizes of the selected species. Nature conservation has to be replaced by nature management, given the space to anticipate and rejuvenate.

Trends in impact evaluation on landscape

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Landscape impact assessment together with visual impact assessment belong to actual landscape management tools. At the same time, they are the key aspects in both environmental impact assessment and strategic environmental assessment. Usually, it focuses on predicted landscape changes evaluation together with evaluation of its visual effects (IEA a LI, 1995, Belčáková, 2012). Both are related issues. Landscape value and its visual receptors are subject of decision-making procedure on large investments as well as on policies, plans and programmes. Within the framework of landscape management practice it represents the process from landscape evaluation and landscape planning towards landscape design (Haaren et al., 2006, Herberg, 2000). In many countries, landscape impacts relate to changes in fabric, character and quality of landscape. Visual impacts relate to appearance of these changes.

The EC Directives emphasize that landscape issues are relevant to assessment processes at both – project and strategic levels. They mostly focus on the appearance of the land in a way in which people respond to landscapes indicating some other factors. Landscape and visual issues play an important role in the investment and planning process.

Within the framework of recent research done by several universities, this contribution bring some results on the current practice in this field. It presents the common philosophy that is followed by the assessment of landscape and its visual resources at project and strategic levels and prediction of direct and indirect effects or significance of those changes. Then the role of assessment in landscape management should be clearly described.

Furthermore, differences and complementarities in their methodologies and techniques used were identified. Finally, we have looked at the role of landscape planning in the assessment process at strategic levels, especially in the field of land use planning.

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Small Hydro Power Stations Development in the Carpathians as a likely Threat: EIA and SEA Aspects

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Nowadays the mini and small hydropower plants (MHESes) offer potential in the sphere of renewable energy in Ukraine. The program of mass construction of hundreds derivative, fluvial and dam MHESes have been approved after the introduction of "green" tariff that aims at promoting environmentally sound electricity generation. At the same time the planned MHES construction (foreseen number - 500) poses an evident threat to fragile Carpathian ecosystems and caused a significant opposition of society.

The key issues of the impacts of the MHES construction on the environment should take into account the cumulative effects of the MHESes if many of them are planned for construction in the river basins. Building even one MHES entails a complex effect on all components of the environment. The overall feasibility of development of small hydropower industry in the Carpathians must be determined by the results of the Strategic Environmental Assessment

(SEA) and the construction of individual MHESes should follow the Environmental Impact Assessment (EIA) procedure.

Plans for massive development of the Carpathian MHESes were developed without consideration of the environmental legislation of Ukraine and the requirements of many international conventions: the Carpathian Convention and its protocols (2003), Ramsar (1973), Bonn (1979), and Espoo (1992) conventions, Rio Convention on Biodiversity (1992), and others.

Today it is necessary to introduce a moratorium on MHES construction in the Carpathian region. The moratorium should be based on the SEA and the EIA procedures in Ukraine with adoption of systematic steps to greening of energy generation process.

Springs of the Roztocze Highlands (SE Poland) as landscape phytogeocomplexes: diversity, management and protection

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The Roztocze Highlands is among the three most valuable regions in terms of crenology in Poland after the Western Tatra Mts. and Cracow-Silesia Uplands. Considerable relief, a network of cracks, rock faults, and large crevices leading waters towards outflows are necessary prerequisites to spring emergence. Particularly the outer (south-western) escarpment zone of Roztocze sloping steeply towards the Sandomierz Basin (Sub-Carpathian depression) is characterized by vast abundance and a variety of springs.

Out of over 300 springs functioning in the region, some tens objects were chosen for detailed analysis. Their characteristic was based on the results from own field studies conducted with varied intensity in the years 1997-2014 supplemented with data from previous hydrogeochemical papers. The studies aimed to present the floristic and phytocoenotic diversity of springs on the background of geomorphology and hydrology, in particular the profile of the terrain that they inhabit (a spring niche), niche size, water-bearing rocks (Cretaceous, Neogene and Quaternary formations), efficiency (0.5-300 dm^3s^{-1}), and hydrogeochemistry of waters. Another objective was to evaluate the degree of their naturality or synanthropization (called also ruderalization) in relation to spring location (objects in forests vs. non-forest areas, mainly in rural ones), and to answer the question if spring protection as nature monuments is effective.

Patches of vegetation accompanying spring effluences form enclaves of different size and shape, which together with the substrate may be referred to as 'spring complexes' or 'landscape phyogeocomplexes'. The vegetation of the springs, particularly in forest areas, is formed of a specific set of vascular plants and bryophytes representing all groups of crenophytes: obligatory, facultative, indifferent, and accidental ones. However, in the recent decades, the plant cover of many spring complexes, especially in rural areas, has been subjected to the influence of anthropo-pressure: drainage of spring catchments, damming up spring waters in the so-called small retention objects, economic utilization of springs, penetration and pollution of niches, trampling, grazing, etc.; all of which lead to ruderalization of the spring vegetation. Many examples of human interference within spring niches show a rather low ecological awareness among their users and low effectiveness of spring protection as nature monuments.

Engineers in the forest – how do foxes and badgers modify forest vegetation?

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Ecologists who study different interactions in ecosystems cannot ignore the role played by animal species as so-called physical engineers. Ecosystem engineers directly or indirectly modify the availability of resources to other species by changing the physical state of biotic or abiotic materials (Jones et al., 1994). Animals which build persistent abiotic structures like burrows are good examples of physical engineers directly creating non-food resources and living space for other species (Jones et al., 1997). Carnivores can play a different role in ecosystems. It is broadly known that they regulate prey population size, but they also disperse some amounts of seeds endozoochorously and generate disturbances and change soil conditions by burrow digging (Kurek et al., 2014).

Fox (*Vulpes vulpes*) and badger (*Meles meles*) are good examples of physical engineers. They create persistent burrows which play a role of small patches in forest ecosystems that increase landscape heterogeneity. They also transport some amounts of seeds, which are deposited with faeces in a non-random pattern along the borders of their territories. Badgers and foxes leave faeces containing seeds also in the close vicinity of their burrows. Seed inflow and soil disturbances are two main factors shaping the distribution of fleshy-fruited shrubs and trees in the surroundings of burrows. We studied the qualitative and quantitative structure of understory trees and shrubs in the vicinity of burrows in comparison to control plots located in places with no animal influence observed. Special attention was paid to fleshy fruited species with large fruits, like *Prunus cerasifera* and *Pyrus* sp. which were significantly more frequent in the neighbourhood of burrows than far from them.

Frequent disturbances, the creation of habitat patches and the consecutive inflow of endozoochorous seeds into them cause the increase of local plant species diversity accompanied by a higher equitability of species abundance. It also increases the level of heterogeneity in the forest ecosystem and its general species richness.

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Geosystem-Scale Risk Assessment and Forecasting

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We consider landscapes as geosystems created by regular flows of energy and matter. River basins are the most important type of geosystems which requires corresponding management tools including risk assessment and forecasting. The Danube basin has been chosen for our study due to the unique size of this geosystems, long-term hydrological data (since 1840 at Orsova/Turnu Severin gauging stations and since 1876 at the Bratislava-Devin gauging station) and large-scale impacts of water regime change. The first task of risk assessment is cause-and-effect analysis of phenomena in time of floods and low flow. The next step should be the identification of factors which are behind the observed anomalies.

To get reliable solutions we are focused on periods when the Danube discharge was well above or below the mean level for three consecutive years. In total 10 sequences have been selected, namely 1845-1847, 1914-1916, 1922-1924, 1965-1967, 1999-2001; and 1861-1863, 1885-1887, 1949-1951, 1971-1973 and 1990-1992 for high flow and low flow events respectively. Corresponding relative values of maximal and minimal discharge are as much as 122 per cent and as much as 80 per cent.

The key issue for environmental risk assessment is time series prediction of dangerous processes. There is a long tradition to use stochastic models of river runoff generation for these purposes. The information on external relations of the geosystem allows implementing an alternative deterministic methodology. Among possible driving forces of the geosystems, functioning of the outer planets motion has been examined. Comparison of two above mentioned sets of water discharge by means of standard deviation of month geocentric longitudes of Mars, Jupiter, Saturn and Uranus shows that there is significant difference in the position of planets during times of floods and droughts (according the Mann-Whitney nonparametric U-criteria). As our base statistics ending with 2001 there is an opportunity to make a back test of the proposed methods. The test has revealed that it should be high water in 2006 and low water in 2011. The “retrocast” was quite correct.

