Science for the Carpathians

CONFERENCE ABSTRACTS

Martin BOLTIŽIAR (Editor)

FORUM CARPATICUM 2012

From Data to Knowledge, from Knowledge to Action

30 May - 2 June 2012,
Stará Lesná, Slovakia

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From Data to Knowledge – from Knowledge to Action

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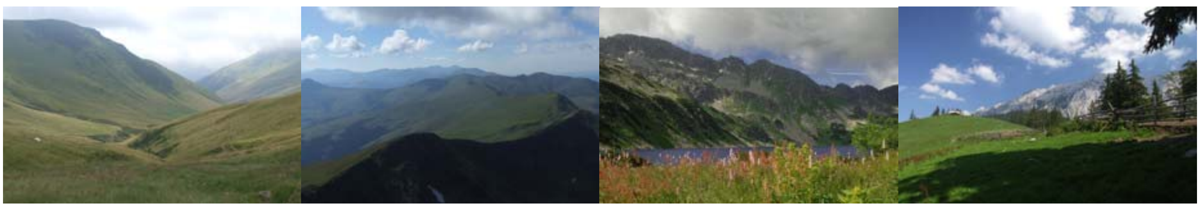
The Forum Carpaticum 2012

From Data to Knowledge, from Knowledge to Action

30th May – 2nd June 2012, Stará Lesná, High Tatras, Slovakia

Conference Abstracts

Martin Boltižiar (Editor)



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PLENARY SESSIONS

Network Enabled Research:
Not just better or faster but fundamentally different

Cameron NEYLON

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The web is just the latest example of a network that has qualitatively changed what human society is capable of with a limited set of resources. Before the web networks of mobile phones, and before that fixed telephony made qualitatively different forms of social interaction possible. Twenty years ago an impromptu meet up between local friends and someone visiting for a day would have been near to impossible. Today it is trivial. Prior to the telephone the telegraph, postal service, moveable type, the stage coach, and writing itself all created similar changes in human and social capacity.
We are only just beginning to see the first glimmerings of what network enabled research might make possible. Tim Gowers, one of the worlds great mathematicians, described the experience of the PolyMath project compared to his normal approach to mathematics as like a driving is to pushing a car. The level of qualitative change is indicated by the solution of a problem that he regarded as too hard for him to solve within a matter of weeks by a group of mathematicians acting as nodes on a network. Examples can be multiplied but they are single isolated examples. Our research capacity remains similar in practice to what it was in the 1980s. The question must be, for the future of ourselves, and the planet, how can we best exploit the capacity of networks across our research effort. In short: how can we make networks of research resources, people, information, and tools that work. What will they look like? And how do we get there from here?
The path remains at best obscure at the moment but an emerging understanding of how networks function can help to guide the way. The key aspects of an effective network are threefold:

The larger and more connected the better: Networks thrive on connectivity. The larger the network and the more connected it is, the greater the opportunity for critical information to reach the right person.

The lower the friction the better: Transfer of non-rivalrous resources at speed and with low friction is the most important capacity of a network. Artificially introducing friction, or not acting to reduce friction means effectively breaking connections within the network, reducing its capacity.

High information flow requires effective demand-side filtering: A consequence of high network connectivity and low transfer friction means a large quantity of potentially incoming resources to any given node. If that node is a person they won't be able to cope. But filtering at source is creating friction. Therefore the information flow necessitates the design of flexible and configurable filters that can be used to modulate resource flow on the demand side.

What does this mean in practice for scholarly communication? At the moment we have systems set up to reduce connectivity and scale - by limiting access to research resources to limited groups of people - we deliberately create friction in the system due to legacy business models - by charging for distribution and dissemination when these costs are disappearing making the first copy costs the most important to recoup - and we have a system based almost purely on supply side filtering.
In an ideal world we would utilise the (as near as makes no difference) zero cost of dissemination to enlarge the scale and connectivity of our research network by making the content free. We would actively reduce friction to sharing of research resources by focussing business models on the generation of "web ready" content, charging for the first copy costs up front and competing on the basis of the service offering. And in a perfect world we would abandon pre-publication peer review in favour of a model of filtering services that would enable the consumer to decide what they want to see, what quality filters they want applied, and who they trust to apply them. In this world there are

many services which currently don't exist but look quite similar to thing that happen in major publishing houses. The question is how to get there from here, ideally without bringing the whole system crashing down around our heads en route.

Remote Sensing of Mountain Environment – Sate of the Art and Outlook

Marc ZEBISCH, C. NOTARNICOLA, A. TETZLAFF, C. IASIO, C. STEURER, R. SONNENSCHEIN, K. LEWINSKA, N. SPINDLEr, A. POLYCHRONAKI, S. SCHNEIDERBAUER, M. PETTITA, B. VENTURO, M. DUGUAY, R. MONSORNO, A. COSTA

EURAC.reserch – Institute for Applied Remote Sensing (IT), Bolzano, Italy
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In a changing world, environmental monitoring and assessment is a field of growing demand, expressed for instance in rising obligations to report on the status of the environmental system, the request for monitoring climate change impacts or the appraisal of risk to natural hazards. This Talk will present state of the art and outlook on remote sensing as a very useful tool for environmental monitoring of mountain environment.

Satellite data today offers a huge range of scales and sensor types from weather satellites to high resolution radar satellites. Still the most common used sensors are optical sensors. Spatial resolution is usually a tradeoff of temporal resolution and the area covered. While large scale satellites cover whole mountain ranges within one scenes and can provide several acquisitions a day, with finer spatial resolution the coverage shrinks to an image with of 100-200 km at a resolution of 10-30m and a revisit time of several days to a coverage of below 20km at a resolution of 40cm. Latest developments are more spectral bands, new bands, which allow for better classification of vegetation and a higher temporal coverage through wider swath and satellites constellation with more than one satellite. New high resolution Radar Satellites allow Earth observations also under cloudy conditions. With ESA's new Sentinel family a whole series of new satellites with free data access will be available.

Parallel to new sensors the potential for fast processing and semi-automatic image analysis, classification and interpretation have improved in the last years by introducing techniques like Object Based Classification or Machine Learning Techniques. With Radar Interferometry a total new field of application, the monitoring of terrain movements has emerged.

A few applications of remote sensing in mountain regions may illustrate the capabilities of this technique:

- Snow Cover monitoring: with optical data based on daily MODIS satellite data an operational snow cover monitoring product which covers the Alps as well as the Carpathians is presented. The data is processed in near real time with a time lag of 2 hours and produced with a resolution of 250m.
- Snow cover monitoring and soil moisture monitoring with Radar: high resolution X-band as well as C-band data is used to provide weather independent information on snow and soil moisture.
- Habitat Mapping and Monitoring: NATURA2000 habitats are mapped with multitemporal high resolution RapidEye satellite data. Also conservation status is assessed.
- Forest Damage Assessment with change detection techniques. Damage after storm events is analyzed with change detection techniques in high detail
- Mapping of land-slide movement with radar interferometry. Based on high resolution X-Band Radar data by ComoSkyMed movements of a large land slide are studied.

We assume that remote sensing can particular contribute to environmental monitoring when integrated with in-situ data and other techniques such as modeling, making use of the greatest advantage of remote sensing, the area-wide data availability and overcoming the strongest constraint, the “fuzziness” of the data (accuracy, resolution, data gaps).

The SEIS role in support of pan-European environmental data sharing

Stefan JENSEN

European Environement Agency, Kongens Nytorv 6, 1050 Copenhagen,
E-mail: stefan.jensen@eea.europa.eu

SEIS, the Shared Environmental Information System, is a European policy initiative which aims to modernize and improve the production, handling and exchange of environmental data and information. It is implemented through the promotion of a set of principles as well as through operational activities around its three pillars governance, content and infrastructure.

The presentation will show the most relevant activities undertaken both on the European level as well as in Member States to progress in the above mentioned areas. Main activities in the governance field include the further strengthening of the European Environment Information and Observation Network as well as the extension of SEIS into the European neighborhood countries. International links are as well of relevance. On content, there are new assessment frameworks which are supported by SEIS through systematic work on indicators, accounting and ecosystem services. In particular in this area there are strong links to the work of the scientific community.
The SEIS infrastructure makes use of the progressing work on standards and of the latest developments in Internet technologies as well as of the growing importance of crowd sourcing and citizen science. EEA has been engaging very actively in these four areas and examples will be provided to underpin this.
Free access to environmental data and information including data from administrations, citizens, research and space programs is actively promoted by EEA.

Why it is so difficult to implement science-based solutions in ecosystem management?

Ladislav MIKO
European Commission, DG Health and Consumers, Brussels, Belgium

The modern society more than any time before claims to respect and follow the results of science as the main base for informed and good decisions in many areas, including the management of ecosystems and nature conservation. Still, it appears that it is extremely difficult to bring this principle into real life. What are the main reasons for this situation?
The presentation will address different motivations of stakeholders, questions of reliability, clarity, and simplicity, role of traditions, cultural history and scale, links to politics and other aspects of the problem. The purpose is to challenge some standard clichés and beliefs, invoke the discussion and invite participants to bring ideas on how to bridge some gaps between scientific advice and reality in the ground.

THEMATIC SESSIONS

ORAL PRESENTATIONS

The brown bear management plan for Poland: needs of a transboundary population

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National legislation and international treaties oblige Poland to prepare and implement a management plan for the brown bear *Ursus arctos*, first at the national level and later at the population level. With this aim, data was collected and a series of workshops organized during two years and the final proposal was presented in November 2011. The brown bear in Poland is a protected species, listed in the Annex II and IV of the Habitats Directive and classified as a priority species. The brown bear population in Poland is restricted to the Carpathians and represents the most northern border of the Carpathian population. The distribution is discontinuous, with two main reproductive areas in the Tatra (western segment) and Bieszczady mountains (eastern segment); occasionally in Beskid Zywiecki. The connectivity between the western and eastern segments of the population is very limited in Poland, and practically null in Slovakia.

Some of the key problems that the present management plan tries to face and solve are: (1) the lack of reliable monitoring methods, (2) the lack of or insufficient coordination and communication among responsible institutions and social sectors involved in bear management in the region, (3) the lack of or insufficient scientific knowledge on species biology, ecology and conservation in Poland, and (4) the lack of or insufficient proper implementation of the existing legislation and real protection of brown bears. One of the most important problems for the conservation of bear habitat is the lack of spatial planning in Poland, which is leading to the fragmentation and loss of bear habitat through unplanned and spread building, often in remote areas. The human disturbance to bears, damages to beehives, increasing food conditioning due to intentional feeding of bears and non proper management of rubbish are among other problems to be solved in the field. The situation of captive bears, the cooperation with neighbouring countries, mainly Slovakia, and the promotion of research and education are also pending issues.

The vision of this plan is the preservation of a viable natural brown bear population and its habitat in a favourable conservation status in the coexistence with humans. This vision reflects an ecosystem approach and calls for promoting bears' natural behavior, preserving their natural habitat, maintaining ecological processes and considering bears as an important element of forest ecosystems. The plan also aims at providing to authorities reliable data and detailed guidelines to solve existing or potential conflicts and take management decisions based on scientific evidence. The plan sets the framework for the coordination of the management measures and for future decisions based on scientific data and monitoring. Specific goals are:

(1) Preserve the natural bear habitat and its quality.

(2) Prevent, react to and provide solutions to all kinds of human-bear conflict situations.
(3) Avoid bear habituation and food conditioning.
(4) Minimize bear damages, especially to beehives.
(5) Preserve and improve the connectivity between the reproductive nuclei in the western and eastern Polish Carpathians.
(6) Maintain a stable and continuous bear population along the northern Carpathian range in cooperation with Slovakia and Ukraine.
(7) Decrease and control brown bear mortality due to human factors.
(8) Implement a solid and coherent monitoring program and create a reliable and available brown bear Data Bank.
(9) Promote the coordination of management activities and information flow among involved sectors.
(10) Improve the scientific and public knowledge on the species in Poland.
(11) Keep the public informed by making available monitoring data and annual reports.
(12) Establish a permanent and close cooperation with Slovakia and Ukraine and increase the international cooperation.
(13) Promote public awareness and participation in brown bear issues and monitoring.
(14) Improve the living conditions of captive bears.
(15) Promote environmental education in all social sectors.
(16) Guarantee the proper implementation of the existing legislation and a real protection of brown bears and their habitat.

The main lines of actions proposed to fulfill the above objectives are:

ACTION 1. COORDINATION AND IMPLEMENTATION OF THE MANAGEMENT PLAN
Creation of a Bear Working Group, a Bear Emergency team, a Bear Data Bank and implementation of Standard Protocols. Creation of a bear website and annual reporting to the public of monitoring results and bear situation in Poland.

ACTION 2. IMPLEMENTATION OF THE MONITORING PROGRAM
The proposed monitoring program is "adaptative" and consists of three main branches:
(1) Baseline monitoring (continuous): annual survey through questionnaires to monitor bear distribution, monitoring bear mortality, monitoring bear damages;
(2) Intensive monitoring (periodical, every 6-10 years): genetic monitoring (every 6 years in coordination with EU report on conservation status), systematic presence surveys and habitat monitoring (these two coordinated, every 10 years);
(3) Monitoring ad-hoc: study on the connectivity between the Tatra and Bieszczady mountains (bear presence surveys and genetic monitoring in this region in 2013-2014).

ACTION 3. CONSERVATION OF BROWN BEAR HABITAT AND ITS CONNECTIVITY
Avoid habitat loss and fragmentation by implementation of urban spatial plans and management plans for Natura 2000 sites in the regions of bear distribution. Restoration of ecological corridors in the critical points identified, and specifically in the corridor Tatra-Bieszczady. State Forest and National Parks should avoid fragmentation by forest roads and limit human access to the areas identified as of high habitat quality (secure habitat areas).

ACTION 4. REDUCTION OF BROWN BEAR MORTALITY AND DISTURBANCE CAUSED BY HUMANS
Better implementation of the national species protection law; registering all cases of bear mortality. Increase the vigilance by national park staff on activities that can disturb bears.

ACTION 5. PREVENTION AND DIMINISHING OF BROWN BEAR DAMAGES
Program of damage prevention and information campaigns.

ACTION 6. AVOIDANCE OF BROWN BEAR HABITUATION AND FOOD CONDITIONING

Establish regulations for intentional baiting of bears. Action program and information campaign about waste management and methods to secure rubbish.

ACTION 7. IMPROVEMENTS OF THE CONDITIONS OF CAPTIVE BEARS
Change the current law to increase the established minimum size of bear enclosures. Promote the building of a bear sanctuary.