To our knowledge the Danube runoff will be mainly above normal through the next 10 years, especially in 2020-2024.

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The shaping of rural municipality landscape for nature conservation

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The shaping of rural municipalities landscape for nature conservation is very important in planning and management. Many elements, i.e. forests, meadows, pastures, settlement units, surface water and arable land are occurring in rural municipality landscape. Municipalities are characterized by a diverse ecological and landscape structure. The aim of the study is to determine the ecological structure of the Gromnik municipality for the development of the natural system of the study area. The main criteria of division were types of land uses in Gromnik. Few types of landscape units were distinguished as forests, mosaics, valleys, settlements. The next stage of research was vegetation evaluation which distinguished areas/units with diversified natural values. The next stage included analysis of landscape ecological structure of the study area. There were recognized three main ranges of ecological corridors - I order, II order, III order. The most important ecological corridors of landscape structure were represented by forests and the river valley. Forests are located in the whole study area, and the river valley crossed the municipality. The others units are represented by mosaics of fields, pastures, meadows with tree plantations.

The ecological structure of Gromnik municipality requires shaping and strengthening the ecological relationships especially between existing ecological corridors. Tree plantings are very common elements in rural landscape on study areas, but they are not included into ecological structures. The areas which should be afforested were chosen. New afforested areas are the connection between tree plantings, small forests and manor parks with existing forests. New III and IV orders of ecological corridors were designed. The existing "green islands" in the form of fragments of small forests, woodlots or manor parks should be included in the natural system of municipalities, because they are very often the last refuges of rare, valuable plant species.

National Ecological Network of Ukraine in the Context of Road Transport and Urban Factors

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The map of national level with potential threat for the ecological networks of Ukraine was elaborated. As pilot detailed research the Transcarpathian region was selected. For assessment of the level of fragmentation of potential ecological corridors in the Transcarpathian region of Ukraine were used the “effective mesh density” and “effective mesh size” parameters, calculated by a methodology available on the website of the European Environment Agency (EEA). By use the program GOOGLE EARTH were created rectangular contours – model of territory for eco-

corridors, that has fragmented areas of: cities, towns, gardens around settlements, roads and unfragmented area of: forest, meadows, wetlands, pastures. For each site of corridors by means of calculation table the effective mesh density and effective mesh size parameters were calculated. The obtained results of calculations of effective mesh density and effective mesh size were compared that allowed to choose the least fragmented territory to create international eco-corridor for animals. The fragmentation parameters of effective mesh density and effective mesh size are the European Union's instrument for the development of ecological network of Ukraine.

Selection and breeding of serbian spruce (*Picea omorika* /panč./ purkyne) for urban areas in Serbia

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Genetic and phenotypic diversity of Serbian spruce (*Picea omorika* /Panč./ Purkyne) was studied and tested by long-term analyses of the dynamics of growth and development as well as yield in the urban areas of seven towns in Serbia. Selected towns are located in different types of sites and they spatially covered whole territory of the country. The analyses of growth and development as well as yield were carried out in the five-year period 2000 – 2005, on the sample of 20 trees grown on green areas of towns. The following morphometric analysis of vegetative and reproductive properties was done: tree height, annual height increment, number of branches in the whorl and total number of cones. By standard methods, heights were measured annually to within 0.5 cm; height increment was calculated as well as the abundance of yield followed by mean values, and analysis of variance and LSD test for the analyzed properties.

The potential significance of the recorded Serbian spruce diversity, in urban areas, is one of the most important bases for the future planting of green areas in settlements, as well as for faster and more inclusive breeding of the species for forestry. A closer study of Serbian spruce biodiversity in natural sites, and especially in towns provides the base for a wider and better use of this species in urban areas.

Development of airfields infrastructure in Poland as an environmental challenge

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In Poland, the aviation sector (both civil and military) is currently experiencing a very dynamic development. Such a process is accompanied by a strong expansion of the infrastructure in the form of construction and renovation of airports of different sizes funded from the state and local government funds. New challenges emerge from the development of general aviation what is revealed through, inter alia, the dynamic development of the network of small

private airports. However, such a situation may give rise to environmental conflicts which have two dimensions. On the one hand, they involve threats to biota as a result of the investments and operation of existing airports; on the other hand certain animal species that live in the areas of airports can pose a serious threat to the carried out flight operations. In such a situation the correct prediction of conflict situations in the location planning stage for the airports plays an important role.

The main aim of the presented study was evaluation of existing and potential wildlife-human conflicts on Polish airfields in the context of landscape management. We describe in detail the main wildlife-human conflicts on Polish airfields and propose methods for solving them in the context of flight security. Results of our studies recommend changes not only in local landscape management but also in national legislation.

Contribution of the European Landscape Convention to the Landscape Management and Planning in the Slovak Republic

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The European Landscape Convention (ELC) is the first international treaty with an interest predominantly focused on all landscape types. Such modern type of convention has been adopted by the Committee of Ministers of the Council of Europe on 19th July 2000. The presentation provides an analysis of the ELC accession process in Slovakia, and an overview of the current situation in implementation of the ELC requirements into national legislation, strategic documents and planning processes at the national, regional and local levels. The main focus is paid to innovative ideas and original contribution that the ELC has brought into the field of landscape management and planning. We have identified, analysed and evaluated those activities that can be considered as an original contribution to the implementation of the ELC into the existing process of landscape management and planning in the Slovak Republic. To reach the above mentioned objectives we have selected the main items related to the ELC topics and compared their status before the ratification of the ELC in the Slovak Republic with the current situation (October 2014). Furthermore, selected results of a questionnaire, dealing with the effectiveness of landscape protection, management and planning in Slovakia, have been used. The questionnaire was launched at the occasion of the 10th anniversary of the ELC (October, 2010). Respondents' feedback was received from three groups: a) NGO's, b) representatives of cities and c) university students.

From the obtained results it is clear, that the ELC has inspired the Slovak Republic in many areas. The main idea, which the ELC has brought to this country, is not to debate whether the landscape should be a part of the environmental policy or not, but to introduce the question "how to incorporate the landscape into all key policies effectively" and "which management tools are appropriate". In the conclusion, the international monitoring process of the implementation of the ELC, the next phase of the ELC process and activities dealing with reclassification of the ELC as one of the key conventions of the Council of Europe are discussed.

Acknowledgement
This contribution is the result of the implementation of the project SPECTRA+ No. 20240120002 "Centre of Excellence for the Development of Settlement Infrastructure of Knowledge Economy" supported by the ERDF and VEGA 2/0038/14 Adaptation strategies to natural and social disturbance in the forest landscape.

Landscape diversity as the basis for the implementation of the European Landscape Convention in Małopolskie Province in Poland

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For more than a decade, the Council of Europe has made a concerted effort to protect, manage, and plan natural landscapes across the European Union. Poland became a member of the Union in 2004 and ratified the European Landscape Convention. The need to implement the rules in the agreement generated interest in the typology, classification, and regional identification of landscapes in Poland and other European countries. Perhaps the most important and widely discussed issue is the criteria used to identify landscapes for the purpose of meeting the requirements set forth by the European Landscape Convention.

According to the European Landscape Convention, "Landscape means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors." This definition strongly suggests that the landscape should not be viewed only from the perspective of the natural environment. Manmade elements are also a key part of the landscape. A large number of landscape typologies have been published in Poland. However, none of these typologies serve as the basis for action in line with the regulations outlined in the European Landscape Convention. Existing typologies are either oriented towards the natural environment or the human environment, but not both.

The paper uses Małopolskie Province in southern Poland to propose a new approach to the identification of a landscape typology and assessment of landscape diversity that can be used to help implement the regulations of the European Landscape Convention. The criteria used in the typology were selected in line with the definition of the landscape provided earlier and include spatial, physiognomic, biotic, abiotic, historical, cultural, as well as utilitarian factors. The paper presents a hierarchy of landscapes. Different criteria are used to identify landscapes at each level of the hierarchy. The main criteria are associated with the natural environment, but the number of human-oriented criteria increases going down the hierarchy. The identification of landscapes was done by superimposing the extent of each subsequent component. The proposed method can be used to identify landscapes in other parts of Poland and, with some modification, in other parts of Europe.

Testing and evaluating importance of douglas fir (*Pseudotsuga menziesii* /Mirb./Franco) for growing in urban areas

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For more than a century Douglas-fir *(Peudotsuga menziesii* Mirb./Franco), as the fast-growing species characterized by the high quality wood, wide use in the pharmaceutical industry and establishment of the green areas in the urban and periurban areas, has been the subject of the multidiscipline studies in many European countries, including Serbia. Since the introduction of species to the new sites poses success and adaptability challenges, Institute of Forestry in Belgrade, set up the provenance test in Serbia. Test included 32 provenances of the Douglas-fir from a part of its natural area in North America. The provenance test was established at the site of the montane beech forest (*Fagetum moesiaca montanum* Jov. 1976), near town Jagodina (Central Serbia) and the other one is, at the site of Hungarian oak and Turkey oak forests (*Quercetum frainetto-cerris* Rud. 1949) near town Bor (Eastern Serbia). Douglas-fir provenances best adapted to the environmental conditions of periurban and the forest communities on whose sites the tests were established differentiated depending on the parameters of tree growth and development. Based on the provenance ranking by all analysed parameters, and based on the statistical verification of the study data, two groups of extreme provenances differentiated clearly at analysed localities. The best provenances were: 3 (Oregon 202-27), 4 (Oregon 205-38) and 18 (Oregon 202-19), near town Jagodina, and 31 (Washington 205-17), 3 (Oregon 202- 27) and 18 (Oregon 202-19, near town Bor. The fact that the provenance origin is known and that the ecological parameters of the provenance test sites are researched, makes the study results applicable in future establishment of special-purpose Douglas-fir plantations in periurban areas and for the production of good-quality wood.

Food security and food safety as important factors for landscape management – questions for future from European perspective

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Need for sufficient, sustainable, affordable and safe food production for growing population is generally acknowledged by science and policy. However, these goals have clear and not negligible impact on the landscape. Available solutions either demand more intensive use of land, including use of increased amounts of energy, chemicals and technology or, in case of extensive and organic approaches, potentially higher portion of landscapes being assigned for food production.

These trends may potentially impact a broad array of other landscape functions, particularly those related to services of natural or semi-natural ecosystems. The presentation will summarize existing views and policy options, and present major drivers behind food security and food safety concerns. Possible responses in landscape management policy will be discussed, reflecting the most appropriate level of implementation – at local, regional (national) or supraregional (European) scale. Some new approaches emerging in policy debate such as concept of "sustainable intensification" or behavioral changes in nutrition will be shortly introduced and

commented. The need for broad horizontal discussion in balancing desired outputs with sustainability of land use and crucial impact of food production on future European landscape management will be outlined and confronted with present legal and policy framework of the European Union.

Going beyond public participation': an exploration of the role of ICT Tools to implement the European Landscape Convention (ELC) through challenge, learning, innovation and cooperation

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The European Landscape Convention came into force on the 1st March 2004, and by 2014 has been signed, ratified and enforced by 38 of the 47 parties of the Council of Europe. The goals and actions contained under the articles of the ELC represent a fundamental shift in how we interpret, regulate, and intervene in landscapes in Europe, and worldwide. The ELC represents a key aspiration of progressing towards bottom-up and governance-based models for the management, protection and planning of all landscapes, which are considered an essential asset for the quality of life of (European) citizens. A high degree of flexibility is sought in implementation of the ELC nationally, regionally and locally, to accommodate the concomitant socio-political and cultural contexts. This represents a challenge for both the signatory parties and the Council of Europe itself, and is arguably the basis of many of the hurdles being faced in the implementation of the ELC. Promoting and enhancing public participation is frequently proposed as a key step for achieving the efficient implementation of the ELC. However, the efficiency and equity of traditional approaches to public participation in policy making have often been questioned .

The E-CLIC project (www.e-clicproject.eu/) explored the current achievements, demands and opportunities of using challenge, learning, innovation and cooperation to go "beyond public participation" in the implementation of the ELC. To achieve these goals, the E-CLIC project tested the potential of Information and Communication (ICT) Tools, with knowledge being co-produced between researchers and members of the public of all ages and stages of the lifelong learning process. Project findings show the advantages of digital tools for the improvement of knowledge, skills and understanding, and for facilitating the direct involvement of the public in the interpretation and implementation of European policies for sustainable development. Thus, we state that ultimately the use of ICT tools might help tackle key challenges and unknowns regarding the changing nature, orientation and roles of planning and policy in an era of transition from government to governance.

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The role of *Salix acutifolia* as ecological engineer during primary forest succession

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Anthropogenic sandy areas are exceptionally extreme habitats for plant colonization because of unstable substrate and a lack of soil cover. However, some species of plants with specific morphological and physiological characteristics do appear here. Their modest requirements of nutrient elements allow them to initiate the colonization on such poor sandy areas and further successive fixation, and then, because of that, new species with higher habitat requirements have possibilities to appear here. The pioneer species just facilitate the colonization of new species by making accessible general food resources. Such types of species should be considered as engineers of ecosystems.

The main aim of this work is to show the role of *Salix acutifolia* considered as ecosystem engineer in the process of succession and soil development under canopy of this species. The results showed that this species facilitated the encroachment of early succession species and contributed to formation of primary humus. This is very important stage during ecological succession in poor nutrients ecosystems. As ecological engineers their role concern in formation of canopy, high production of plant litter and fixing of loose sand. In this way creates favourable habitat conditions for encroachment of species with higher requirements. Single specimens of this species within a field sand form vegetation islands. Connection of several islands will lead to the formation of an initial forest community. Intentionally use of this species for the reclamation of sandy region can bring positive effects. The role of *S. acutifolia* in soil formation and creating plant communities is connected with its ecological adaptation to the sandy ground. This property of *S. acutifolia* explains that it can develop in sandy areas. It points at the possibility to apply this species as ecosystem engineers in land reclamation activities in anthropically transformed areas as the alternative for presently applied cost-consuming methods, based on introduction of alien species to the landscape. Investigations carried out simultaneously proved that the most advantageous way to restore natural values to transformed areas is giving up land reclamation in favour of succession of natural vegetation (Rahmonov, 2007).

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The selection of species for reforestation and amelioration of peri-urban areas of Belgrade, Serbia

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The process of reforestation in peri-urban areas of Belgrade was started as early as in the second half of the 19th century. The most significant period of reforestation was after the Second World War. Over the past decade Belgrade has lost several important open spaces and peri-urban forests due to development, but awareness of the importance of protecting these areas is growing. Positive steps have been taken to preserve urban vegetation through legislation and research. Serbian popular and scientific literature frequently focuses on Belgrade's environmental dilemmas caused by the city's rapid expansion and housing shortage. However, the battle between rational and sensitive environmental planning and economic and political development continues.

The selection of species for reforestation has been the weakest link in the previous strategy of reforestation. The scientifically verified theories of the selection of species for reforestation have been elaborated recently. The vegetation-ecological differentiation of forest ecosystems is the most comprehensive base for the selection of species. The black locust was the most frequently used species for reforestation until 1956 while the poplars were most frequently used until 1965. The introduction of conifer trees in the broadleaf forest was a widely-used practice, and the pine (*Pinus nigra* Arnold) and Atlas cedar (*Cedrus atlantica* (Endl.) Manetti) plantations were established most frequently. In the last two decades selection of species or cultivars for municipal plantings involves complex social-political managerial, architectural, biological and commercial relationships. The present day status of afforested areas as well as the list of species for contemporary reforestation are provided in this paper.

Managing deteriorating landscapes: A proposal regarding the recreation of former landscape values. (Case study of the village of Głusko, Western Pomerania, Poland)

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The aim of the study was to identify the changes in the landscape of the village of Głusko (Drawa National Park, Western Pomerania, Poland) and to propose actions towards its restoration. The authors have conducted an analysis of source materials *(*an *ex situ* analysis) in order to determine the general changes in the panoramas. An *in situ* inventory has been

completed in 2013. A comparative analysis of archived and current data resulted in the identification of the spatial changes in the natural and anthropogenic landscape. The authors next determined the tendency and directions of the changes and indicated elements that proved deteriorating for the cultural historical landscape. This was the basis for a landscape study which included the following elements: 1. an identification of the characteristic landscape elements along with photographic documentation and a short description; 2. an analysis and evaluation of the value of the landscape; 3. the specification of a given panorama. In the next stage the authors determined the possibilities of repairing the landscape layouts and proposed corrections of selected landscape forms and principles regarding the handling of cultural landscapes. The conducted inventory work resulted in the division to the following categories of landscapes:

1. landscape interiors: subtype semi-natural (architecture-landscape), subtype anthropogenic, subtype natural landscape;
2. the panorama of the village of Głusko: subtype semi-natural; subtype natural landscape;
3. view corridors: subtype anthropogenic;
4. view point: subtype anthropogenic.