ACTION 8. INCREASE COOPERATION AT NATIONAL AND INTERNATIONAL LEVEL
Creation of a Polish-Slovakian Commission for large carnivore issues which will meet every year. Agreement on conservation policies with Slovakian authorities in relation to bear control and prevention of damages. Unify and coordinate monitoring in Polish-Slovakian management units.

ACTION 9. PROMOTE SCIENTIFIC AND APPLIED RESEARCH
Bear Data Bank available for scientific purpose.

ACTION 10. PROMOTE EDUCATION AND RAISE PUBLIC AWARENESS
Public involvement in the monitoring program. Frequent update of the brown bear website and information to the public and media.

The present management plan has been conceived as a flexible document that should adapt to the rapid changes going on in the Polish society and natural environment, and that should follow the growing scientific knowledge on bear ecology and conservation.

A sustainability challenge: Managing the Tatra National Park and Biosphere Reserve in the past, now and in the future

Eva STREBEROVÁ

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The Tatras constitute a natural border for the Polish and Slovak Republic and occupy an area of total 785 km^2, of which one quarter lies in Poland and the rest stretches over northern Slovak Republic. For these two neighbouring countries the mountain range is of symbolic and cultural importance and became a UNESCO Biosphere reserve under the Man and Biosphere programme in 1993.
The study area is a mosaic of valuable mountain ecosystems and is home to several endemic Carpathian fauna and flora species, large carnivores (brown bear, northern lynx, wolf, common wild cat, pine marten, and common badger) and 1,300 species of vascular plants. In 1949 the Tatra National Park (TANAP) was created on the Slovak side of the border and a few years later in 1954 the Polish National Park followed (Tatrzanski park narodowy - TPN). Currently 64% of the Slovak territory is under protection of the Natura2000 directives and the TPN is almost entirely protected by Natura 2000. Although belonging to two countries, the Tatras are one mountain range, but the management approaches at each of the sides of the border differ significantly in practice (Izakovičová et al., 2008, Vološčuk et al., 2011).The study area encompasses one of the most attractive part of the Tatras – the High Tatra mountain grouping and has a long history of human-nature interaction. The research territory falls between the borders of the cadastral territory of the town of Vysoké Tatry (means High Tatras). From a spatial perspective, the Vysoké Tatry is not a usual town, it consists of 15 small settlements scattered on an area of 398 km^2 (which is almost the area of the city of Prague). These settlements were originally first tourist and climatic spa centres that appeared with the

establishment of the first railway that was connecting eastern Slovakia with the west and the Czech Republic in 1871 (Lukniš 1973, Andráši, 1991, Vološčuk et al., 2004).
According by Fischer-Kowalski et al. (2004) the "internal sustainability" of protected areas (like for example biosphere reserves) depends on resolving conflicts between conservation of nature and development. In other words, it is important for local stakeholders to have a balance between the costs for conserving the nature, which means restrictions of use and economic development, with the benefits stemming from a status of a protected area (income from tourism, healthy environment, cultural values, etc.).
The aim of this contribution is to determine indicators which are directly causally related to conservation of nature and development in the study area, using the methodological steps as proposed by the integrated monitoring and assessment framework for Biosphere reserves (Fischer-Kowalski et al., 2004). The research takes a case study approach in investigating the dynamics in the study area from an environmental and socio-economic point of view, building on knowledge from existing local strategic documents, research already undertaken in the study area, studies and management plans for sustainable development and nature protection in the Tatras (Vološčuk et al., 2004, Huba, 2005, Körnerová, et al., Körnerová 2006, Hanušin et al., 2007, Izakovičová et al. 2008).
In the very early phase of research in 2011 semi-structured interviews were undertaken with representatives of 13 state and non-state stakeholder groups relevant to this topic in the study area. This method yielded sufficient data for undertaking a stakeholder analysis and map which both complement the methodology as outlined in the previous paragraph.
In the interviews stakeholders expressed what they perceive as obstacles to sustainable development– mostly stemming from the fact that they have different interests, costs and benefits from the study area and do not share a vision of what sustainable development in the Tatras should be like. Another important conclusion is that there is insufficient institutional regulation and support of the state in maintenance of social and natural capital in the study area. (Streberová, 2011).
The indicators outlined in the contribution are building on the sustainability vision of research already done in the Tatras, on the status of a national park and a UNESCO Biosphere Reserve and therefore could be interpreted as critical factors for monitoring sustainable development in the High Tatra.

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Why should we preserve historical agricultural landscape?

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Agricultural landscape covers almost half of the area of the Slovak republic, and it is significant from the production as well as the ecological point of view. Within the agricultural landscape of Slovakia, the remnants of traditional historical agricultural landscapes (HAL) can still be found, especially in the hilly and mountain regions of the Carpathian Mts. They represent a type of cultural landscape that contains, within a geographic area, both natural and man-made features, and a cultural expression reflecting past events or patterns of socio-economical development.
The aim of this study is to point to diversity of HAL and different ecosystem services, that HAL provide for society and thus to promote the knowledge of them and their preservation. Significance of natural, semi-natural and cultural ecosystems in agricultural landscape for the protection of environment is multiple. Natural, semi-natural and cultural forest or non-forest ecosystems of HAL are not significant only from biodiversity point of view, but they support also various ecosystem functions and provide ecosystem services that are necessary for society and have irreplaceable ecological, social-cultural and economical value (Hassan, Scholes, Ash eds., 2005). The unique islands of species-rich plant and animal communities play an important role in water retention and the prevention of soil erosion – both important with respect to climatic changes. The value of HAL is increased also by cultural ecosystem services as they represent cultural heritage, places for recreation and ecotourism, having aesthetic, inspirational and educational functions, a unique sense of place, etc.

This conference contribution presents outcome of aerial photos analysis, and countryside mapping of diversity of historical agricultural landscapes around Slovakia (Dobrovodská et al., 2010). In total 3,011 sites of HAL were identified from aerial photos. Out of that, 593 sites of HAL were validated in the field (19.7 %).

To bring a new knowledge concerning the distribution, conditions and character of historical agricultural landscape in Slovakia, we studied the diversity of these historical landscapes on two levels: as the ecosystem diversity based on the type and intensity of land use of these structures and their habitat diversity, focusing on habitats related to forms of anthropogenic relief (FAR), that are significant as unique islands of species-rich communities in the agricultural landscape, originated in continuous evolution over centuries.

To classify the identified HAL we considered the presence of specific land use elements in the following order: dispersed settlements, vineyards, orchards. We found out that the presence of these elements significantly influences the structure of individual sites of HAL and thus their ecosystems. Consequently we distinguished four classes of structures that represent the remnants of historical agricultural landscapes:

(1) Historical Structures of Agricultural Landscape with Dispersed Settlement,
(2) Historical Structures of the Vineyards' Landscape,
(3) Historical Structures of Arable-Land, Grasslands and Orchards and
(4) Historical Structures of Arable-Land and Grasslands.

To emphasize historical and cultural values of HAL related to biodiversity, special attention was paid to forms of anthropogenic relief and its habitats. We defined and mapped six types of FAR that originated as a result of improving soil and relief quality of cultivated land: terrace slopes, step balks, lengthwise mounds, solitary heaps, unconsolidated walls and mounds/heaps on terrace slopes.

Significance of historical, cultural and natural values of HAL is increased by presence of elements of small architecture and significant species and habitats that were also recorded in the field.

Our study identified also land-use changes, driving forces, threats and trends related to historical agricultural landscape in Slovakia. Genesis of historical monuments or structures in landscapes, their development and finally their disappearance is dependent on social-economical as well as natural conditions. HAL are threatened by abandonment and succession, expansion of the coverage of non-forest woody vegetation and decreases in the number of fragments of historical landscape structures. On the other hand, the main threats are land development and intensive agriculture. All these are a consequence of the development and expansion of the human society.

The diversity of remnants of traditional historical agricultural landscapes and threats pending over them may be similar in the whole arch of the Carpathian Mts. The question how to preserve historical agricultural landscapes remains open.

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Continuous loss of European temperate old-growth forests in the Romanian Carpathians despite an increasing protected area network

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Across the globe biodiversity is declining and the "2010 target" of the Convention on Biological Conservation has not been met. The destruction and fragmentation of habitat along with overexploitation are the main causes of the global biodiversity crisis. Old-growth forests play a key role in maintaining biodiversity and are irreplaceable for sustaining biodiversity. Moreover, contrary to the long standing view that old-growth forest are carbon neutral, they not only continue to sequester carbon, and store more carbon than any other ecosystem or forest successional stage. Old-growth forests are both an important carbon sink, but also potentially a large carbon source if disturbed.

Despite their ecological importance, old-growth forests around the world are vanishing at an alarming rate, thus diminishing ecosystem services (e.g., habitat, genetic resources, protection from natural hazards) that they provide. Especially in the northern, industrialised countries, land-use changes and forest management have almost completely eradicated old-growth forests. Of the total forest area in central Europe, only 0.2% of old-growth forests survived mainly in remote, mountainous areas or within nature reserves. Furthermore, human disturbances within these remaining old-growth forests continue and that has long-lasting negative effects on species composition and key habitat functions.

Goods and Services from European temperate forests, such as clean water, wood products and recreation opportunities in relation to the large number of people living in close proximity, make these forests an important ecosystem. One area where forests are particularly valuable are the Romanian Carpathians. The Carpathian old-growth temperate forests have high biodiversity and nature conservation value due to their high diversity in plant and animal species. They are also an important foundation for local livelihoods, and for ecosystem goods and services in the region.

Assessing the status of old-growth forests in the Carpathians is difficult due to outdated, incomplete and fragmented forest resource information. The last national forest inventory for Romania was carried out in 1984. This lack of information is worrisome because Romania is where some of Europe's last and most extensive old-growth forests are located. Vast forests including these old-growth forest patches, provide important habitat for the largest European populations of brown bear *(Ursus arctos)*, gray wolf *(Canis lupus),* and lynx *(Lynx lynx).* Moreover, these old-growth forests have been recognized for their exceptional biodiversity harboring many endemic, rare, and threatened forest species. Between 2001 and 2004, the old-growth forests in Romania was comprehensively assessed, and about 210.000 ha of old-growth forest were identified (5% of all Romanian forests). This is more than in any other Central European country. However, Romania's old-growth forest

cover has decreased drastically throughout the last decades (by 70% since 1945) and numerous severe threats have been identified.
One of the most pressing recent threats relates to the changes in forest ownership pattern. Public forests have been restituted to their prior owners, and this has often resulted in changes in forest management, as is often the case. Moreover, economic hardship accompanied by weak political institutions triggered the capitalization of forestland by new forest owners through harvesting. Additionally, the combination of changing institutions factors, poverty, high economic value of old-growth forests increases the pressure on these forests. At the same time, economic instability and numerous small-scale forest holdings (around 800,000 by the end of the restitution process), hampered the establishment of sustainable forest management practices and of effective safeguards of old-growth forests. Last but not least, weak law enforcement enabled illegal logging. The combination of all these threats makes, and the high ecological value of Romanian old-growth forests necessitate a new assessment to update and proof the last inventory from 2001 to 2004. Moreover, identification methods used in this inventory did not include a reporting or spatial description of already existing disturbances at that time.
Satellite image interpretation is the only feasible approach to assess forest cover changes across large areas. Particularly images from the Landsat Thematic Mapper (TM) and Enhanced Thematic Mapper Plus (ETM+) sensors are able to capture canopy removal and allow for robust comparisons across regions, and prior case studies resulted in accurate forest cover maps for parts of the Carpathians. Satellite analyses are particularly well suited to map forest disturbances, because the reflectance of a given pixel changes drastically when forest cover is removed either due to harvesting or to natural disturbance. In contrast, it is much harder to distinguish old-growth forests from other forests, because the spectral difference between the two is not as large. This means that the task of mapping disturbances in areas known to be old-growth forest is one that satellite imagery is particularly well suited for.
Our goal here was to quantify disturbance (defined here as full canopy removal due to either natural disturbances, such as wind or insects, or anthropogenic disturbances, such as logging) in Romanian old-growth forests based on the delineations from the last inventory. Specifically, we ask the following research questions:

1. To what extent did disturbances occur in Romanian old-growth forests between 2000 and 2010?
2. How were disturbances distributed among forest-ecozones, and elevation and slope zones?
3. How effective were protected areas in safeguarding old-growth forests in Romania?
4. What are possible causes of old-growth forest cover disturbance?

Forest disturbance maps were obtained from three previous studies with foci on different regions in Romania. All three maps were generated using either Support Vector Machines (Pal and Mather 2005), Disturbance Index (Healey et al. 2005), the LandTrendr (Landsat-based detection of trends in disturbance and recovery) set of change detection algorithms (Kennedy et al. 2010), and/or Chain Classification (Knorn et al. 2009). The original forest disturbance maps were subject to individual rigorous accuracy assessments, based on independent ground reference points. To build an area-wide forest disturbance map covering all of Romania's old-growth forests, maps from the three original studies were aggregated and the original classes merged to 'permanent forest', 'permanent non-forest', and 'forest disturbance' from 2000 to 2010. Using the area-wide forest disturbance map, we summarized old-growth forest disturbances based on the polygons from the baseline digital inventory map. We derived proportions of old-growth forest disturbances in relation to both forest ecozones and protected areas. In addition to the conditions inside old-growth forest patches, the degree of fragmentation on the surrounding forest matrix is also important. To determine the intactness of the surrounding landscape, we delineated areas within 250 m of each old-growth forest patch and summarized the forest disturbances within those areas.
In total, 1.3% (about 2720 ha) of old-growth forest was disturbed during the last decade, taking into account that 7238 ha (~3.4%) of the inventoried 210,882 ha old-growth forest stratum could not be

classified due to clouds or cloud shadows in the satellite imagery. Old-growth forest disturbances were mainly concentrated along the interior mountain complexes of the Carpathian Ecoregion. Clusters of disturbance occurred in the Maramures Mountains in the north, the Apuseni Mountains in the west, and the south/south-western rim of the Carpathian mountain chain. In total, about 72% of all disturbances in old-growth forests were found within a protected area. Disturbances in areas within 250 m of old-growth forests occurred on a total of 3290 ha. This corresponds to about 1.6% of the total buffer area and is thus about 570 ha higher than the respective disturbed area within the original old-growth forest patches.

Our study highlights the fact that intact old-growth forest landscapes continue to disappear in the temperate zone. Romania's protected areas have not been successful in safeguarding these forests, confirming recent concerns about the effectiveness of nature protection in this region (UNEP 2007; Knorn et al. in press). Romania harbours the largest share of Carpathian's high-conservation old-growth forests. If these valuable forests are lost, they cannot be restored in the foreseeable future (Wirth et al. 2009).