The following reasons for the detrimental changes have been identified: mental - the local community does not notice the landscape values and does not perceive the value of a landscape as a unique type of good; management-related - the local authorities do not take proper care of the spatial values; financial-the commune has a poor budget.

Detailed project guidelines for the development and protection of landscape values have been provided in reference to each specific analysed case. Finally, the authors have formulated a set of general guidelines regarding the management of dying landscapes: restoration of an open landscape, reconstruction of woodlots and introducing new ones, preventing architectural dispersion, introducing new structures exclusively within the respective village, as well as introducing dominant elements into the landscape with each new structure.

Local policies for curbing urban sprawl: evidence from Switzerland

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Landscapes have been affected by urban sprawl for several decades and in many regions of the world. In Switzerland, the impact of urban sprawl on landscape fragmentation is highly visible. Sprawl-related issues are especially concentrated on the country's central Plain because of its high population and infrastructure density. Even if Swiss municipalities range from small rural communities to large agglomeration centres, all categories of municipalities are affected by urban sprawl to some degree. Starting in the middle of the 20th century, many land-use regulations and policies have been developed at municipal scale in order to curb urban sprawl.

Until recently, no exhaustive inventory of these land-use regulations and policies existed. It was therefore impossible to precisely know which kinds of regulations and policies are being implemented, and by which types of municipalities. In order to fill this knowledge gap, we addressed a questionnaire to the spatial planning authorities of all Swiss municipalities. The survey entailed questions about the implementation of twenty different land-use regulations and policies aimed at controlling urban sprawl. The objectives of the study are threefold. First, we will assess the differences and similarities among the Swiss and the US/EU regulation apparatus in the case of urban sprawl by conducting a review of the existing international literature. In a second step, we will analyze the land-use regulations and policies implemented in Switzerland

and classify them according to their aim (comprehensive planning/concentration of settlement development/improvement of settlement quality) and to their implementation principle (regulatory vs. incentive-based approaches). Finally, we will relate the kinds of implemented land-use regulations and policies to different types of municipalities. Our hypothesis is that particular categories of municipalities (e.g. rural, touristic) implement distinct sets of land-use regulations.

In doing so, we wish to contribute to scientific knowledge about landscape and urban governance in the context of urban sprawl, by presenting new insights from Switzerland. Also, we hope to provide Swiss municipalities and institutional authorities with precise data about the current implementation of land-use regulations and policies against urban sprawl. Such information is crucial for a future evaluation of the effectiveness of these policies.

Restoration potential of certain native and exotic woody species planted on degraded mine habitats in a dry tropical region of India: Implications to re-establishing a new forest landscape

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Developing a new forest landscape on any particular degraded ecosystem can play a significant role in mitigating the effect of global climate change. But, restructuring of vegetation on such degraded landscape is not an easy task. It needs careful scientific consideration prior to applying restoration principles.

Present study was conducted on a degraded ecosystem in a dry tropical region of India where mining is one of the serious problem. Mining operation not only degrade the forest cover even degrade the soil composition. Hence, restoration of such kind of degraded landscape is a really challenging ecological problem as natural succession is very slow.

We selected eighteen plantation sites as a total in different ecological models (mono- and mixed culture) for assessing restoration potential and efficiency on coal mine spoil for this study. Fourteen 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. Eight woody species were indigenous and hardy, and 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. The objective of the present study was to assess restoration potential and their role in soil rehabilitation by examining several soil and vegetation parameters with increasing age of plantations.

Results indicated that influence of planted species in terms of restoration potential, accumulation of soil organic C and their sequestration was more pronounced with origin and ecological models with increasing plantation age. In comparison to monoculture plantation stands, mixed culture either legume or non-legume combination showed a strong tendency of restoration potential for redeveloping a new forest on degraded landscape.

Impact of military region on long-term changes in land use, road network and agricultural management – case study Libavá, Czech Republic

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Establishing of a military region has unquestionable impact on land use, agricultural management as well as road network of the given area. Former use of the land is abolished, population in the region is usually transferred and road network can be significantly changed. All these actions lead to general abandonment of the landscape which is usually represented by overgrowth of fields, disappearing of settlements and spread of forest. However, military actions in the region can lead to establishing of new landscape elements, such as water reservoirs in the training areas. Also, military region can unintentionally serve as biodiversity hotspots since large portions remain virtually untouched.

The Libavá military region (Czech Republic) was officially founded in 1950. Libavá military region is 327.33 km^2 large. It is used for artillery training, infantry training and tank training.

The research was based on topographic maps from 1836-1841, 1876, 1948, 1952-1955, 1959-1968, 1988-1992 and 2010-2013. We have distinguished nine land use categories (arable land, permanent grassland, orchard, vineyard and hop field, forest, water area, built-up area, recreational area and other area). Other area comprised predominantly of abandoned settlements. We have identified major changes in land use categories, expressed by their area, and analysed changes in road network which were expressed by changes in the length, density, categorisation of the roads and accessibility. Finally, we have identified areas that have not changed as well as areas with maximum changes and what types of changes occurred between adjacent time steps, i.e. main landscape change processes.

As expected, our results show large abandonment of settlements and agricultural land in the form of arable fields and orchards. These two processes were synchronized with the population transfer despite the fact that Libavá military region has the highest number of population from all Czech military training areas. Forest spread extensively as did permanent grassland which has been very often used as an impact area for artillery. In these impact areas water reservoirs were established. Agricultural management in military region is in the responsibility of the Military Forest and Farms of the Czech Republic. Major changes in road network occurred – most of main road connections were diverted outside the area, the road density decreased.

Studying the identity of urban landscape for participatory city planning

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With the adopting of the European Landscape Convention (2000), landscape studies incited the development of a new context of city and landscape planning, allowed to look at city images from lay-public point of view. Landscape studies argue that (1) subjective values, images and perception of the environment influence on individual and community decisions, behaviour and

actions; (2) evaluation of subjective perception could be used for implementation of participatory approach in landscape planning.

The main starting point for this article is that while city management in Russia was under transition for the last two decades, city planning remained largely the same. City planning is an arena of the architects and planners and the applying participatory approach to landscape planning is very limited. This paper shows that experts' vision differs from the lay-public's perception of the urban landscapes. The communication about this gap could lead to implementation of the participatory approach to city planning, reduce conflicts and insure sustainable city development. The main goal of this article is the exploring the lay-public's perception of the centre of Krasnoiarsk city. For achieving the goal the next research questions were examined: (1) What are distinctive elements of urban landscape which are shaping city centre image and place identity according to citizens' perception? and (2) What are differences between perception of lay-public and experts' vision?

The paper assumes that (1) definition of landscape by Landscape Convention is a core point for studying subjective perception of urban landscape; (2) the full reflection of the perception of the city centre is expressed in the concept of place identity; (3) sketch mapping technique is appropriate for exploring subjective perceptions.

Similar to elsewhere, the key issue of participatory planning is distrust between professionals and public, strong expert-based approach to planning and low level of awareness of public about planning procedure. At the same time, knowledge about city image, landscape identity and place attachment of lay public could be useful for minimizing potential land use conflict, increasing satisfaction with spatial planning mechanisms and involving public in decision-making process. Mental maps proposed good starting point for discussion about planning solutions and created a platform for mutual understanding between professionals and lay-public.

Vegetation and habitat changes of the Krowie Bagno peatland as a consequence of land management

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Most mires in Poland are used for agriculture, mainly as grasslands. The Krowie Bagno peatland located in eastern part of the country is a good example of mires that have lost a great deal of their original diversity as a consequence of the disappearance of habitat variety. Land drainage works carried out at the turn of the 70's and 80's of the 20th century resulted in intensification of moorshing and decession of the peatland. Consequently, nearly 30% of rare and protected plant species were extinct, and the number of plant associations declined by half (Fijałkowski et al., 2000). Currently, about 88% of the study area is occupied by meadow communities, which replaced the previous natural plant communities as a result of land management (Jargiełło 1976).

The aim of the presented studies was to investigate the vegetation and habitat transformation under the influence of agricultural intensification in the Krowie Bagno peatland. The studies were conducted in patches of *Molinietum caeruleae*. In some of them, phytosociological relevés were made. Simultaneously at each study site, a soil sample was taken from the depth of 0-15 cm. Peat samples were transported to the laboratory, and analysed in terms of pH, organic matter, and P, K, Ca, Mg, Fe, Mn, Zn, Ni, Cu, Pb, and Cd contents.

Generally, the parts of the peatland transformed into grasslands are characterized by the highest species richness and diversity in relation to the formed forest phytocoenoses with dominance of *Betula pubescens*. Moreover, in the upper peat layers of the forest communities, a lower organic matter content, lower pH, and a lower concentration of P, Ca, and Fe were noted. Very important is the fact that meadow soils are characterized by a higher concentration of heavy metals in relation to forest sites. Unfortunately, some phytocoenoses reclaimed 40 years ago were spontaneously changed into communities with dominance of *Potentilla anserina*, *Urtica dioica*, *Solidago gigantea*, *Cardaminopsis arenosa*, *Calamagrostis epigeios,* and other synanthropic plant species.

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Vegetation and the course of present aeolian morphogenesis in the area of Bledow "Desert"

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The Bledow "Desert" is located in the eastern part of Silesian Upland (southern Poland). The beginning of this area goes back to the early Middle Ages and it is a cultural landscape. This area was deforested to gain timber for contemporary lead-, silver- and later also zinc ores. Such deforestation caused the initiating of aeolian processes and this continued until the end of the 20th century. During these periods aeolian morphogenetic processes and the development of vegetation took place without interruption.

The purpose of this paper is to present the relationship between the forms of terrain and the vegetation. We analysed the created forms in terms of shape, size, and internal structure and within the hills we made also a floristic list. Totally 24 forms were analysed.

As a result of the study we identified two groups of different landforms. These are spherical and linear forms. The first group is closely linked with *Salix arenaria* and the second one with *S. acutifolia*. Both willow species, despite adaptation to dry and hot substratum (in summer), prefer northern slopes of landforms. It is related to the morphology and adaptation of species in such habitats. Within forms there were found the psammophilous herbaceous species as *Corynephorus canescens*, *Koeleria glauca*, *Elymus arenarius* as well as lichens of the genera *Cladonia*, *Cladina*, *Stereocaulon* and *Cetraria*, bryophytes of the genera *Polytrichum* and *Ceratodon* and algae. Lower organisms form a specialized community here, which can be described as a biological soil crust and occurs at the edge of the forms.

The main role in the sand fixing and simultaneously in the creation of aeolian relief of different landforms is played by the mentioned *S. acutifolia* and *S. arenaria*, thanks to which the relief changes, the deflation areas decrease and succession develops in the direction of the forest. In order to protect the aeolian processes the landscape should be artificially kept open through periodic loosening of the sand.

Database of defunct ponds and the soils of these sites as a source of information for optimal landscape use

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Small water reservoirs are a basic element of the agricultural landscape within Central Europe and represent one of the most valuable near-natural components of the cultural landscape. Ponds represent an ancestral inheritance which significantly affects the character of landscape. Some pond systems, along with surrounding landscape and its architecture, even fulfil the strict criteria for inclusion in the World Cultural Heritage List. Although the first mention of ponds in the Czech lands dates back to the turn of the 10th and 11th centuries, the main development in pond management occurred from the mid-15th to late 16th centuries. During this time ponds became a long-term and lucrative investment. Just as the ponds were relatively quickly established in those days, so they extensively fell into disuse after about 200 years. At the time of their greatest expansion the number of ponds is estimated to have been between 75 – 78,000, with an area of over 180,000 ha. In CZ there are currently about 22,000 ponds, more than 2/3 of ponds being cancelled during the last two centuries. In the course of our research we have carried out mapping of defunct ponds with the use of material from the 2nd Military Mapping Survey. During spatial analysis using GIS it was found that, in the last 150 years, a total of 3,479 bodies of water fell into disuse, of which 3,416 were ponds greater than 0.5 ha, and that almost 70% of this area is now used as agricultural land. The use of land and basic soil characteristics on the site of defunct ponds was further analysed and the resulting database, which will be presented at the conference, can be used in planning the optimisation of agricultural landscape. Current use of this land is not optimal in all cases, and at a time when we are dealing with the issues of both flooding and drought, it is worth considering a change in the use of some of these areas within revitalisation and flood-prevention measures, or even within farm management. The results of our research may be very helpful in this planning.

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Nature protection and socio-economic development (Czech protected areas case)

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Relationship between the nature protection and socio-economic development is the issue which can be traced in professional literature worldwide, articulated however by use of different discourses. In papers depicting the situation in Europe and in "developed" countries generally, the wealth is obviously suggested as the predictor of pro-environmental behaviour, whereas in "developing" countries the same issue is, as a rule, articulated in terms of a relationship between

poverty and local resources utilisation. Regardless the discourse, however, the attitude of people to nature protection is hypothesised as being dependent on particular socio-economic situation.

This paper reports on outputs of the analysis aimed at revealing the extent to which the attitude of local people to nature protection is shaped by particular overall regional socio-economic context. In order to achieve this objective, situation was compared in protected areas situated in economically "non-problematic" regions and those located in regions structurally affected. In all model areas, social perception of nature protection was analysed, i.e. how local people reflect their current socio-economic situation, and how they relate to nature protection. Triangulation approach combining questionnaire survey, key informant interviewing and content analysis of local periodicals was used as the methodological frame for gathering of empirical data.

Our hypothesis presumed that relationship of local people to nature protection would be shaped by overall regional socio-economic context. Based on empirical data gained in our model areas however, we suggest this hypothesis to be rejected. Though there are differences in overall socio-economic milieu in which particular studied areas are situated, these differences appeared to be insignificant in this respect. Therefore we can state that, in Czech conditions, different overall socio-economic context should not be considered as a factor differentiating relationship of local people to nature protection. On the other hand, we can suggest that different shaping of the above mentioned relationship can be explained as the result of concrete behaviour of administration of particular protected area applied in the process of implementation of concrete nature protection measures.

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Are times changing for landscape management following the European Landscape Convention? Insights from Hungary and Scotland

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The European Landscape Convention (ELC; 2000) came into force in 2004, and by 2014 has been enforced by 37 countries. It defines Landscape Management as an "action, from a perspective of sustainable development, to ensure the regular upkeep of a landscape, so as to guide and harmonise changes which are brought about by social, economic and environmental processes". This is a comprehensive yet flexible definition that should be adapted to regional and local decision making frameworks using policies, regulations, grant schemes and planning. Additionally, the ELC considers Landscape Management a territorial project, which promotes adaptive approaches that account for "social aspirations, anticipated changes in biophysical and cultural characteristics, and access to natural resources". According to this, implementing Landscape Management across scales requires a shift in how we deal with knowledge, learning, innovation and cooperation. In this paper we discuss changes in conceptualizing and operationalizing Landscape Management before and after enforcement of the ELC. To do this we

examined trends in theory and praxis by looking across the scientific and policy literature. First we searched the Web of Science for 'Landscape Management' in the titles and keywords of papers. To understand how the ELC's definition of this concept has influenced scientific approaches, we restricted our search to Europe, and examined differences in papers published prior and following publication of the ELC. To evaluate the policy and planning literature, we focused on the micro-regions (LAU-1) of Gönc (Hungary) and the Borders (Scotland), where we examined differences in the interpretation of Landscape Management before and after ratification of the ELC by the UK (2006) and Hungary (2008). Joint results in the analysis of theory and praxis indicate to the dispersion in the interpretation of Landscape Management. A key role in such dispersion is played by the contingent approaches to knowledge, learning, cooperation and innovation that have shaped differences between scientific disciplines and policy and planning regimes. Unravelling such differences might ultimately assist in implementing Landscape Management approaches across European regions that are consistent with the ELC.

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Assessing the Optimality of Landscape Structure in Landscape Planning

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The problem of the optimal structure of cultural landscape still remains the most complicated in the area of land management. Universally, landscape optimality can be interpreted through the system of the fundamental anthropoecological criteria forming the methodology of land management. Application of these criteria determines the main prerequisites of the optimal structure of cultural landscape: geobioecological stability, psychological comfort, adequacy to social identity, ergonomics in regard to the determined activity, economy reflecting the conditions of territorial development.

The aspired aim of cultural landscape quality is to set a standard for the structure of individual landscape territorial units, corresponding to the highest public standards of ecological and economic awareness and scientifically-based indicators of landscape structure, all to ensure ecological sustainability, psychological comfort, and rationality of socio-economic land use.