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Survey and research in the Hungarian forest reserves – a review

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Virgin forest remnants and forest reserves are among the most important natural heritage of the Carpathians. However actual knowledge about the research results at a pan-Carpathian level is still very fragmented due to the different history and deepness of forest reserve research in the different Carpathian countries and due to the difficult accessibility of a part of the research documents, such as native language articles or research reports. In Hungary since 1990, a national forest reserve program is supported by the ministry of environment. The program has aimed the designation of forest reserves, establishing the legal framework of strict protection and the standardized field surveys of the forest reserves. Prior to- and parallel to this program several research groups from universities and institutes investigate forest reserve sites at a very diverse thematic scale. Summarized data and information related to Hungarian forest reserves appear in the literature either as a part of a European scale overview (Schuck et al. 1994; Brockmeyer 1994; Parviainen J. et al. 1999) or as a Central European thematic review such as beech woods dynamics (Standovár & Kenderes 2003), dead wood (Christensen et al. 2005; Vandekerkhove 2008), or dead wood inhabiting fungi and bryophytes (Ódor et al. 2006). These reviews refer to data from the most intensively studied 2-3 sites.

Our review presentation aims to provide a broad literature overview about the research results of the 63 Hungarian forest reserve sites. The literature identified in this presentation was chosen on site connection, and thematic limitations. We overviewed the papers referring or at least overlapping area of the 63 forest reserve sites. Thematically the following subject areas are discussed: 1) Forest reserve surveys: on stand structure, shrub and regeneration layer, ground vegetation and site survey according to the FOREST+n+e+t methodology (Horváth et al. 2006) 2) Biodiversity aspects: fauna of the reserves; bryophyte assemblages, fungi, mykorrhizae; 3) Forest structure: remote sensing and stand structure, dead wood 4) Forest dynamics - gap dynamics, 5) Forest naturalness 6) Forest and landscape history 7) Climate change and CO2 sequestration. Not only published papers were chosen but other type of documents, research reports, PhD thesis in the case, if it contains forest reserve survey results. The main source of literature was the Hungarian Forest Reserve Archive (maintained by the Institute of Ecology and Botany, CER HAS), other sources were ScienceDirect, and MATARKA - Hungarian Periodicals Table of Contents Database, and libraries of research institutes and universities. Large proportion of the literature does not appear in the electronic databases, hence quantitative analysis was not planned in this paper. The studies concern to the 63 forest reserves with the most characteristic (semi-natural) forest types of Hungary and the Pannonian Biogeographical Region: riverine and swamp woodlands, mesic deciduous (oak, oak - hornbeam or beech dominated) woodlands, closed and open dry deciduous (dominated by dry-tolerant oaks) woodlands, and rocky mixed forests (Horváth et al. 2012). But the majority of the studies are connected to the northern hilly region of the country which belongs to the Carpathian region.

According to the number and quality of papers, the beech forest reserves has the largest literature (about 140 documents). Well studied areas are stand dynamics and gap regeneration (Czájlik 2003, Standovár-Kenderes, 2003; Kenderes et al. 2008; Czájlik 2009); diversity of dead wood inhabiting fungi and bryophytes (Ódor et al. 2006; Siller 2004). These results refer to the 2-3 intensively studied beech sites. Not too many papers discusses the comparison of managed and semi-natural forests (Standovár 1998). Oak or oak dominated forests were discussed in less than half of papers as beech forests. The most intensively studied oak forest in Hungary is the Sikfőkút Forest, (Síkfőkút Project, Jakucs 1985) which is a long-term site and not a forest reserve. Oak forest reserves are better

represented in the forest reserve surveys according to the FOREST+n+e+t methodology (Horváth et al. 2012). Analysis based on FOREST+n+e+t survey databases are now in an initial phase, examples of the first ones are in the Haragistya FR (Aggtelek karst): Zboray 2007; Tanács 2007. Soil surveys and soil mapping is a part of the FOREST+n+e+t survey an analysis is shown in Illés et al. 2011. From the riverine and swamp woodlands mainly survey results were available.
The aims and focus of forest reserve research are changing in time. In the 1990's the aims of the new Hungarian Forest Reserve Program were in line with the recommendations of the COST E4 Action (Brockmeyer 1994; Parviainen J. et al 1999). These aims were: 1) to ensure conservation of natural/semi-natural forest stands, b) to get knowledge, as natural reference and to transfer this knowledge towards conservation and forest management (Horváth & Borhidi 2002). Since then new challenges emerged for example: the predicted retreating low altitude/low latitude (xeric) limits of forests in the Carpathian basin (Mátyás 2010), the natural succession of abandoned woodlands under changing climate and forest management, the role of semi-natural forests in the carbon cycle. Increasing the accessibility of local research results and datasets contributes to the better coordination of research at a regional level.

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Legal recognition of biosphere reserves as learning sites for sustainable development? Case studies in the Ukrainian Carpathians and Sweden

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The Man and Biosphere (MAB) program and its network of Biosphere Reserves (BR) is a United Nations approach that seeks to simultaneously reconcile and promote conservation of natural and cultural values, environmentally and socio-culturally sustainable economic development, and research, in collaboration whith local stakeholders (UNESCO 1995). Initially, the BR concept that was developed by United Nations' Educational, Scientific and Cultural Organisation (UNESCO) in 1974 had two primary goals: conservation and ecological research (UNESCO 1974). However, in response to the proliferation of international policies promoting conservation of biodiversity in combination with sustainable use and fair sharing of benefits from utilisation of natural resources, the BR concept expanded to provide also testing grounds for various models of sustainable development (SD) toward sustainability (e.g., UNESCO 1995; Bridgewater 2002; Price et al. 2010). According to the current

definition, each BR is intended to fulfil three core functions: (1) a conservation function to conserve genetic resources, species, ecosystems and landscapes; (2) a development function to foster SD as a societal and collaborative process; and (3) a logistic support function, to support research, monitoring, education, training, establishment of demonstration sites, and to promote environmental awareness related to local, national and global policy ambitions related to conservation and SD (UNESCO 1995). In 2008, the Madrid Action Plan adopted by the 20th Session of the MAB International Coordinating Council elevated the BR concept as the principal instrument of the world community to assist and facilitate the SD process in the 21st century.
Thus, over the last two decades many BRs have been in transition from being primarily protected areas to "much more than just protected areas" (UNESCO 1995). This transition provides a main challenge for more or less all the 500+ BRs globally. Today, three main groups of BRs could be identified (Batisse 1997; Price et al. 2010; Ishwaran et al. 2008; Schultz & Lundholm 2010): (1) those designated to focus on biodiversity conservation only, (2) those serving as "learning sites for sustainable development", and (3) those transitioning from conservation only to become learning sites for sustainable development"
The importance of governance in the development of BRs has been acknowledged by UNESCO-MAB (Schliep and Stoll-Kleemann 2010). In the year 2008, the Madrid Action Plan (2008) recommended member states to give BRs a legal recognition and to include a legal framework for BRs in their legislation. However, challenges to establish BRs and to establish this legal framework is different in countries with different traditions in governance related to natural resource conservation and use. The aim of this study was to analyse the legal and official recognition of BRs as learning sites for sustainable development in the Ukrainian Carpathians and Sweden. The two countries were chosen to represent two different governance models, with Sweden being a market economy and Ukraine being in transition from planned to market economy. In Ukraine, the first BR was designated in 1984 with a nature protection aim only. There are currently eight BRs in the country; and plans to establish new BRs, including two trans-boundary BRs along the European Union's eastern border and one or two along the border with the Russian Federation. In Sweden the first BR appeared in 1986, currently there are four newer BRs and the first one was cancelled due to problems with the transition from conservation only to the wider aim of SD. The present BRs in Sweden have been initiated on the ground as results of collaboration among different stakeholders with the main aim to achieve sustainability on the ground. There is no legal recognition of BRs in the Swedish national legislation; and involved stakeholders use diverse national policies and laws in order to satisfy different functions of BRs.
We assessed the extent to which legal and official recognition and national policies are relevant for BR initiatives on the ground in order to satisfy their diverse functions based on multi-level and participatory governance. First, we describe the motivations for the BRs' development in both countries using two BRs in the Ukrainian Carpathians Mountains and two BRs in Sweden as case studies. Second, we compare the properties of BR development and designation process in Ukraine and Sweden. We used the "model law" proposed at the 20th Session of the MAB International Coordinating Council in Madrid (Bonnin and Jardin 2009) for inclusion of the BR concept in national policies or laws to compare if the provisions for the BR concept in the national policies and legislation are compatible with those in the model law. Our study indicates that a large suite of laws regulates the use and conservation of natural resources as well as economic and social development in both countries; however, there is a substantial gap between the requirements for BR provisions presented in the "model law" and the national legislations. For example, our case studies in the Ukrainian Carpathians show that the implementation process on the ground was severely affected by a number of constraints due to, among other things, the "mismatch" between the "model law" and existing institutional arrangements at the national level. The process in itself was socially constrained since the legislative domain of the BR concept had a clear impact on the different perceptions of what the BR concept is by different stakeholders in the case study. Therefore, the 'misfit' or 'mismatch' between, the "model law" for BRs and existing institutional arrangements at the national level, has

the potential to create tensions which constrains implementation effectiveness which in turn might lead to social conflicts due to e.g. different expectations among involved stakeholders, and thus potential limitations of the BR aims to support all dimensions of SD.

During recent decades, many initiatives, such as BR, promoting the SD process towards sustainability have appeared in the Ukrainian Carpathians and in Sweden. To encourage implementation of such initiatives and their local acceptance at least the following issues need to be considered: (1) Does national legislation or national policy reflect the multi-sectoral character of the BRs? (2) Does the name of the initiative reflect all dimensions of SD and sustainability? (3) Do those who promote initiatives to encourage SD on the ground have the knowledge and skills to facilitate SD as a collaborative social learning process, working with and communicating the full spectrum of sustainability dimensions?

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POSTER PRESENTATIONS

The management principles of the Carpathians primeval beech forests as World Heritage Sites

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Introduction. The Primeval Beech Forests of the Carpathians have been inscribed on the World Heritage List on June 28, 2007, during the 31st session of the World Heritage Committee, Christchurch, New Zealand under criteria of outstanding universal value.

The Primeval Beech Forests of the Carpathians represent an outstanding example of undisturbed, complex temperate forests and exhibit the most complete and comprehensive ecological patterns and processes of pure stands of European Beech (*Fagus sylvatica)* across a variety of environmental conditions. They contain an invaluable genetic reservoir of beech and many species associated and dependent on these forest habitats.

They are indispensable to understanding the history and evolution of the genus *Fagus*, which, given its wide distribution in the Northern Hemisphere and its ecological importance, is globally significant. Beech is one of the most important elements of forests in the Temperate Broad-leaf Forest Biome and represents an outstanding example of the re-colonization and development of terrestrial ecosystems and communities after the last ice age, a process which is still ongoing. Effective implementation of the integrated management plan is required to guide the planning and management of the serial property. Key management issues include forest fire control and conservation of monumental old trees conservation and management of mountain meadows, river corridors and freshwater ecosystems, tourism management, research, and monitoring.

Total Core area of WHS: 29 279 ha (100,0 %), Slovakia: 5 766 ha (19,7 %), Ukraine: 23 513 ha (80,3 %). Total Buffer zone: 48 693 ha (100,0%), Slovakia : 13 818 ha (28,4 %), Ukraine: 34 875 ha (71,6 %).

The Carpathians Beech Primeval Forests preserved their natural character in large extent as due to their considerable geographical (altitudinal) configuration, difficult access and for Central European conditions relatively small and delayed anthropogenic influences. They comprise three principal developmental stages: stage of effective height growth (the so called growing-up stage), stage of the starting stagnation of growth processes with the highest stand volume (optimum stage), stage of natural dying of tree species (destruction stage).

The potential of landscape surrounded the Primeval Beech Forests is able for render of supposition of different using for necessity of society: traditional agriculture, forestry and water sources, cultural and historical monuments, tourism, enviro – education and management of meadows.

General objectives of integrated management plan:

- To ensure the most effective conservation of the WHS properties with all their abiotic and biotic components, geo- and biodiversity and ecological processes. To secure a lasting homeostasis and self-reproduction of the respective ecosystems and their protection both against anthropogenic factors.
- To maintain and expand the existing, ecologically connected complex of primeval and natural beech forests that encompass and connect (link) the WHS on both the Slovak and the Ukrainian sides – within the corridors connecting the WHS. Supporting the succession of managed beech semi-natural forests.
- To use WHS for scientific research in order acquire knowledge transferable and applicable on the level of sustainable. To use WHS for enhancement of landscape ecological stability.
- To use WHS for enhancement of ecological and environmental education, awareness of primeval forests – chosen to maintain integrity and conservation of the existing sites, to preserve their naturalness and uniqueness.
- To support of traditional crafts, products and ecotourism.

Practical Management:

- Establishment of the Joint Management Committee of the WHS property and regular meetings of the JMC.
- Provide operation management for Management Plan by administrations of the
- Carpathian Biosphere Reserve, the Uzhanski National Nature Park, the Poloniny National Park
  and the Vihorlat Landscape Protected Area.
- Appoint Join Steering Committee mechanisms for the Integrated Management Plan realization.
- Optimization of border of the property and its buffer zones.
- Founding of special working groups.
- Conduct regularly together with local authorities and other interested parties,

operation management especially in buffer zones of the WHS.

- Improving conservation of beech primeval forests as an integral biological formation.
- Continue investigations of structure, functions and biogeochemical cycles in virgin forests.
- Analyze existing management systems and management guidelines for controlling negative impacts to outstanding natural value.
- Effective management checked by long-term monitoring.
- Establish permanent plots for annual qualitative and quantitative recording of vegetation to detect early signs of changes.
- Implementation of the buffer zoning and connecting corridors system and long- term monitoring of their effectiveness.
- Extensive monitoring and mapping of social and economic factors on the terrestrial environment and natural resources.
- Income generating activities from traditional products and activities.
- Enhance public support , collaborate with development agencies to develop join nature conservation and development activities.
- Implement alternative to intensive forestry and agriculture technologies which are environmental friendly within the connecting corridors.
- Monitoring and documentation of ecological and socio-economic changes (Vološčuk 2009).
- Increase public awareness and organize conservation awareness campaigns.
- Develop communication skills of protected areas staff, who are responsible for education in the sphere of conservation, carry out ecological monitoring and implement special protected measures in the Carpathian region.
- Organize meetings, seminars and workshops among environmental officers to exchange experiences.
- Support local communities´ initiatives in culture, education and social spheres.