The conceptual basis of landscape management lies in establishing landscape planning zones with different landscape use, protection and management measures for achieving target/optimal spatial structure of the landscape.

At the national level of planning, landscape structure optimality should be assessed in compliance to the strategic macro-zones' (differentiated to ecologic compensation and economic activity) proportion, matching the universal "golden ratio" (~60:40).

The suggestion was made that in district (or basic) level of planning, landscape management zone optimality is measured using seven indices: naturalness, healthiness, visual distinctness, memorability, accessibility, terrain flatness and productivity. One of the tasks of the research was to create a parameter setting system that could help to automatically determine the optimal land

use structure parameters for any type of the existing or emerging landscape management zone (planotope) taking into account: (1) the general nature of the landscape (the degree of cultivation), (2) the use and management regulatory interests (priorities), (3) the major geomorphologic features. The suggested qualitative gradation setting and adjustment works by stepping down through the mentioned (1) to (3) planotope classification levels, at each level revising and narrowing the meaning of the parameters. The set of three correction tables corresponding to each level of classification is offered.

Landscape-Related Measures of the Austrian Agricultural Policy for the Period 2015-2020

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The Common Agricultural Policy of the EU, with its more or less strict national scopes of action depending on the measure, has been stringently implemented in Austria since 1995. In its periodically development it gained more and more integrative view of agriculture and rural regions. From the beginning Austria had its focus on the second pillar with some direct and a lot of indirect effects on landscape and environment. The recent CAP reform for the period 2015-2020 now increasingly follows a holistic approach with a complex calibration of the measures according to a hierarchical system of goal, priority, focus and measure. Theoretically in sum 41 objectives have to be served at the same time, among them objectives concerning landscape and ecology. The two pillar model of the last periods will be somewhat softened, for instance, through the "greening" measures in the first pillar and increased scope for action for the member states. Increased importance is now being given to education and innovation measures as a cross cutting topic which influences landscape and ecology measures too.

The main influence of CAP on landscape is given by second pillar measures like organic farming, Natura 2000 and Water Framework Directive payments, agri-environmental payments (biodiversity measures, green cover measures, erosion protection, maintenance of steep and mountain grassland areas, alpine farming, ground and surface water protection measures, nature protection projects), climate payments, payments in areas facing natural and other specific constraints, investments in irrigation.

The paper introduces, describes, classifies and assesses the CAP objectives and the Austrian CAP-measures with potential effects on landscape, ecology and environment for the period 2015-2020. As the participation on CAP measures in Austria in previous periods was – and is expected to be furthermore – beyond 90 percent of the agricultural area, the effects are and will be very high and visible nationwide.

The Influence of Agricultural and Forest Land Conservation in Poland on the Protection of the Countryside

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This article is focused on the issue of agricultural and forest land conservation in planning documents drawn up in Poland on various administration levels and it presents the influence of legal regulations on the protection of countryside.

This article indicates the connections of legal regulations with the investment processes and the appearance of investment barriers being a result of the legal protection of agricultural and forest land in the countryside. The spatial policy on the local level and the local plan carried out in compliance with the adopted spatial policy are crucial in the spatial development planning. In the documents indicating the spatial development policy a number of development conditions are analysed, among which one may find the occurrence of agriculturally useful soils and the presence of forests. These areas are protected from investments in the further development of the districts. It may be stated that legal regulations influence the conservation of countryside landscape considerably by maintaining the forest land area and preventing the investments on the area with soils of high valuation classes. The research was carried out on the selected rural municipalities in central and southern parts of Poland for years 2008 to 2014.

Section 5: Environmental awareness and education in landscape ecology

Landscape conversations. Getting involved with local people and their landscapes

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As researchers we sometimes think that we should go out and teach the people working/owning the land how better management should be done. However, often, when we try to do this we find that this process is two-way – both sides teach each other. This need for the two-way communication becomes especially apparent in the current discussion on heritage and landscape, where one of the debate topics is whether heritage is defined top-down or, on the contrary, bottom-up. And this, in turn, has implications in planning, but also in research.

Social aspects of the environmental quality assessment for rural settlements

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The environmental quality assessments accomplished so far indicate that the focused quality depends first of all on the properties of the natural setting, ecological condition of ecosystems, anthropological impact and the resulting changes, i.e. on representation and negative effects of stress factors, representation and significance of positive socio-economic elements, and indicators of the settlement community. It means that the environmental quality assessment for rural settlements requires interdisciplinary approach involved with the assessment of environmental, socio-economic and social factors. It is very important to pay the necessary attention to the assessment of subjective factors and to accompany the research with the opinion and attitudes of people to environmental quality as they see it. This part of research is extremely demanding as people respect different values and their perception thresholds differ. Hence, the environmental quality assessment for rural settlements is based on combination of landscape-ecological, environmental, and sociological research and on confrontation of environmental problems (which emerged due to spatial clashes between the positive and negative socio-economic phenomena) with the problems specified by the selected sample of population.

Apart from the assessment of changes in landscape structure and the assessment of the effects of human activities on landscape components and environmental quality, it is important to detect how the population perceives and evaluates these changes. Results of our sociological research conducted via questionnaire and interviews were used for the environmental quality assessment on the example of model settlements in the district of Trnava. The questions posed in our sociological research were intentionally focused on the area of stress factor effects on the environment in settlements in view of specification of serious environmental problems, establishment of priorities in the development of the given commune, evaluation of human

potential, etc. Results of the sociological research are accompanied by those obtained from the computed coefficient in the frame of a landscape-ecological assessment. Research results are presented by description and graphic visualisation of respondents' replies.

Cooperation of the Lomonosov Moscow State University with the All-Russian Children's Center "Orlyonok" in ecological education

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The universities and other educational institutions play one of the most vital roles in shaping the world's future. They are responsible for preparing children and young people to be tomorrow's decision makers and to be active and responsible citizens. The ecological education must be based on effective training of specialists, outdoor teaching and field and experimental research. It is better to use a complex approach due to the integrity of nature. That is the reason why we consider landscape studies to be more effective in education of youth.

The cooperation of the Department of Physical Geography and Landscape Science of Lomonosov Moscow State University and All-Russian children's Center (ARCC) "Orlyonok" is a good example in realization of such approach. The teachers and participants of Student Scientific Society of the department put in the practice the ecological studies in "Orlyonok" during 10 years. This biggest Federal Centre with the whole year round education for the children from 80 regions of Russia gives good opportunity for widespread dissemination of ecological knowledge and methods of complex research within the whole country.

Some main trends of ecological education are carried out by MSU team. The landscape study of the territory ARCC "Orlyonok" and it surroundings, landscape mapping and profiling, study of ecological state of nature components (water, soil, vegetation) including anthropogenic modified geosystems were done first. The organization of nature trails for children of different age, landscape planning were carried out on the basis of landscape study and compiled maps in the second stage. The educators and pupils of "Orlyonok" and domestic schools were involved in field research in each stage. The teachers and students show the main methods of study using different modern instruments, help to collect field data. They also worked out ecological programs for pupils and methodical papers to specialists of "Orlyonok", trained the pupils and participated in ecological conferences and other activities and explained the global and region ecological problems. Some landscape maps and special maps of modern ecological situation, activity of nature processers, dynamics of unique sand beach and etc. have been compiled for the study area as well as the maps of natural trails. The organization of such trails is one of the effective methods of education and training that actively help the youth get acquainted with nature and local ecological problems.

Comparing local farmers' and conservationists' perceptions of landscape change in Hungary

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The perceptive approach has become central in the landscape definition of the European Landscape Convention; together with the acknowledging of different knowledge and attitudes on landscape. The aim of our study was to compare knowledge and perception of different social groups such as local farmers and scientist-conservationists about landscape change processes.

Our area of study is a 20x30 km territory in the central part of Duna-Tisza Interflow, Hungary. It is a mainly agricultural, rural area, characterized with fine scale mosaic of arable fields, vineyards, orchards, abandoned fields, tree plantations and high nature value sites (e.g.: Pannonian sand dunes, wetlands, salt lakes), and protected areas of Kiskunsági National Park. Our main goal was to acquire knowledge on local landscape history, and to explore and compare people's perceptions concerning on landscape changes. Based on previous studies we focused on dominant ecological trends such as land abandonment, spontaneous and deliberate afforestation, loss of wetland habitats, spread of adventive plants and wild animals etc. We conducted semi-structured interviews about these landscape trends and about their subjective evaluation, and occasionally we augmented the interviews with an unstructured outdoor portion on the sites concerned (guided field walks).