Management of tourism:
The regions of the World Heritage Sites are interesting not only by their remarkable natural formations, but also by the abundance of its material evidence of man activity, such as monuments of architecture and typical landscape.
Tourism development and visitor activities associated with World Heritage Properties should always contribute to the protection, conservation, presentation and transmission of their heritage values. Tourism should equitably generate sustainable socio-economic development and contribute tangible as well as intangible benefits to the local and regional community in ways that are consistent with the conservation of the properties. Tourism should mobilize local and international awareness, understanding and support for their protection , conservation and sustainable use. Tourism planning and management, including cooperative partnerships, should be an integral aspect of the site management plan.

Principles of tourism management:

- Develop co-operation between protected area administrations with tourism and recreation establishments.
- Determine optimal recreation regimes for different ecosystems of the World Heritage Sites, buffer zones and connecting corridors, and implement special regimes for visitors in different seasons.
- Support sustainable ecotourism activities and services in the broader region, develop visitor-centers and educational paths within the framework of international cross-boundary schemes, such as the EU – funded INTERREG.

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Protected area Šándorky – the site with remarkable xerotherm vegetation at the southern foot of the Štiavnické vrchy hills (SW Slovakia)

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The site of Šándorky (south slope of the Štiavnické vrchy Mts.) was in 2010 declared as the protected area with an area of 3.11 hectares (Ulrych, Vojtek 2008). At the same time it is a territory of European importance in the system of protected areas of the Natura 2000 an area of 1.5 hectares (SKUEV 0271). There are some habitats types of Community interest as: 6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia), Sub-Pannonic steppic grasslands (6240), Subcontinental peri-Pannonic scrub (40A0), Rupicolous calcareous or basophilic grasslands of the Alysso-Sedion albi(6110) respectively, and plant species of national importance *Pulsatilla grandis* and *Echium russicum*. However, at the site there are other protected and endangered species such as *Cerasus fruticosus* (VU), *Convalaria majalis* (LR: nt), *Quercus pedunculiflora* (VU), *Stipa tirsa* (§, EN), *Thymelaea passerina* (LR: nt). Nevertheless the site is threatened by processes of secondary ecological succession, primarily it is ingrowing shrubs.

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Habitat Fragmentation and Connectivity in the Central Part of the Southern Carpathians

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The paper aims to quantify habitat fragmentation in the central part of the Southern Carpathians taking into account the controlling factors and to design an ecological network on the basis of the resulted connectivity.

The study area from the central part of the Southern Carpathians represents the most unitary group from the Romanian Carpathians. Natural protected areas cover 82% of its area (three national parks,

totally or partially integrated in the region, a natural park, and 45 nature reserves while NATURA 2000 network includes 3 SPA-s and 9 SCI-s).
In spite of these positive aspects there appears a significant habitat fragmentation. This is a serious disadvantage because many species are highly habitat-fragmentation sensitive and easily disturbed by tourist circulation, grazing and forest exploitation.
On the basis of habitat fragmentation versus connectivity we made an evaluation of the actual natural protected areas configuration and proposed an extended ecological network able not only to assure better connection within the region but also to interconnect it with the larger neighbouring mountains areas.
The proposed ecological network was designed by means of GIS exploring spatial data and finally adjusted according to miscellaneous field observations as tourist fluxes, traffic agglomeration, hunting zones, etc. The examined GIS data were DTM, forested surfaces, system of communications as roads and railways, alpine ski runs, human settlements, and protected natural areas.
We identified shifting barriers and designed ecological corridors that permit population and repopulation of territories and breeding or hibernation migration. Within the region such corridors appear especially on less humanly affected interfluves while on the borders they mainly appear under the form of forest corridors or ecoductes. Special attention was paid on the ecological corridors that make appropriate connections with the neighbourhood.

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A case of evaluation of some forest small-scale protected areas from Western Carpathians in Czech Republic

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In recent decades, there are efforts to evaluate the status of protected areas, the effectiveness of care (e.g. Stoll-Kleemann 2010 etc.). At the national level are being developed specialized methodologies for specifying the various categories of the IUCN (1994). In the Czech Republic (CZ) for categories of protected national monuments and landscape elements (IUCN 1994: III) and managed nature reserves (IUCN 1994: IV), which are generally referred to as small-scale protected areas, created some methodologies for example Svátek & Buček 2007; Rebrošová & Honzová 2011.Svátek & Buček (2007) tries rather rapid and comprehensive evaluation of the effectiveness of protected areas, which would record the state of all small-scale specially protected areas in the CZ. In 2009, a methodology for evaluation of forest small-scale specially protected areas and their buffer zones was devised (Rebrošová & Schneider 2009). The principle of the methodology is by some GIS application, a 50 m wide border around the protected area around this linie creating another linie with a width of 50 m. In the resulting map is placed a square network of size squares of 50 × 50 m. Each square has a number and is given the value 5, which equals 100%. For these means that the area of a square is in the best optimal or ideal situation in terms of subject proetction. The negative events are considered as the following e. g.: the incidence of invasive plant species with abundance around 100 m^2, the predominant non-native species composition of vegetation, the incidence of industrial buildings, the incidence of permanent roads, etc. The methodology was applied in selected protected areas in the Western Carpathians in CZ. In total, 12 areas were assessed.The first areas were located in the Western Carpathians in Chřiby (8 areas) and others in Beskids (4 areas). About the methodology has shown interest Nature Conservation Agency of CZ.

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ORAL PRESENTATIONS

Snow, Ski Tourism and Climate Warming in the Southern CarpathiansAnalyzing Climate Warming Trends in Ski Areas of the Southern Carpathians Using Indices Derived from Climatic and Remote Sensed Data Case Study: the Bucegi Mountains

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Winter sport tourism is a genuine source of income in many mountain regions of the Southern Carpathians, part of the Romanian Carpathians. The Bucegi Mountains with their surroundings – the Prahova Valley, in particular – are home to the most important ski area in Romania. Each of the four resorts of Sinaia, Buşteni, Azuga and Predeal has ski areas located between 2,000 m and 1,000 m altitude.

The increasing warming trend of alpine climate is affecting the ski industry worldwide. Thus, in order to address the empirically observed problems that ski resorts in the Bucegi Mountains face, as outlined during the past decades, i.e. less snow, winter season shortening and decrease of overall income value, we have based the present study on the analysis of climatic variability and its impact on tourist flows. The importance of this study is doubled by the present government policy regarding this particular industry, granting €180 million for the *Ski in the Carpathians* national programme, aimed at developing ski areas and building new ones.

The climatic data used was collected from three weather stations located in the Bucegi Mountains at 2,505 m, at 1,500 m and at 1,090 m, respectively, thus comprising characteristics of the entire range of ski resorts located here. Along the climatic data series for the 1961-2007 time interval, specific climatic indices have been calculated in order to determine the winter climate's variability and trend for this particular mountain region.

The Winter Standardized Index (WSI) calculates the nature of the winter season: ranging from very cold to very warm, based on mean winter temperature, mean annual temperature and standard deviation of their calculated difference. The results were consistent with those of other authors – Beniston (2006) and Jungo, Beniston (2001) Weber et al., (1997) – indicating a strong increase in winter temperatures after the year 1980. Even if the percentage of warm and very warm winters is higher at the highest altitudes, for the time interval considered, this does not yet affect the overall ski industry. On the other hand, areas located under 1,500 m altitude are greatly affected by the increasing number of warm and very warm winters.

Another analyzed parameter was snowfall, which recorded a decrease in the number of days at all of the considered altitudes, with a maximum of -69 days during the 46 winter seasons analysed, at 1,500 m altitude (Micu, 2007). Snow cover duration indicates a significant decrease at low and medium altitudes (at 1,500 m and below 1,500 m). According to Bălteanu et al. (2008), in the Southern Carpathians, the estimated variation rates are between six and eight days/decade, between 1961 and 2007.

Using the Mann-Kendal test to observe the snow cover trend at characteristic thresholds, the results revealed a decrease at the thresholds of ≥ 10 cm and ≥ 30 cm snow depth, with a 90-95% confidence interval only for the Sinaia weather station, where the largest ski area of the Bucegi Mountains is located.
Data regarding the snow cover of an area can also be acquired from satellite images. Snow cover area is the most reliable snowpack parameter that can be obtained from satellite data (Singh and Singh, 2001). In order to extract the snow cover data we have applied the Normalized Difference Snow Index to LANDSAT satellite images of the studied area and have calibrated the results according to the specialty literature (Dozier, 1984; Hall, Riggs, 2004). The satellite images were selected (from the available USGS data-base) in order to determine whether they supported the results obtained through the use of the WSI. Therefore the acquisition dates for the months of December, January and April were chosen so as to correspond to different "types of winter". The conclusion of the LANDSAT image analysis is that the snow-covered area shows a great variability over the years for the same intervals within a month. This variability shows a negative trend indicated by the rate of change of the snow-covered surfaces between 1961 and 2007. The largest negative results are revealed by the ratio between the "warm/very warm" and the "cold" winters, especially for the areas below 1,500 m, where the snow-covered surfaces drop by a maximum of 98% for the month of December.
The correspondence between climatic variables and winter tourist activity is based on certain tourist indicators (Konig, Abegg, 1997). The present study focuses on the number of overnight stays indicator correlated with snow depth variation during 2002-2007. Tourist flow variation is sensitive to a wide range of variables; however, as a general rule, the months of December and January receive the largest number of tourists keen on spending the winter holidays in a mountain resort. On the other hand, the month of February overlaps with the inter-semester school holiday and academic break, during which the resort of Predeal records the largest number of overnight stays. Nonetheless, irregularities in these almost characteristic flows were noticed when irregularities in the snow depth were recorded, such as a second peak in overnight stays in March, when snow was absent during the traditional holiday interval and present during the second part of winter and the beginning of spring.
These results should be taken into serious consideration in the business strategy of existing ski resorts in the Bucegi Mountains, or in the feasibility studies for implementing new resorts, in order to find suitable solutions for the proper use of the large amount of funding granted by the Romanian government for the Ski in the Carpathians programme.

Data sources:
Climatic data: processed climatic data from the National Meteorological Administration Archive
Satellite images: U.S. Geological Survey data base accessed through http://glovis.usgs.gov/

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Wooden sacred architecture in Maramures Land – iconic significance for tourism planning strategies

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The present study explores the significance of wooden sacred architecture in tourism planning strategies. Previous works (Ilies, 2007) have presented wooden churches from Maramures Land as part of the built patrimony of international importance or as significant cultural tourist attractions. The present approach is the result of several research projects involving the Romanian traditional villages. Cultural rural tourism is always considered an economic viable option of forest exploitation, or migration. This part is omnipresent in local development strategies; every community recognises it as important. Therefore, planning projects take it into consideration, regardless of scale. As empirical studies show (Iorio and Corsale, 2010), wooden churches are prominent landmarks of rural landscapes in Maramures Land. They are defining the tourist destination image of the region and largely used at national level as iconic images.

The first part of the paper will explain why it is important for communities, tour-operators and organizations. A narrative part is showing how it became iconic and when. Further, integrating the problem in the knowledge-action cycle, the paper presents several conclusions articulating research with the cultural tourism development, preserving the traditional villages. Research projects had to adapt the outcomes to a more „technical" audience, even if in essence it is about Tourism Geography. The relationship with the beneficiaries of the research projects is visibly improving based on innovative methods in Romanian space. Concepts as „demand-pull" and "technology-push" finally get a sense, and the presence of a communication platform becomes vital when tourism planning is triggered by university, government or county council. This approach also tries to answer the questions related to key influences encouraging participation in tourism planning projects and the paths of their outcomes.

Traditional architecture in Maramures Land has two important elements: the wooden church and the wooden house(hold). Synthesizing the regional specificity in style, building materials, techniques, wooden churches became landmarks and synonymous with the civilization of Maramures. Almost every community has at least one wooden church, 42 of them are listed monuments, dating from XIV-XVIII-th Century AD and five listed on the UNESCO World Heritage List. Romanian communities

across the country and abroad are building wooden churches with these features. Related literature was examined from the two ends of the problem: works related to tourism research and tourism planning projects' documentation. Tourism related studies were divided into separate concepts: destination image, brand/icons visualization, knowledge diffusion issues. Tourism planning projects were evaluated separately as case studies, combined with design and content analysis.
Working in an emerging tourism region of Romania (Maramures Land) has offered an excellent background to study a wide range of tourism planning projects. In most cases project area is related to mountain resorts; less explored issues are related to mountain tracks starting from rural settlements, without a "resort" label. Rural tourism activities are often linked to walking paths in the villages and between them, as other activities are still emerging. This opportunity was rapidly taken into account by young organizations and translated in tourism planning projects. In addition, rural heritage areas emphasize on connecting attractions, distinctive tourist products, events, festivals. Majority of issues are concerning information about destinations and access to the attractions. Terms like destination image, brand identity and image, brand association, have been widely acknowledged in scientific literature (Qu H et all, 2011). Extending the significance of the terms, we considered that the sacred wooden architecture in Maramures can play a role in tourism planning projects as mark. Standardization process directed the research to the conclusion that every destination has its own needs and models, seen as good-practice examples that can only be adapted. That is why the result is a reflexive one. Examples of criteria will include: destination image (wooden church as associated icon); brand image (pictogram use); knowledge diffusion issues, following the KM (Pyo S., 2005); tourist/or general planning projects (actors, funding source, educational background); accessibility of final results (dissemination and availability).

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Urban, Environmental and Tourism Indices Used in Evaluation of the Tourist Development Opportunities. Case Study: The Romanian Carpathian Small Towns

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The urban network in Romania contains at the base of its hierarchy the settlements classified as third and few as second tier cities, known under the name „small towns". Almost ¼ of them overlap the Carpathians and make the subject of the present paper. The reasons of chosen them as a theme of study are multiple, among are: problems facing thier development due to the comunist legacy of being mono-functional settlements; the new trend of polarisation of economic power in big cities, thus some of them seem to be marginalised or entered into decline; their role in the settlements network as a link between urban and rural systems-very important elements in achievement a balanced territorial economic and social development; the need to insert national, regional politics of urban development matching with targets expressed by the European Charter of Planning (1983-Torremolinos, Spain), Community Area Development Scheme, 1999, Guiding Principles for Sustainable Spatial Development of the European continent, 2000, Territorial Agenda, Leipzig, 2007 etc. Moreover, regulations for environment, tourism, territorial development (e.g. The National Planning Assessment), The Mountain Law 347/2004 (completed by EO no. 21/2008) and the European Charter for Mountains (CLRAE), 1994, Chamonix stipulate the direction of enhancing space mountain, through a public designed to preserve the natural qualities etc.

Realities on the ground identified in the last 20 years show a specific economic decadence of the mountain areas as a result of industrial restructuring and brutal penetration of the market economy system, to the most vulnerable beneficiaries of services keepers of the mountains, an upward trend of two controversial economic activities, with a largely character of externalities: forest exploitation and mass tourism.