By studying people's perceptions we could gather in-depth data not just about the landscape changes, but also about the social and political drivers and human decisions behind them. We considered the effects of the implementation of European environmental and agricultural policies as well. In some cases we found locally different perceptions of landscape trends, because of the diverse geological, historical and economic conditions. The variable reference states, experiences and mobility of the informants also caused differences in the acquired data. We hope that understanding different discourses within and between the studied groups could help to explore hidden land use conflicts in the future, and to bridge the gap between EU policies, conservationists and locals.

Conservation goes social – using social sciences methods in conservation education

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The Master course „Nature Conservation and Biodiversity Management" was established in 2007 at the University of Vienna. It is open to all students with a background in biology and related disciplines and aims at an university education that increases employability of students but is well-founded in the academic research activities of the faculty. Therefore, the curriculum consists of a mixture of basic lectures and practical courses in conservation biology. Learning

outcomes of these courses do not only focus on various methods of modern and classic conservation assessments, but do also include basic skills in social research and communication as well as insight into practical conservation management (http://131.130.59.133/mnb/Teaching/curriculum.cfm).

With this presentation, the author – being senior lecturer and coordinator of these Master courses – wants to provide an overview on study aims and how they are achieved with the current curriculum. Secondly, the importance of conveying a broad understanding of nature conservation by offering well-defined interfaces between conservation biology, landscape ecology and socially oriented landscape research is highlighted. This is done by presenting the results achieved by student works in relevant courses, such as opinion surveys, expert interviews, working with focal groups, including partly published (Schindler et al.2011), partly unpublished material. Thirdly a number of Master theses dealing with the landscape and human dimension of conservation research will be used as illustrative examples for this approach by presenting major results.

Finally it will be discussed to what extent such a broad conception is affordable within the clearly defined range of a Master course that has to be compatible with the „Bologna" process and is therefore limited to duration of 2-years and the achievement of 120 ECTS. Including landscape issues and nature perception in such a tight schedule is a challenging task, but rewarded by new insights and methodical innovations that are well received by a wider audience.

Acknowledgement

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Workshop: Ecosystem Services in Changing Landscapes: How to assess trade-offs and land use options?

Challenges in sustainable development – comprehensive scenario modeling and assessment at different scales

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One of the key challenges in sustainable development consists in balancing manifold demands and concerns of actors. This includes respecting different scales of interest, different actor types and consequently different priorities framed by private and public constraints. The concept of ecosystem services (ES) provides a powerful framework for assessing the impact of land use and land management change (LULMC) scenarios to inform decision processes and support actor involvement from the management planning unit up to the landscape scale.
This presentation intends to demonstrate how a fully integrative scenario modeling and ES based impact assessment can be structured, which requests need to be satisfied to get different actor types on board and what kind of information on spatial pattern and temporal fluctuations in ecosystem services provision and related trade-offs can be operationalized to address different information requests.

Coal mining area as an example of rapidly changing landscape in terms of ecosystem services (Koš, Slovakia)

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This study refers to the assessment of changes in ecosystem services at the local scale on an example of the rural agricultural landscape of the village Koš with a specific management due to subsurface coal mining activities. There are two main turning points in a recent history of this area concerning the ecosystem changes; the first started in 1950's when the all-over unification of agriculture land parcels was executed with an effect of biodiversity degradation (e.g. loss of grassy balks and hedgerows). The second one began in 1980's with a progress of the coal mining towards to the cadastral area of the village which had both natural (e.g. generation of mining subsidence pools and their reclamation, riverbed relocation) and social implications (resettlements).

The research is based on land cover change analysis methods using remote sensing data (historical and present orthophoto images covering the time period 1950-2014), GIS tools and additional data for the reclassification purposes. The landscape units are interpreted by means of

EUNIS habitats classification with an assigned ecosystem function and stored in geographical database. The evaluation of habitat change directions is based on spatial data reclassification using additional databases (e.g. soil properties, cadastral parcel database). The proposed model provides an analytical background for valuation of changes in existing ecosystem services or potentially more suitable ones. In this case it is a question how to valuate benefits of adopted management of the land affected by mining activities, e.g. whether the recultivation of the mining subsidence pools means also the cost-effective way of land utilisation compared to other scenarios.

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Wood bioenergy production in the northeastern United States: Understanding and avoiding negative ecological effects and increases in landscape-scale net carbon emissions

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Demand for wood bioenergy is increasing globally and across the United States, but ecological effects of harvesting and net carbon emissions at large temporal and spatial scales remain uncertain and actively debated. Relatively few studies have evaluated these concerns using field data from actual bioenergy harvests. We addressed both shortcomings using inventory data from 35 recent harvests, pairing harvested sites with reference areas in the northeastern U.S. We developed harvesting scenarios in which bioenergy production expands across the landscape based on these empirical data, applied them to Forest Inventory and Analysis data for a larger set of 362 forest sites across the northern forest region, and modeled those 160 years into the future using the Forest Vegetation Simulator. Bioenergy harvests were modelled as integrated operations, combining biomass with other types of wood products, and staggered over time and space, to better approximate the way real forested landscapes are managed.

Multivariate analysis suggested the strongest predictors of habitat effects were silvicultural treatment and equipment type rather than the proportion of harvested volume allocated to bioenergy. Harvesting impacts were highly variable, supporting a role for harvesting guidelines aimed at encouraging retention of ecologically important structural attributes. Whole Tree Harvesting (WTH) resulted in the greatest net carbon flux compared both to bioenergy harvests not using WTH and non-bioenergy operations; the difference was attributed to operational factors. When these effects were simulated within the landscape scale harvesting scenarios, choice of baseline resulted in contrasting conclusions about wood bioenergy emissions. Relative to starting landscape condition, all the bioenergy scenarios added carbon to terrestrial sinks and/or offset fossil fuel emissions. If foregone C sequestration potential is the benchmark, and if harvest intensities increase, then net emissions are predicted to increase over both near (10-20 years) and long-term (160 year) timeframes.

We recommend that policymakers weigh the benefits and trade-offs of increased investment in wood bioenergy production to minimize unintended consequences, such as negative ecological impacts of increased harvesting pressure and emissions increasing in the short-term.

We recommend a variety of forest management practices, bioenergy development foci, and conservation measures to minimize potential lag times until net greenhouse gas emissions reductions are achieved.

Spatial-explicit changes on ecosystem services, trade-offs and conflicts assessment for planning futures

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Information on land cover and land cover change is believed to be one of the benchmark data sets because of its value as an environmental change indicator. In a world of shrinking forests worldwide, Europe is expanding its forest area. This poses forest planners and policy makers with a difficult task: how to make decisions that affect the future delivery of ecosystem services when faced by rapid land cover change shifts? One approach is to consider how a range of futures may unfold and stimulate interdisciplinary debate about land cover changes scenarios. Given the relationship between space and time scales appropriate for observing different aspects of patterns and processes can only be perceived within a long term scale. I will provide an example of future trends of land-cover in a complex mountain landscape facing environmental conditions that directly affect biodiversity variability, potentiality of timber production and forest accessibility parameters. Trade-offs become then relevant to plan for the future while evaluating potential conflicts for planning decisions in complex landscape contexts.

How would a Mediterranean landscape change under different scenarios? Social multicriteria evaluation of trade-offs among ecosystem services for landscape planning

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The ecosystem services (ES) framework is very useful for communicating the manifold ways in which natural systems contribute to human well-being. For this reason, it is a high useful tool for land managers and decision makers. However, trade-offs exist among ecosystem services at different scales and between the supply and demand of ES by society and especially by different groups of stakeholders.

In this contribution, we applied a multicriteria assessment of different future land use change scenarios, involving the society and scientists to discuss about the future of multifunctional Mediterranean landscapes and trade-offs of ES in order to evaluate how their change affects people living or making use of them. These cultural landscapes are currently undergoing intense transformations resulting in a polarization of land uses across an intensification-abandonment continuum with uncertain and no-linear interactions and impacts on biodiversity, ES and local wellbeing.