The Romanian small towns in the Carpathian area enjoy local resource benefits, so most of them kept or have turned to tourism development, seen through the tourists' arrivals (23% from all country).

Otherwise, Carpathian small towns are divided in three categories: resorts, former mono-industrial towns which suffered a shrinking process and recent small towns with a legacy of rural statue. Almost all of them knew an explosion of tourists' accommodation infrastructure, leisure facilities or vacation houses spreading, hence the question of whether tourism is seen as a panacea for their economic development.

Starting from the above overview and the input given by the Super Ski Program, the recent "Explore the Carpathian Garden" brand launched by The Romania Ministry of Regional Development the study tries to identify if the tourism provides a real chance for the development of the Carpathian small towns.

Data processed came from NIS and refer to the period 2006-2008, MTDT and field observations. The study is based on: numerical models using GIS techniques for tourism issues - Analysis Tools and Spatial Analyst Tools of ArcMap (Magablih & Al-Shorman, 2004); the factor analysis (SPSS v.17© and XLSTAT trial version) to extract and to determine the optimum factor number of the 62 case points and the statistic-mathematical computing of UDI using Hull score, (Ianoş 1997) and ECh.I (Manea, 2003). Maps were created using ArcGIS 9.x (ESRI, Redlands, CA, USA) and Global Mapper v9.01 applications, ortophotoplans taken from the National Agency for Cadaster and Real Estate Publicity (ANCPI) and SRTM data for the DEM of the Carpathians (USGS, Maryland, USA).

Results reveal that urban infrastructure, measured by UDI (Urban development index), of the small towns in mountain region subscribes to the Romania's small towns patterns (Matei et al, 2011): the poorer development (18 %)-recent urban centers with agricultural profile and former industrial centers; average development for 13%; fair development 51% and good urban development for only 18% (Sinaia, Predeal tourist resorts, Brezoi, Zarnesti, Rasnov with an active economy). But the dynamic of UDI since 2006 till 2008 shows a convergence process and hence the power of polarization for the last group and a divergence in all the others, which can be correlated with the departure of doctors, the decreasing of population, the unemployment rates, despite the efforts of local authorities to increase the urban facilities. This dynamic also correlates with the increasing of human pressure, expressed by EchI (Environmental change index), which, in the same period, registered significant loss due to the demand for build up area, deforestation for different purposes (ski slopes, business etc.).

Development potential for tourism (DpT) data offered by PATN bonitation systems express medium and high values for all small towns except several former mining towns. On top development tourism potential are tourism resorts and some peripheral towns nearby the national parks, their position playing an important role (Vaishar, 2004).

The correlation among the three above indexes (UDI, EchI and DpT) demonstrates that tourism potential has the main power in urban development.
The configuration of towns' response for tourism indicates that while tourist resorts have a great diversity of accommodation types, a big density of tourist units and consistent flows of tourists, several non-tourists towns have the same trend for tourism. The interrogation of the dynamic of tourism initiatives' database after 2009 underlines that the towns with tourism function attract many entrepreneurs and new centers with a previous emergent tourism orientation have been continued their increasing of the accommodation units as a response to the market's demand. Thus, tourism is still a main force for all small towns-resorts of national or local interest and half of others towns trend to orientate their economy on tourism, based on the local policy makers or tourist stakeholders' options. The matrix of matching the analyzed variables indicates that only 20% of 30 non-resorts towns have a real chance to develop themselves through tourism.
In sum, much attention is paid for environment and urban development in small towns with tourist function. Other Carpathian small towns have ad-hock development towards tourism, which cannot ensure their development on long term. In this sense, local authorities must inverse the route of development from planning to action.

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Social geographical comparison of peripheral regions in Eastern Moravia (CZ) and Banat (RO)

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The paper is aimed at the comparison of databases and possibilities of their utilization for the purposes of the regional development. Two relatively similar regions were selected in Czechia and Romania. Zlín region represents the Czech case, Bojkovice micro-region forming the detail for the analysis. In Romania, the region Caraş-Severin with the micro-region Clisura Dunării is the case study.
The similarities of both the regions consist in the natural character (preliminary mountain), economic level (the second worst in the country according to the GDP per capita), border position (the border is formed by the natural barrier in both the cases), protected landscape. There is also ethnographic

contact between both the regions: a part of the population of Moravian Wallachia allegedly came from Romania whereas inhabitants of some Banat villages have originated from Czechia and/or Slovakia.

The investigation was made with the knowledge that the paradigm of regional research moves from quantitative to the qualitative one. The combination of qualitative and quantitative approaches considers for optimum. The quantitative approach is represented mostly with statistical data in our case whereas the field research constitutes the most important part of the qualitative investigation (interviews, observation). But also the historical and ethnographical approaches can be classified with the quality. Data for population censes 2001 and 2011 were mostly used as a base for the quantitative evaluation. In Czechia, there are also other data at disposal on the level of individual communes, e.g. population balances (Czech Statistical Office), unemployment (Ministry of Labor and the Social Affairs), data from communal statistics including land use etc. Searching comparable data in Romania was one of the aims of the work.

We come out of the theory of regional geography or theory of (micro)regional development. Peripheral regions are the result of geographical polarization of the space. Such polarization is a nature consequence of geographical organization in the sense of core - periphery. Naturally, the attention was paid firstly to the cores in the science. The periphery takes a turn in the last time in connection with efforts of limitations of their economic backwardness. Regional politics is the addressee of the research applications.

The settlement of the mountain villages in both of regions is relatively young, being a result of the planned colonization. Both the regions are remote from the economic and political centres of gravity of their countries. The remoteness is given not only by distance but also by the configuration of the terrain and partly also by the quality of roads.

The economy of the regions under study contains a relatively big part of primary branches (agriculture, forestry). But both the regions are preliminary industrial. Original industries (weapon industry in Eastern Moravia and mining and heavy industry in Banat) lost their importance and have been transformed. The present industrial production is not able to substitute original branches neither in quantity nor in level of incomes. Developing service sector is not able to balance the situation in the labour market – especially in the rural part of the regions.

In such a situation, the tourism is considered to be the promising branch. Its potential is seen in a combination of natural, cultural, religious, balneological activities or nostalgic tourism. But their development is hindered by important characteristics: an expressively seasonal character, insufficient tourist infrastructure (or infrastructure for modest visitors only), weak preparedness of the people to serve, unsatisfactory cooperation among providers of tourist services, incomplete (or one-sided) offer. The question is whether landscape protection could help the tourist development.

On the other side, negative consequences of some attempts to improve the situation were observed. To create infrastructure for challenging tourist is not only expensive but it could lead to the deterioration of the regional image as a relatively intact territory.

So the future development has to be based on a balanced relation among different branches: extensive agriculture directed partly to the landscape maintenance and connected with tourism, industry based on elaboration of local sources or on some industrial tradition, tourism using a collaboration between its providers and offering a relatively complex activities, services for local people, for tourists and special services. The question is how to use the possibilities of the cross-border collaboration e.g. within existing Euroregions.

The paper shows which data and other knowledge is at disposal in both countries, or which knowledge can be gained in the field and how to elaborate the data for their application in regional politics.

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The old narrow gauge railways, an almost lost opportunity for mountain tourism in Romania

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The Romanian Railroads history stretches back for 158 years. The first railroad in the world was built in England, the "Coal road": Stockton-Darlington (1825). In Romania, the first railroad for cargo transportation was also a "coal road", opened in 1854, Oravita-Bazias (Transylvania), for feeding coal to the Danube seamboats. This line was later opened for passenger traffic in 1856. In Dobrudja, at that time part of the Ottoman Empire, an English consortium built and opened in 1860 the Cernavoda-Constanta railroad. The first railways built in the Romanian kingdom were realised by concession to foreign companies. An English consortium opened in 1969 the Bucharest-Giurgiu railroad. The first railway ever built by Romanian engineers was the Buzau-Marasesti railroad (1881).

Tourism in the Romanian railway transport

Remarkable are the touristic travels organized in Transylvania on the narrow gauge railway between Sibiu and Sighisoara, and in the end of the XIXth century the "Leisure trains" that were running between Bucharest and Sinaia, in the Romanian kingdom. 6 railroads with special touristic purpose were built: Oradea – Episcopiei Baths (1855), Timisoara – Buzias (1869), Darmanesti – Vatra Dornei (1908), Constanta – Mangalia (1938), Constanta – Rex (1938), Caciulati – Snagov (1948), measuring together 2.5% from the Romanian railroads network in 1948.

The total length of the Romanian railways is 22,247 km with international gauge (1435 mm) from which 8585 electrified railway, and 487 km narrow gauge railroads.

After 1989, due to the decline of the industrial production and the competition from the road transportation, there has been a regress of the passenger and cargo railway traffic. The railroads that were under construction were abandoned, some railroads were shut down, the national railway company was divided and an important share was privatized. The cargo and passengers grand total still represents only 40% from the value of internal transportation, and is continuously decreasing.

Narrow gauge railways

The narrow gauge railways (under 1435 mm) were measuring a total of 4349 km in Romania in 1959, most of them forest railways.

The first forest railway in the kingdom of Romania was built in 1893 in the Tarcau valley, in Transylvania this type of railroads being present even since 1871. In 1970, 3000 km forest railways were still in use, and in 1989, 15 railways measuring a total of 1000 km.

Currently, their vast majority were closed. For tourism, only these railways are being used: Vaser, Comandau-Covasna, Moldovita and Gura Humorului.

Among the industrial railways that are still being used or were recently closed, which could be rehabilitated, we mention: Brad – Criscior, Busteni, Fieni, Gavojdia – Nadrag, Govora, Hunedoara – Zlasa, Lonea-Petrila, Rodna, Sotanga – Doicesti, Turda Cement. For tourism is used the Brad – Criscior railway.

"Mocanita" is the popular Romanian name of the narrow gauge railway forest train. Today only a few of the old narrow gauge railways are still in working condition, and the local administration and the civil society make efforts for the conservation, reconstruction and reinsertion into the tourist circuit of some narrow gauge railways.

We present the mountain area narrow gauge railways that are being used for tourism or have approved rehabilitation projects for touristic purposes.

The beginnings of the forest railway Moldovita date back to 1889, in 1909 it measured already 52 km. There also was a railroad with a horse-drawn tram, built in 1907. Currently there still is a touristic utilization on a 6 km section.
The narrow gauge railway from Hunedoara to Retisoara (Ghelari) was the first narrow gauge railway in Transylvania, built for carrying the iron ore for the Govajdia furnace (where the Eiffel Tower components were cast) and the Iron Factories in Hunedoara. The track, comprising three tunnels, impressive viaducts and the only railway station in Europe where the trains go around the station building, was in working condition until 1999 for cargo and passengers, but today is completely disposed, but some restoration projects are approved.
The best known “mocanita” is the one in the Apuseni Mountains, in the “Tara Motilor” land. The construction of the narrow gauge railway between Turda and Abrud began in 1891 and finished in 1912. The narrow gauge train run for 12 kilometers, between Abrud and Campeni. The track has not been used by the Romanian Railway Company since 1997. The listing of this narrow gauge railway among the historical monuments succeeded.
The Brad – Criscior railway was built in 1907, to connect the Gurabarza mine and the main railway. The trains were carrying coal and miners and was suspended in 1998. The railway and the tourist transport were restored and are active for tourism since 2011.
Covasna-Comandau is a complex of narrow gauge forest railways with a total length of 118 km, built during the 1889-1935 period, including an inclined plane for gravitational traction, technical ensemble unique to the world, built in 1890. The railways were abandoned progressively, the last few of them and the inclined plane in 1995. A short section was restored for tourism beginning with 2001.
In Bukowine, the construction of forest railways began in 1887-1889. From hundreds of kilometers of railways, today only two small sections are being used: Moldovita and Gura Humorului.
The Moldovita track was built beginning with 1888 and reached a length of 73 km. It was gradually disposed of, the last forest activities being recorded in 2001. Since 2005 a section of 11 km was restored for tourism and is now working.
In the town of Gura Humorului, for touristic purposes, a track of 2 km narrow gauge railway was built and is now used for tourism.
There are some projects for the touristic restoration of the forest railway Berzasca-Stănic.
The „mocanita” on the Vaser valley has a 56 km track. Construction has been finished in 1932. It is the last Europea forest railway that still uses steam traction and the longest usable narrow gauge railway in Romania. Utilization is mixed, both for forestry and for tourism, the trains running 3 times a week, and daily in the high season. There are also trains arranged for the tourist groups. The railway is state-owned, being concessioned for usage, and the engines, wagons and transport management belongs to a private company, owned by Coman Vasile. There is also an associated private company, doing tourist activities and having their own infrastructure.
Until now the Vaser Valley narrow gauge forest train is the best experience in the field and demonstrates that, despite many difficulties, the mixed usage of narrow gauge tracks in the mountain area, mainly for tourism, could have a future in Romania. Although a bit late, the local administration and numerous foundations and non-governamental organizations are currently making efforts for the restoration of what can still be restored from the narrow gauge railways in the areas with touristic potential.

POSTER PRESENTATIONS

Recreation specialization of Carpathian region of Ukraine: transdisciplinary approach to sustainability

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The Carpathian region is regarded as a human-enviromental or socioecological recreational system (SERS) with a certain degree of orderliness (negentropy). Viability of this system is determined by the level of equilibrium between its social, economical and natural components directed towards their joint progress.
Quantitative indication of SERS is the executed work, divided into:
- operations for carrying out recreational functions;
- operations to ensure self-reproduction of all components of the system. SERS operates on free energy (Ev), which consists of internal (Ep) and external energy (Ez). Internal energy of SERS appears to be the energy of available natural resource potential (medicinal waters, fango, ozokerite, landscapes, climate, etc.). External energy is produced in the result of interaction of SERS with the environment (management system, organizational fonns of the environment protection, etc.)

Within the scientific-methodological context this method envisages new approaches to determination of social-economic and ecological efficiency of funct ioning of recreational systems on the basis of ensuring a socioecological balance in them. This permits to detennine in advance the expediency and the alternative to the usage of local recreational territories.
Within the practical context - maintaining sustainable development of the Carpathian region through recreational specialization of these territories.

Models of Sustainable Tourism Development in Babia Gora Biosphere Reserve

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Tourism is an important socio-economic function in mountain areas of Europe. It is also a source of increasing stress on mountain ecosystems. The aim of this work is to present models of tourism development in one of the biosphere reserves in Poland (Babia Gora Biosphere Reserve in the Carpathians) in relation to idea of sustainability and to biodiversity objectives.
The Babia Gora Biosphere Reserve lies in Western Beskidy Mountains and encompasses massif of Babia Gora reaching the height of 1725 m above sea level. It is a nationwide unique area as far as landscapes and natural heritage protection are concerned. The Babia Gora B.R. offers high recreation and exploration values for tourists. But tourism is not evenly distributed in the space and concentrated mainly on two mountain routes, especially on the route from Zawoja to the Diablak. The high tourists pressure is observed also in view points and around Markowe Szczawiny chalet.