We first identified and described the main land uses units in the studied area (i.e. *Sierra Morena* eco-region) through semi-structured interviews (N=33) with key players and influent stakeholders. For each unit the local stakeholders evaluated the demand of ecosystem services, their "importance of preference" and "vulnerability degree". The interviewee also described alternative landscape configurations under prioritized direct and indirect drivers of change. The ES prioritized, the drivers analysis and the resulting narrative of assumptions and consequences of scenarios were discussed with local stakeholders during a workshop (N=19) and creatively represented by using theatre with the help of professional actors. Secondary data provided scores of the supply of ES for each land use unit. We finally adopted the aggregation procedure of NAIADE (https://weadapt.org/knowledge-base/adaptation-decision-making/naiade) to assess the trade-offs and synergies of ecosystem services supplied and demanded under the different landscape configurations. According to the weights attached to each ES by participants we also evaluated the distance trees (i.e. alliances) among stakeholders. The paper discusses these preliminary results in terms of relevance for landscape governance and management.

References::
https://weadapt.org/knowledge-base/adaptation-decision-making/naiade

Ecosystem service mapping to assist Regional Planning: The Scottish Borders Regional Land Use Pilot

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This paper presents a practical application of the ecosystem approach through comprehensive ecosystem service mapping and evaluation of key market and policy drivers. The Scottish Borders Regional Land Use Pilot was carried out as part of the testing of the Scottish Government Scotland's first Land Use Strategy (LUS). Published in 2011 this strategy set out a vision for future land use in the country to 2050, with a focus on three objectives relating to the economy, environment and communities - the three pillars of sustainability. The pilot project used an innovative yet practical mapping system SENCE (2014) to map the stock of 17 existing ecosystem services. Opportunities for areas where the ecosystem services could be enhanced were mapped for 7 key services. These maps were taken out to public consultation to show the people of the region a new way of looking at their landscape. Following this exercise a comprehensive analysis identified the main drivers acting at the landscape scale. Further modelling showed areas where changing land use would result in interactions of key services, necessitating a choice to be made between one service and another. Areas which would have multi-benefits from any actions were also identified.

This suite of mapping provides a comprehensive decision support tool for the Scottish Borders. By taking detailed mapping at this local scale the work can potential add value to a wide range of organisations who work with land managers as well as local and regional decision makers.

This paper will cover the mapping methodology and many practical uses this work will have, and how the theory behind it and benefits are transferable to other regions within Scotland and beyond.

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Using landscape services to address trade-offs and synergies in land-use policy and planning. Two case studies in Scotland

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Ecosystem Services are acknowledged in science, planning and policy as a concept useful to better understand and guide the complex sets of relationships between nature and human societies, including land use. Efforts have been made to identify and describe the multiple trade-offs amongst different ecosystem services, and also the various ways in which land-use policies and plans should account for such trade-offs, enhancing synergies and mitigating conflicts. However, the rapid spread of Ecosystem Services as a useful concept has not happened without critique, and potential for improvement has been identified in relation to theoretical and operational aspects. One such critical approach is provided by the concept of Landscape Services, which has been proposed as an alternative or complementary approach to unravel the multiple benefits that nature provides to human societies. Key gaps in the Ecosystem Service approach that may be tackled by employing the Landscape Service concept include the consideration of coupled social-ecological systems, of the spatial, cultural and perceptual aspects of the environment, and the adequacy of the landscape scale to better understand the place of humans in nature. In this paper we examine the potentials of this concept by examining the trade-offs and synergies amongst different types of Landscape Services driven by land-use policy and planning. To do this we examined two case studies in Scotland that are representative of two key challenges of Scotland's land use policy; the conflicts between wind-farm development and landscape protection, and between forestry expansion and land-use multi-functionality. For the former we chose Central Scotland's Green Network, where the majority of the Scottish population resides. For the latter we studied NE Scotland, where rapid urban expansion is in contrast with the rural character of landscapes. Results indicate to the advantages of using the concept of Landscape Services to unravel the cross-scalar complexity of planning and policy frameworks driving land-use change. However, using this concept does not help resolve all the gaps encountered in the definition and application of Ecosystem Services, and further insights on how to better combine both concepts are strongly encouraged.

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Environmental resilience of selected rural areas in Malopolska region to agriculture

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Environmental resilience is understood as the ability of the environment to counteract changes in the structure and functioning of environment due to natural and anthropogenic stimuli (Przewoźniak 1991). According to the ecosystem services concept it is defined as the basic ability of an ecosystem to maintain desired ecosystem services in the face of a changing environment and human activities (Carpenter et al. 2001; Folke et al. 2002) and is somehow a prerequisite for ecosystem services.

The impact of agricultural land use on environment involves different effects such as: soil erosion, nutrient and biocides leaching which, in consequence, cause soil degradation and lead to water contamination. Apart from that, agricultural activities (i.e. using fertilizers and biocides as well as livestock farming) have significant influence on air quality causing its deterioration. Negative impact of agriculture concerns also vegetation.

In this study, the negative impact of agricultural land use is analysed taking into consideration specific environmental properties in test areas. The evaluation was conducted on the basis of environmental capacities (potentials) and ecosystem services concept. Actual land use account for demand in case of the second approach. Results of resilience assessment of selected rural areas of Malopolska region to agricultural land use are presented and compared.

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New EU level scenarios focusing on policies and ecosystem services

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OpenNESS is a EU FP7 research project with the objective to translate the concept of ecosystem services into operational frameworks that provide tested, practical and tailored solutions for integration into land, water and urban management and decision-making. The scenarios presented in this paper contribute to the objectives of OpenNESS by providing a framework of plausible assumptions about potential characteristics of European policy environments as well as cross-sectorial vs. sectorial policies driving changes of ecosystems and their services. The scenarios are intended to serve as common boundary conditions for a number of research approaches in OpenNESS such as regional case studs and modelling approaches at different spatial scales, as well as in-depth policy analyses. The scenarios are being developed by a scenario team integrating input and needs from case studies and other stakeholders and in an iterative approach, following procedures adaptted from Priess and Hauck (2014). The four scenarios have been developed focusing on two uncertainty axis: 1) characteristics of the European policy environment, between concentrated and dispersed responsibilities and assuming 2) cross-sectoral vs. sectoral policies. The scenarios comprise storylines and quantified assumptions about changes of key-factors. The storylines provide information about triggers of change, mid-term developments until 2030 of political, societal and economic change, urban, rural and grey infrastructure development, land use and environmental conservation as well various long-term developments until 2050. Key-drivers of change covering social, economic, political and land-use topics have been quantified. Together these assumptions built a common framework allowing the synthesis of results at different scales, and from different research approaches within and beyond OpenNESS.

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WORKSHOP: Ecosystem Services in Changing Landscapes: How to assess trade-offs and land use options?

Previous International Symposia on Landscape Ecology held in Slovakia:

1st Int. Symposium - Theoretical problems of biological landscape research
4–9 September 1967, Bratislava and Východná, the High Tatra Mts.

2nd Int. Symposium - Application of landscape ecology in the practice
21–24 September 1970, Smolenice

3rd Int. Symposium - Content and object of the complex landscape research
28 November – 1 December 1973, Smolenice

4th Int. Symposium - Ecological data for optimum landscape utilisation
22–26 November 1976, Smolenice

5th Int. Symposium - Ecological stability, resistance, diversity, potentiality, productivity and equilibrium of landscape
19–23 November 1979, Stará Lesná, the High Tatra Mts.

6th Int. Symposium - Ecosystem approach to the (agricultural) landscape
Foundation of IALE on 29 October 1982, 25–30 October 1982, Piešťany

7th Int. Symposium - Topical problems of landscape ecological research and planning
21–26 October 1985, Pezinok

8th Int. Symposium - Spatial and functional relationships in landscape ecology
3–7 October 1988, Zemplínska Šírava

9th Int. Symposium - Theory and practice in landscape ecology,
14–19 October 1991, Dudince

10th Int. Symposium - Present state and new trends in landscape ecology
21–24 November 1994, Smolenice

11th Int. Symposium - System approaches to landscape research
12–16 November 1997, Nitra

12th Int. Symposium - Protected areas and landscape ecological research
7–11 November 2000, Stará Lesná – the High Tatra Mts.

13th Int. Symposium - Landscape ecology – an international integrating tool in environmental issues
30 September – 3 October 2003, Mojmírovce

14th Int. Symposium - Implementation of landscape ecology in the new and changing conditions
4–7 October 2006, Stará Lesná, the High Tatra Mts.

15th Int. Symposium - LANDSCAPE – Theory and Practice
29 September – 2 October 2009, Bratislava

16th Int. Symposium - Landscape Ecology: From Theory to Practice
24-27 September 2012, the SAS Congress Centre Smolenice

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