Development of tourism in BGBR should eliminate or reduce the negative environmental effects and bring opportunity for local community to reach a higher level of socio-economic development.
The author will present the models of tourism development in Babia Gora Biosphere Reserve prepared for that region in 2008 as a part of UN Environmental Program "Conservation and Sustainable Use of Biodiversity through Sounds Tourism Development in Biosphere Reserves in Central and Eastern Europe"
Taking into account different possible ranges of human activities in respective biosphere reserve zones, two tourism models (subsystems) in the reserve area and its surroundings were prepared. One in the central and buffer zones of the reserve and the other one in the transition zone and surrounding areas.

Bioclimatological differences in similar spas in the Carpathians

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During the last two centuries the health care resorts in the Carpathians were developing very fast. The locations of mountain spas were based mainly on the fresh/clean air, mineral water springs and thermal waters. Another factors were appropriate conditions for tourism/recreation and winter sports. Besides that, climatological conditions that influence peoples well-being were very important issues that have been taken into consideration.

The poster shows the study about differences in bioclimatological conditions occurring in two Carpathian spa resorts. The variation of those conditions will be presented together with their influence on peoples well-being using bioclimatological indexes. They are built on the basis of several elements like air temperature, wind speed, hours with sun radiation, air humidity, extreme temperatures and precipitation. The study is about to show how location, relief and elevation influence climate and other conditions that occur in the Carpathian spa resorts.

ORAL PRESENTATIONS

The West Carpathians in the Last Glacial Period and Early Holocene (vegetation, climate and landscape character)

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The character of a territory results from the influence of many factors. Besides the prevailing abiotic factors (geology, geomorphology, climate, pedology, hydrology, etc.) the landscape is also influenced by biotic factors. Vegetation cover is the result of all natural and anthropogenic conditions within a certain territory in a certain timeframe. If we are able to reconstruct the palaeovegetation, we can obtain an initial point for further paleoreconstructions. For example, particular types of palaeofauna are linked with corresponding types of palaeovegetation. From the character of the vegetation we can also reconstruct, with a certain degree of caution, palaeoclimate. The method of pollen-analysis is the principal method for palaeoreconstruction of vegetation. From the territory of the former Czechoslovakia, we analyzed pollen data about palaeovegetation concerning mostly the Late Glacial Period and the Holocene. Thanks to the careful field survey of the scientists from the Museum in Spišská Nová Ves, organic material was found in the form of "natural archives" at the locality Šafárka at Spišská Nová Ves. The profile was rescued immediately before the complete destruction of the site. Pollen analytical results and radiocarbon dating proved that these sediments were from the Wistulian Period (> 52,000 – 16,000 BP). Other profiles and sediments of Pleniglacial age from the localities Jablůnka and Týn n. Bečvou from the westernmost part of the W Carpathians (NE Moravia, Czech Republic) completed the results from Slovakia. The sediments were obtained accidentally in these cases as well. The pollen analytical record from the oldest profile Šafárka made it possible to reconstruct vegetation and consequently also climatic conditions. A time period of more than 60,000 BP was recorded. The analysed profile recorded the older part of the Late Glacial and nearly the entire Middle Pleniglacial. In the coldest climatic phase (basal sediment of the profile Šafárka) the territory was covered by vegetation of forest-tundra character with prevailing *Larix*, sporadic occurrence of *Betula,* also with *Pinus cembra* and *P. sylvestris* / *P. mugo*. The larch forest-tundra was probably frequent in the basins and at middle altitudes in the Carpathian Mountains. Communities of mountain tundra can be expected at higher altitudes. The beginning of a warmer climate is documented by the abrupt invasion of *Betula*, which, as a pioneer woody plant, quickly penetrated the existing larch stands. After this transition stage larch-birch stands appeared. They formed a transitional zone from forest-tundra to park taiga of the northern type. At present, a partial analogy to this vegetation type can be observed in the basins of the Polar Ural Mts and in the southern part of the Yamal peninsula in W Siberia. It cannot be excluded that some park-forest communities with the prevalence of larch had a character similar to that presently observed in the Alps. The expansion of *Picea* was enabled by markedly warm climate and the subsequent improvement in hydrologic conditions. *Alnus* was also spreading along with the spruce. High pollen values of *Pinus sylvestris* type can come both from *P. sylvestris* and from *P. mugo*. Pollen analytical data and AMS radiocarbon datings from the Moravian Carpathians apparently also recorded this warm climatic change in the

Middle Pleniglacial. Unlike the spruce-dominated taiga at the site Šafárka, the taiga stands in the Moravian Carpathians had a different composition at that time. *Pinus sylvestris* type was prevailing in the pollen spectra while the occurrence of the pollen of *Picea* was sporadic. *Larix* and *Pinus cembra* showed, however, surprisingly high pollen values. Therefore the vegetation cover in the Moravian Carpathians at that time can be characterized as stone pine-larch or larch-stone pine taiga with *Pinus sylvestris*. Sufficiently large open enclaves for the occurrence of more light-demanding bushes (e.g. *Hippophaë*) existed in this light taiga, an analogue to which can be observed today in continental Siberia. A whole series of climatic changes occurred over the Last Glacial Period. Vegetation responded to these sensitively although with a certain time-lag. Based on the results discussed here and on the knowledge gained from the field work as well as from observations in the tundra, forest-tundra and taiga regions of W Siberia, a partial idea can be formed about the Carpathian landscape during the Last Glacial Period. It should be stressed that the character of the original landscapes was very varied from the vegetation point of view – it was mosaic-like. Vegetation responded sensitively to all changes in abiotic factors. In the case of the W Carpathians, this means that a whole series of other vegetation formations besides forest-tundra and taiga existed in this region. In basins in the Carpathians there were wetlands of dwarf shrubs and shrub tundra during the cold stages. In warmer phases, when water was released from the soil permafrost, glaciers and snowfields of the surrounding mountains, there existed many peat-bogs. On the other hand, vegetation of cold-steppe character was growing on limestone and geomorphologically rugged terrain. Unfortunately peat-bog sediments from the Last Glacial Period which could be used for pollen analyses have been mostly destroyed by erosion. They have survived only in those cases when they were covered over in time by solifluction (Šafárka), alluvial sediments (Jablůnka) or by material from a land-slide (Týn n. Bečvou). As already mentioned, since the end of the Last Glacial Period we have substantially more information achieved through palaeobotanic methods. From the Late Glacial Period evidence about the vegetation is available from the sites Sivárňa, Hozelec and Valalská voda. In the Late Glacial Period the vegetation cover in the sub-Tatras basin and at middle altitudes in the surrounding mountain ranges still had the character of larch-forest tundra with *Pinus cembra* and *P. sylvestris / mugo*. *Picea* also had its refugial occurrence there. At the boundary of the Pleistocene and Holocene, i.e. at the end of the Young Dryas, as well as at the beginning of the Preboreal the larch-forest tundra was turning into larch taiga. However, it did not persist for a long period. Very soon it was strongly limited by the expansion of *Picea*. After that spruce stands were the dominant forest communities in basins in the Carpathians and the surrounding mountain ranges. We lack objective evidence to work out a similar palaeoreconstruction of the vegetation in the Czech Massif for the Last Glacial Period. For the time being we suppose that *Larix* occurred also in the Czech Massif during the Last Glacial Period (Podbaba - Praha). In the Late Glacial, *Larix* had either quite sporadic occurrence or was complete absent in the Czech Republic. This problem will be addressed by further research in the future.

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Remark: Further information can be found at http://ekolbrno.ibot.cas.cz

Modelling the effect of climate change on the site conditions for dominant forest forming tree species in Western Carpathians

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In recent decades, changes in certain climatic indicators have been observed in the Central Europe, and subsequent implications are expected in the future (IPCC 2007, Albert and Schmidt 2010). Climate change impacts on growing conditions and results in general in accelerated growth and rising net primary production of some tree species in several parts of Europe (Spiecker et al. 1996, Hasenauer et al. 1999). Environmental changes also affect the vitality and stability of forest stands (Rötzer et al. 2005).

The climate change trends projected for Central European Mountains will also have a heavy impact on forest ecosystems (Socha and Durło 2011).

The objective of this study is to identify the relationship between present climatic conditions and the growth of European beech, Norway spruce and Silver fir, and to simulate the effect of changes in temperature and precipitation resulting from climate change on the site conditions for analysed forest forming species in the Western Carpathians. The investigations were carried out in the Beskidy Mountains, in the Western Carpathians region, southern Poland (18˚48'50" E and 19˚58'58" E longitude and 49˚23'52" N and 49˚41'3" N latitude). Data were collected in 2003-2011 from over 550 sample plots located in even-aged stands.

On the basis of present climatic data and the data generated with a time horizon of 100 years ahead as well as the aforementioned data on site productivity for European beech, Norway spruce and Silver fir, a models describing relationships between the site conditions, expressed by means of site index, and the basic climate indicators was developed. In order to describe the relationship between the site index with climate indices, a unimodal dose-effect-curve model was used (Pretzsch 2009).

The climatic model of site index expressed by dose-effect function was used for forecasting the effect of temperature and precipitation change on the site productivity for analysed tree species. The difference between the current and future potential site conditions was used to map changes in the site conditions for the projected level of carbon dioxide concentration.

The observed trend of increasing mean annual air temperature undoubtedly will modify site conditions for analysed species. When adopting the scenario assuming the doubling of CO_2 concentration in the atmosphere, the mean annual temperature projected under this scenario would increase by about 2.7º C and the rainfall during the growing season would decrease by about 70 mm. Thus, such a climate change would result in a significant improving site conditions for European beech and Silver fir and deterioration in site conditions for Norway spruce in the major portion of the forest covered area of the Western Carpathians. In these new, altered site conditions Norway spruce could maintain a dominant role among tree species at the highest locations, i.e. higher than some 1 000 m above sea level, only. If this scenario came true, the species composition of stands at the lower altitudes than so, should be changed in this region.

A slightly better prospect for the growth of Norway spruce in the Western Carpathians would take place when the scenario assuming a 30% increase in CO_2 concentrations in 50 years to come would be adopted. As a result one may expect the increase in mean annual air temperature by about 0.7 ºC while maintaining the current level of mean annual precipitation and a slight reduction in rainfall during the growing season. These changes would cause just a slight improvement in site conditions for European beech and Silver fir on the whole area and deterioration in site conditions for Norway spruce up to an altitude of about 800 m a. s. l..

These analyses of the site conditions in the Western Carpathians may serve as a basis for decisions concerning the future role of analysed species in stands composition, depending on their location.

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Interactive effects of changing climate and air pollution on the Carpathian forests – evaluation of present and future risks

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Carpathian forest ecosystems are affected by numerous interacting climate change and air pollution stressors. These interactions may be additive, synergistic or antagonistic in nature. Potential effects could differ in various ecosystem types and would depend on a magnitude of the climatic or air pollution drivers, and types of interactions between them. It is important to address these issues from a perspective of future risks to ecosystems and development of science-based management strategies and their implementation in a manner that would allow for optimal adaptation of forests to those changes. Evaluation of such risks should be done with a comprehensive understanding of the key ecological, economic and societal values of forests. Ideally, this improved knowledge and ability to assess risks should be based on state-of-science research, well-coordinated monitoring and implementation of management and policy strategies which are well coordinated and implemented at local, national and regional levels.

Climate change and air pollution interactions affect nutrient uptake and status, physiology and biochemistry of plants that influence plant susceptibility to stressors. This in turn may result in plant damage, altered growth, susceptibility to pests and diseases, changes in species composition and distribution, increased fuel built-up and fire danger, reduced water resources, changes in recreation value of forests, and many others. Climate change can affect impacts of air pollution on forest ecosystems, and vice versa, responses of ecosystems to specific climatic change can be modified by air pollutants.

Carpathian forests have been exposed to elevated levels of various air pollutants, and among them ozone (O_3), sulfur dioxide (SO_2) and various reactive nitrogenous (N) pollutants are of highest importance (Muzika et al., 2004). Among reactive N pollutants, nitrogen oxides (NO_x), ammonia (NH_3) as well as nitric acid vapor (HNO_3) vapor may have direct phytotoxic effects at high concentrations and can also significantly contribute to elevated N deposition that can have various effects on forests (Bytnerowicz et al., 2002). Ozone has the highest phytotoxic potential and with its steadily increasing background levels can have long-term negative effects on forests (Fowler et al., 1999). On the other hand, elevated levels of N air pollutants and increased N deposition can also have positive effects such increased growth of some tree species as it has been observed in some European areas. However, such enhanced growth could pose a risk for the forest ecosystem stability, especially at sites where the long-term acidic deposition has led to the deficiency of base cations and phosphorus in forest soils and imbalanced nutrition of trees (Fenn et al., 2010).

Among most important climatic factors affecting forest ecosystems are increasing and highly variable temperatures, unpredictable precipitation patterns, including a lack of winter snow cover, prolonged droughts, and increasing frequency of strong winds. Climate change factors that increase stomatal opening, such as low carbon dioxide (CO_2) or high relative humidity, may increase sensitivity of plants to toxic air pollutants such as SO_2 or O_3, while parameters that lead to stomata closure such as water stress or increased CO_2, help to protect plants from toxic air pollutants (Matyssek et al., 2007). However, some more subtle mechanisms may also taking place, such as O_3-caused sluggish stomatal response to reduced water availability (Grulke et al.,). Prolonged growing season caused by global warming changes phenology of plants and increases length of plants' exposure to air pollutants. Extended drought can reduce length of the growing season, consequently resulting in lower dose of absorbed pollutants, and less damage to plants. Due to such effects, important Carpathian tree species such as Norway spruce (*Picea abies*), Silver fir (*Abies alba*) or European beech (*Fagus sylvatica*) could become more sensitive to various individual air pollution, climate change stressors, their combinations and insects and diseases. Negative effects of combinations of all those various stressors can also be expected on some important endemic species such as Swiss stone pine (*Pinus cembra*) that is highly sensitive to elevated O_3 concentrations (Wieser et al., 2006).

Another factor that should be considered in relation to future growth of the Carpathian forests is increased concentrations and availability of CO_2. Better understanding is needed on how ambient O_3 or N deposition may modify responses of trees to elevated CO_2. The effects of O_3 on net photosynthesis and C sequestration should be factored into future calculations of C budgets for forests.

Better understanding of interactive effects of air pollution and climate change on susceptibility of forests to catastrophic fires is also needed as more frequent events of prolonged high temperatures and droughts can be expected. In addition, improved understanding of mechanisms leading to massive windthrows, such as that that took place in the Tatra Mountains in November 2004, is also needed. That event is a good example of interactive stressors, such as long-term elevated levels of air pollution, increased N and S deposition that could lead to the reduced below ground/above ground biomass and extreme winds that has become more frequent with changing climate.

Improved knowledge of mechanisms causing decline of forests health and reduced sustainability of forest ecosystems is essential for developing future adaptation and mitigation management

strategies. For that purposed long-term monitoring of climatic changes, air pollution and condition of forests in the Carpathians is essential. It should be done in close collaboration of all Carpathian countries, European programs such as ICP Forests or ICP Integrated Monitoring, ENVeurope, or COST Actions, and international organizations such as International Union of Forest Organizations (IUFRO).
In such evaluations, the state-science concepts like air pollution exposure index, ozone effective flux, critical loads for acidity and nutritional N and indexes of forest nutrition should be utilized and supported with comprehensive information on abiotic and biotic stressors from well-designed, long-term monitoring networks. These concepts should be verified and updated by realistic nutritional and pollution-exposure regimes in long-term experiments such as free-air O_3 and CO_2 for exposure of aspen and birch seedlings at the FACE experiment in Wisconsin, USA, or canopies of mature trees in Kransberg Forest in Germany. In that regard understanding of mechanisms of changes and their predictions for the Carpathian forests is still poor. A main goal of this presentation is to provide an update on what is known in this regard and list and discuss recommendations for future work.

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Trees' growth and health status under air pollution effects in Southern Carpathians (Retezat National Park) in 2010 growing season

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The presentation describes air pollution status and evaluation of effects of phytotoxic pollutants on tree's growth and health status in selected forest ecosystems in Retezat LTER Site, Southern Carpathians. The results are based on the LTER network emplaced in Retezat NP where multidisciplinary research is conducted since 2000. Ambient ozone, ammonia and nitric dioxide were measured with passive samplers in 11 plots (10 in selected forest ecosystems and one in alpine area), covering the 2010 growing season (15 May to 15 October). Also, in 5 plots, monthly measurements of wet and dry atmospheric depositions were measured for calculating pollutants' input fluxes from the atmosphere. In two of these plots, soil solution is collected with the same frequency for calculating element outputs. Growth of 15 trees in each of the deposition plots was measured using permanent girth bands. The trees were selected in order to cover as many as possible of the diameter classes and to be in the first tow Kraft classes. Crown condition was assessed in all 10 plots emplaced in selected forest ecosystems in August 2010. Ozone concentrations ranged between 18.4 and 56.4 ppb, highest values being registered in the second exposure period (15 June – 15 July), both at plot and whole research network level. In most of the plots, the concentrations distribution is irregular, with two maximums (15 June – 15 July and 15 August – 15 September). NH_3 concentrations were low at the beginning of the growing season (< 1.5 µg m^{-3}), the NH_3 level raising in the following exposure periods (3.5-4 µg m^{-3}). Compared with 2000-2002 period (Bytnerowicz et al., 2005), NH_3 concentrations were considerably reduced due to diminishing of background pollution at national level. NO_2 concentrations ranged between 0.02-0.54 µg m^{-3}. Maximum values were registered during the entire growing season in Baleia Urs and Campusel plots due to nearby new built forestry roads. The analysis of throughfall and open field atmospheric depositions showed that acid depositions (S, N) are low and very low in all five plots. Highest S-SO_4, N-NO_4 and N-NO_3 fluxes, both in open field and under canopy were registered in Campusel plot. The canopy interception varied between -2.4% in Baleia Stana plot and 21.3% in Gura Zlata. These negative values of interception were registered in 2 plots. This phenomenon can be explained by frequent occurrence of fog and clouds, which very effectively deposit water droplets within the canopy (Villegas et al. ,2007; Hildebrandt and Eltahir ,2008).Soil solution analysis in Gura Zlata plot showed an increase of S-SO_4, N-NO_4 and N-NO_3 fluxes on the profile till 40 cm depth, at 60 cm their values being very low, fact which leads to the conclusion that these pollutants accumulate between these depths. The water flux that reached 60 cm depth is very low at this plot (5.1%) compared with the one registered at Campusel plot (47.5%) where the proportion of coarse mineral fraction in soil is very high. The maximum growth registered in one month was 0.21 cm *for Fagus sylvatica* and 0.14 cm for *Picea abies*.

Cause-effects relationships between air pollution and tree responses (defoliation, growth) will be established.

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Ozone air pollution in mountain areas of Europe

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Ozone air pollution (O_3), despite of active policy concerning to emissions reduction is still serious problem, especially for rural mountain regions due to long-range transport of persistent secondary air pollutants. Elevated O_3 levels and air quality indices suggest vulnerability of forest ecosystems and human health conditions in the Carpathian Mountain areas. The aim of this paper is to analyse data of O_3 concentrations measured at selected mountain sites covered by monitoring network of EMEP project (www.emep.int) during last decade period (2000 – 2009). Considered locations were divided into 4 classes (M1-M4) in accordance with UNEP-WCMC definition of mountain elevation parameters: 300 – 1000 m asl. (M1); 1000 – 1500 m asl. (M2); 1500 – 2500 m asl. (M3); 2500 – 3500 m asl. (M4). Statistical analysis of O_3 data was used for investigation of tendency and typical courses of O_3 concentration in relation to elevation zones (M1-M4). In addition, risk of O_3-related effects on living organisms was estimated.

Obtained results did not indicate significant trends of mean annual O_3 concentrations during decadal period of 2000 – 2009 and relative stable values on levels of 60 – 70 μg m^{-3} (M1); 80 μg m^{-3} (M2); 90 μg m^{-3} (M3); 100 μg m^{-3} (M4) were recorded. Greater positive difference was invoked particularly by extraordinary heatwave weather in Europe during summer 2003. On the other hand, statistical analysis suggested significant increase of O_3 abundance with altitude in the lower troposphere. Mean annual O_3 values per decade raised from 66 ±2.9 μg m^{-3} to 101 ±3.0 μg m^{-3} in dependence on altitude linking to classes M1-M4. The high level of O_3 abundance occurred in warm half of year from March to August was related to seasonal O_3 concentrations in range from 79 ±4.8 μg m^{-3} to 112 ±4.6 μg m^{-3}. Course of mean hourly O_3 was different for localities bordered by altitude 1500 m. Daily peak of mean O_3 values at stations situated below this border achieved level about 80 – 90 μg m^{-3} during midday and afternoon hours. Mean hourly O_3 concentrations for sites above 1500 m asl. were relative unchanging both for daylight and nocturnal part of day and exceeded level of 90 μg m^{-3} in elevation zone 1500-2000 m asl. or 100 μg m^{-3} at peak station Sonnblick (3 106 m asl).

Results of health risk indicator SOMO35 (Sum of Ozone Means Over 35 ppb) applied by Worlds Health Organisation (WHO, 2008) show an increase of vulnerability to O_3 effect on health of people who live or stay in the high altitude areas. It is documented by arising mean annual SOMO35 values for selected elevation zones and decadal period 2000 – 2009: 2925 ±509 ppb.day (M1); 4428 ±447 ppb.day (M2); 5573 ±491 ppb.day (M3); and 7265 ±619 ppb.day (M4). Similarly, ozone exposure

indices AOT40 for protection of forest: 16.6 ±4.1 ppm.hour (M1); 24.8 ±4.5 ppm.hour (M2); 26.5 ±4.1 ppm.hour (M3); 35.9 ±5.0 ppm.hour (M4) and also for protection of vegetation 9.9 ±2.3 ppm.hour (M1); 15.1 ±3.2 ppm.hour (M2); 17.9 ±2.8 ppm.hour (M3); 20.9 ±2.9 ppm.hour (M4) show higher risk to O_3 exposure in sensitive and mostly protected alpine and subalpine areas. Furthermore, phytotoxic ozone dose (POD) estimated by DO3SE (Deposition of Ozone for Stomatal Exchange) model for two representative areas in the High Tatras indicate high phytotoxic ozone potential of the Western Carpathians. It is derived from calculation of POD_1 (accumulated stomatal flux over a threshold of 1.0 nmol m^{-2} PLA s^{-1}) for Norway spruce that is the main tree species in the area of High Tatras. Model simulations resulted to POD_1 values 17.8 mmol m^{-2} and 20.4 mmol m^{-2} for two different altitude sites Stará Lesná (808 m asl.) and Skalnaté Pleso (1782 m asl.), respectively. Both estimated POD_1 parameters exceeded critical level 8 mmol m^{-2} set for Norway spruce more than twice. This high exceedance implies not only expected 4.2 resp. 4.8 % reduction in annual growth rates but also suggests higher susceptibility to other biotic and abiotic diseases, in this region represented especially by bark beetle.
The obtained results point out that abiotic regional specifics (relief, land cover, climate, microclimate, hydrological regime, biochemical cycles) may play an important role in distribution, remain and deposition of O_3 air pollution in environment. Further comprehensive research is needed to identify ozone-induced human health risk and vegetation damage associated with cumulative long-term exposure of secondary air pollution.

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Interactive effects of UV radiation and drought on physiological and morphological parameters in selected species of the mountain grassland

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The functioning of many ecosystems and their associated resilience could become severely compromised by climate change over the 21st century (Heyder et al. 2011). The results of a macro-scale water balance model show that the frequency of extreme drought events is projected to increase in future (Tao et al. 2003), causing decrease in ecosystem productivity and environmental functions.
Under natural conditions, plants usually experience more than one stress simultaneously. The stresses cause a variety of interactive responses which can be adaptive or cumulative. Since the drought stress and the enhanced ultraviolet B radiation (UV-B; 280–320 nm) induce similar protective mechanisms (e.g., Hofmann et al. 2003; Cechin et al. 2008), we tested the hypothesis that the UV-B radiation moderates the physiological responses to drought.
It has been suggested that under multiple stress conditions UV-B exposure moderates the effects of drought (Schmidt et al. 2000; Cechin et al. 2008) or that each stress factor seems to bring about some adaptive effect to reduce the damage caused by the other one (Alexieva et al. 2001; Hofmann

et al. 2003). However, present data concerning the interaction between UV-B and drought as well as the implications of combined stresses on plant metabolic processes are controversial.
The manipulation experiment focused on the evaluation of combined effects of UV radiation and drought was conducted in 2011 on the grassland ecosystem (association *Molinio-Arrhenatheretea*, class *Polygono-Trisetion*) at the experimental site Bílý Kříž, Beskydy Mts.. The main objective of the experiment was to investigate the interactive effects of UV exclusion and drought on the changes in accumulation of UV-screening compounds (flavonols), photosynthetic parameters, and morphology in selected species of herbs (*Hypericum maculatum, Rumex obtusifolius*) and grasses (*Holcus mollis, Agrostis tenuis*).
The experimental plot was manipulated by the six lamellar roofs enabling passing (W+; ambient treatment) or excluding (W–; drought treatment) incident precipitation. In addition, the lamellas were made from two types of acrylic. The first one transmitted more than 90% of incident UV-A and UV-B radiation (UV+ treatment), whereas the second one filtered UV-B radiation and the large part of UV-A (UV– treatment). Thus 4 treatments were maintained: UV–W–, UV+W+, UV–W+, and UV+W–. Exposure to the individual treatments started at the beginning of May and lasted for three months.
In situ measurements of UV-screening compounds and physiological parameters were done at regular intervals (approximately 21 days). The CO_2 assimilation rate at saturation irradiance (A_{max}) and maximum carboxylation rate (Vc_{max}) were determined by the gas-exchange analyser Li-6400 (LiCor, USA). The maximum quantum yield, after 25 min of dark adaptation, (Fv/Fm) was measured using the portable fluorometer FluorPen (PSI, CZ). UV screening compounds (flavonols) were determined by the the epidermal screening of chlorophyll fluorescence method (Dualex 4, Force A, F).
Generally, UV and drought treatments had a similar effect on the accumulation of flavonols. UV exclusion resulted in a slight reduction of UV-shielding compounds, particularly in the grass species *Holcus mollis* (up to 36%) and partly also in *Rumex obtusifolius* (up to 15%), under the conditions of ambient precipitation. Likewise, drought treatment caused a gradual increase in the accumulation of flavonols compare to the W+ treatment in all species studied. Thus, the drought treatment reduced the differences in flavonol contents between the UV+ and UV– treatments.
Under the UV– treatment, drought slightly decreased A_{max} , especially in species *Hypericum maculatum* and *Agrostis tenuis*. The presence of UV radiation caused the restoration of CO_2 assimilation rate to the values typical for plants grown at ambient precipitation. We assume that this is due to protective mechanisms induced by UV radiation (accumulation of flavonols), which contribute to the mitigation of negative impacts of drought on photosynthesis. Contrary to other species, a different response to UV radiation was found in *Rumex obtusifolius*, which is typical by gradual decline in A_{max} during the experiment. The UV+W– treatment resulted in the further reduction of assimilation rate in this species.
Among the morphological parameters, shoot length was mostly influenced by the UV+ and W– treatments. While the shoot length was reduced by UV radiation in *Rumex obtusifolius*, it was affected particularly by drought in *Holcus mollis*.

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POSTER PRESENTATIONS

Interannual variability in plant below-ground biomass in a mountain grassland affected by manipulated rainfall

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Predicted scenarios of global change include an increase of drought during the growing season and higher frequencies of extreme rainfall events. Root mass and rhizosphere represent the main pool of organic matter and geobioelements of grassland ecosystems (Hui and Jackson 2006). As these ecosystems store up to 30% of the world below-ground C, it is important to understand how variability in climate factors affects soil C pools/fluxes, and how C cycling might be affected by changes in precipitation, due to climate change (Risch et al. 2007).
Field experiment was established to quantify the effects of different amounts of rainfall on dry mass of below-ground plant parts in mountain grassland. Roofs constructed above the canopy of grass stands and gravity irrigation simulate three climate scenarios: (1) rainfall reduced by 50% (dry), (2) rainfall enhanced by 50% (wet) and (3) the full natural rainfall of the current growing season (ambient).
Results of the four-year experiment suggest that dry mass of below-ground plant parts was affected significantly by treatments and time. A lower amount of precipitation resulted in a decrease of the dry mass of below-ground plant parts. A decreasing tendency in the amount of below-ground plant matter was recorded after reduction of precipitation during four years. The greatest differences between treatments (statistically significant) were found in the third year (2008) when 1571 and only 1172 g m^{-2} of total below-ground dry mass was respectively accumulated in wet and dry treatments. Thus our results indicate that the reduced amount of rainfall can result in the lower accumulation of below-ground plant biomass in some mountain meadows.
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Radziejowa in the Carpathians - forest biodiversity response to climate change (case study)

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BACCARA is a 7.FP project aimed to build the tools that will enable forest managers and policy makers to evaluate the risk of European forest biodiversity and productivity loss under climate change. One of the study areas has been located in the Carpathians in Radziejowa Massif (Beskid Sądecki). A set of 15 experimental plots covering forest diversity in altitudinal gradient (500-1100 m a.s.l.), simulating possible climate change, was established (Ambroży and Grodzki 2010). The experiments were established in 2010 and operated during two growing seasons (2010-2011).
The forest biodiversity was investigated on several functional levels: forest tree species, ground vegetation, herbivory insects and their natural enemies, in function of climatic conditions.
The plots on each altitude were established in the stands representing tree species composition gradient: from pure/nearly pure Norway spruce to mixed ones. On each plot the diversity of ground vegetation, reflecting general biodiversity, was identified.
The investigations on the level of herbivory organisms were aimed to identify the species composition of the bark- and wood-boring insects feeding on Norway spruce, as well as their natural enemies and commensals. For this purpose the sentinel spruce bolts were exposed in the forest for infestation by the insects, then closed in the field eclectors for the collection of emerging insects. The abundance and species composition of insects was used to define the response of tree-associated organisms to various climatic conditions in relation to forest biodiversity defined on the plant level.
The variability of climatic conditions, simulating possible climate change, was characterized based on the results of the measurement of the air temperature during the entire period of investigations, using automatic data loggers.
Possible effects of changing climate on these components of forest ecosystems will be proposed based on the collected results, presented in the poster. This concerns mainly possible vertical shift of vegetation levels due to changing climate (basis to define "what-to-

grow" guidelines) and potential biotic threats and risks to montane forest ecosystems ("what-to-combat" guidelines).

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Impact of Increased Inputs of Nitrogen and Phosphorus On an Alpine Grassland Ecosystem

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Impact of experimentally increased inputs of nitrogen (2g; 6g and 15g $N.m^{-2}.year^{-1}$) and phosphorus (5g $P.\ m^{-2}.year^{-1}$) to an alpine grassland ecosystem was studied on Mt. Salatin, the Western Tatra Mts. Focus of the research was put especially on changes in chemical properties of soil and aboveground plant tissues. Aboveground primary production and plant community structure were also studied.
Experimental plots of size 2x2m were established in 2002 in five repetitions for each concentration and for control, 25 plots together. Since then, they are fertilized with solutions of NH_4NO_3 for N plots and with KH_2PO_4 for P plots. Controls are sprayed only with water.
During the years 2004-2006 regular chemical analyses of aboveground plant material and soil samples were done. Soils on the study site are humo-ferric podzols.
An average soil $pH/CaCl_2$, measured regularly, was 3,19 with minimum differences among treated and untreated plots. An average conductivity, measured once in 2004, was 177,38 μS. Content of humus, measured regularly, was from 8,55 to 27,83%.
Aboveground plant material analyses showed that five years of "fertilizing" caused regular annual increasing in contents of N-total and N-protein from N2 to N15 during vegetation season, from June to August, while contents of P-total were decreasing. On the P plots were detected the lowest contents of N-total and four-time higher contents of P-total as a result of the experimental inputs of phosphorus in to the ecosystem.
The study site is a part of the International Long-Term Ecological Research network.

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Biodiversity 1: Modeling spatial aspects of Carpathian biodiversity

ORAL PRESENTATIONS

Ecological Connectivity in the Carpathians - GIS model to detect the permeability of the Carpathians for particular "Umbrella Species"

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Habitat loss and landscape fragmentation due to the extension of roads and human-related facilities are the main issues of biodiversity loss. Sustaining well-connected networks of large natural areas where ecological and evolutionary processes operate over large spatial and temporal scales could mitigate these threats and help to maintain the population of large predators, gene flow, dispersal area, inter-specific competition and mutualism. Corridors allow ecosystems to recover from natural disturbances as fire and to respond to human-caused disturbance as development of human habitats and invasions of exotic species (Beier et al., 2008). The Carpathian countries are on the way to meliorate and modernize their infrastructures since the end of Communism. Romania as an example for an unprecedented socioeconomic transition process had to face a rapid change from a centrally planned to a liberal market economy which led to profound land use change with inevitable environmental impacts (Turnock 1998). Thus the maintenance of ecological connectivity in a steadily stronger fragmented landscape is crucial for the survival of wildlife populations. Although ecological networks in the Carpathians are still well preserved. Many natural areas became isolated and are hence limited for the migration of large carnivores (Maanen et al., 2006). Regarding new phenomena as climate change in connection with decreasing connectivity and a consequently decreasing biodiversity, initiatives dealing with enhancing connectivity increase (e.g., Van der Grift et al., 2008; Kohler et al., 2009).

Bioregio, a project launched in European Territorial Cooperation South East Europe, is to study and enhance biodiversity in the Carpathians. EURAC aims to highlight ecological connectivity within the Carpathians and in selected pilot areas located at the borders between Serbia-Romania, Romania-Ukraine, and Hungary-Slovak Republic.

In the two-step model approach the amount and distribution of potentially suitable habitat for umbrella species and the permeability between suitable habitats is considered. The expected objective of that analysis is to enhance and sustain the Carpathians ecological network. A web-GIS application will visualize the determined physical barriers hindering free movement and genetic exchange of umbrella species like the lynx, the bear or the wolf. Due to their large habitat requirements they react sensitively to landscape fragmentation (Witkovski et al., 2003). Hence these umbrella species are appropriate for designing a habitat suitability model in GIS that covers their ecological requirements and habitat distribution which is representative for many other Carpathian species. Applying a minimum cost analysis in a second step enables the identification of migration paths (permeability) between high natural patterns that take less energy effort (costs) even if the

land cover matrix in between is not favorable (Fleury and Brown, 1997). This enables the detection of primary ecological corridors and of the hot spots for intervention (Beier et al., 2008).
These suitability models assess the quality of habitats for each umbrella species and provide the basic information for the least-cost analysis to derive the primary ecological corridors. In GIS the habitat suitability models are related to raster- and vector-based layers and consider indicators as land cover, elevation, topography as well as human impact factors.
Every indicator is separated in categories like elevation ranges or altitudinal classes. The habitat preferences of umbrella species are described in a rule-based model considering the spatial structure and the availability of preferred land cover patches relevant for the species considered. The optimal corridors are modeled and visualized in GIS using a minimum cost-path analysis based on the likeliness that the considered species is crossing particular land cover patches. The probability a species uses a patch for migrating depends on its suitability value (0-100%) which is the geometric mean calculated from the defined indicators and their biological weights. The geometric mean has the advantage that if only one weighted indicator is zero, the whole patch is zero and not permeable anymore (Beier et al., 2008). Both – the appropriateness of the indicator and the biological weight for each species – to calculate a suitability value were derived from published ecological profiles and habitat model results (Glenz et al., 2001; Kramer-Schadt et al., 2004; Zajec et al., 2005; Beier et al., 2008; La Morgia et al., 2008; Loy et al., 2009).
For creating a Carpathian wide map to visualize the permeability of landscape and virtual corridors appropriately, neighbor relations, distances among suitable landscape patches (nodes) and potential movement paths (links) are considered in the model. Therefrom potential core areas, stepping stones and corridors across the Carpathians can be identified. Real wildlife observation and presence data are then used to identify the primary ecological corridors for each umbrella species. The overlapping of each umbrella species' map and of road and infrastructure data will define the whole Carpathians ecological network in which physical barriers hindering migration and wildlife genetic exchange are pointed out.

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Landscape continuum model: A case study for the brown bear (*Ursus arctos*) in the Carpathians

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The conservation management of human-modified landscapes requires an understanding of how organisms and their habitats are distributed through space and how individuals can disperse between those habitats. In this context models of landscape structure can be useful tools (e.g., Fischer and Lindenmayer 2006). In fauna research the most frequently used are discrete models of landscape structure (i.e. fragmentation model, patch-corridor-matrix model, patch-mosaic model; e.g. Forman 1995, Haila 2002), in which landscapes are conceptualized and analysed as mosaics of discrete elements (e.g. patches of varying habitat quality) with sharp boundaries. However for many landscapes, the assumptions made by the discrete models of its structure could be overly simplistic. Therefore an emerging issue is the value of alternative landscape models – continuous or gradient models (e.g., McGarigal et al. 2009, Price et al. 2009), in which gradual changes in habitat quality or environmental variables through space are assumed.

One of the gradient approaches - the continuum model presented by Fischer and Lindenmayer (2006), conceptualises landscapes as having variation across gradients of food, shelter, space and suitable climatic conditions, which together shape patterns of species distributions and abundance. This concept is similar to the idea of landscape potentials modified by Solon (2004) to the relation "population (group of organisms) - landscape", where several partial potentials could be considered, e.g. the food-related potential, the concealment-related potential or the transportation potential. Adopting approaches of Fischer and Lindenmayer (2006) and Solon (2004) we built the habitat suitability and continuum model concept for the brown bear (*Ursus arctos*) in the eastern part of the Polish Carpathians (the Bieszczady and Beskid Niski Mountains).

Brown bears in Poland represent the most northern range of the distribution of the Carpathian population, which has been estimated in c.a. 8,100 bears (Swenson et al. 2000). The distribution of the species in the Polish Carpathians is discontinuous, with two main reproductive areas - in the Tatra and the Bieszczady Mountains. Around 95 of brown bears live in the Polish Carpathians, with 66 individuals in the Bieszczady and Beskid Niski Mountains, being the most valuable areas for the bear population in Poland (Jakubiec 2008). Brown bears have high energetic requirements and use a variety of foraging resources (e.g. Bojarska and Selva 2011). Both their energetic needs and the availability of food change seasonally, with fall being a crucial season, when bears' diet has to meet the demands of the accumulation of lipid stores required for winter dormancy, gestation and lactation (Hilderbrand et al. 1999). In this period bears in the study area rely mostly on fruits from abandoned orchards and hard mast (fruits of beech *Fagus sylvatica* and hazel *Corylus avellana*, Frąckowiak 1997). Brown bears avoid contact with humans. They are mostly nocturnal and spend the daylight hours in a shelter in confined areas with high habitat density and low human disturbance (e.g. Martin et al., 2010).

The specific objectives of our work were to:

- -develop a continuum model of a landscape,
- -designate important areas for conservation management and assess overall landscape connectivity for the brown bear in the eastern part of the Polish Carpathians,
- -evaluate the applicability of the continuum model for fauna conservation in human-modified landscapes.

For the Bieszczady and the Beskid Niski Mountains we modeled continuous gridded surfaces reflecting the availability of food, shelter and space for a brown bear in the fall season. The availability of food was measured by deciduous forest and orchards cover, while the availability of shelter by woody vegetation cover in general. The distances to settlements and roads were also taken into account as variables affecting the availability of shelter and space. The supervised, hierarchical approach combining image segmentation, knowledge-based rules to extract a training set and support vector machine (SVM) classification was applied to the Landsat data, scenes 186/26 and 187/26 (path/row), to identify forests and orchards cover. The settlements and roads were obtained from the Vector Map (VMap), level 2.

We combined created gradient surfaces in a continuum model reflecting habitat suitability for the brown bear. Therefore, each grid cell of the resulting continuous surface reflected the potential effective use of a cell as habitat and for the movement within the landscape. Based on our model, we delineated important spots for conservation and assessed the overall connectivity of the landscape for the brown bear, based on least-cost path analysis and graph theory.

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Wisent – a potential umbrella species, universal for the whole Carpathian eco-region

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Wisents (*Bison bonasus*) extirpated from the Carpathians by the beginning of 19th century, are now being re-introduced to a number of countries of the region. Present numbers of free-ranging bison in Polish, Slovak, and Ukrainian parts of the range amount to over 350 individuals, and the establishment of new herds is planned in Romania and Hungary. Annual home ranges of wisent herds there, are of a considerable size, exceeding even 250 sq. km. Those animals inhabit protected areas like a national park or a biosphere reserve, but also roam commercially exploited forests. The largest part of this metapopulation (about 300 animals) inhabits Bieszczady Mountains in south-eastern Poland (Perzanowski, Kozak 2000, Perzanowski 2001).
Large scale analysis based on remote sensing data has proved, that within this ecoregion still exists a number of sites potentially suitable for further introductions of the species, regarding the habitat type and size of habitat patches. The Carpathians, being the largest European mountain range regarding the total area, and stretching across the area of seven countries (Romania, Ukraine, Poland, Slovakia, Hungary, Czech Republic and Austria), are among the most important ecological corridors for wildlife within the continent. Therefore, there is a need for a consistent approach towards nature conservation there, which could be adequate for possibly the widest range of wildlife species (Webster et al. 2001, Bashta et al. 2010, Kummerle et al. 2010).
Wisents with their considerable requirements towards the home range and habitat connectivity could become a flagship species for such initiative. They belong also to priority species for the Natura 2000 network, and all Carpathian countries except Ukraine, being EU members are implementing this system. Home ranges of wisent herds in the Carpathians overlap with territories of all large predators (brown bears, lynxes, wildcats and wolves) living there (Perzanowski 2001, Makomaska–Juchiewicz, Tworek 2003, Perzanowski, Olech 2004, 2007).
Hence, on a basis of a transboundary system of wisent refuges (e.g. planned in connection with Natura 2000 sites), it would be advisable to plan and create a network of protected areas, serving for

the conservation of all large mammals of the region, with the wisent playing there a role of an umbrella species (Perzanowski et al. 2009, Kuemmerle et al. 2011). Assumptions for such a network will be discussed and presented.

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Habitat requirements of capercaillie (*Tetrao urogallus rudolfi* Dombrowski, 1912) in the lek centers in Romania and its anthropic threat

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Introduction: Capercaillie is an important element of natural heritage of Carpathians. It is considered as an "umbrella species" (Suter *et al.*, 2002), it is an indicator of healthy community of coniferous forests, which includes other rare and protected species (Graf, 1998). There is only a little knowledge concerning the capercaillie subspecies *Tetrao urogallus rudolfi.* Habitat of capercaillie (*Tetrao urogallus rudolfi*) was studied during the years 2009 – 2010 in 21 display grounds in the Southern and Eastern Carpathians in Romania, namely in the Fagaraş Mts., Piatra Craiului Mts., Bucegi Mts., Diham, Prisciu Mts., Harghita Mts., Haşmaş, Călimani Mts., Rodnei Mts., Maramureş Mts.. This study

provides an evidence of presence of threats to endangered capercaillie in Romania and suggests concrete steps necessary for its preservation.
Results: Generalized Linear Models (GLM) (McCullagh & Nelder, 1989) were used in order to interpret the relationship between the habitat variables and the number of males in the lek centers. The final model which explains the changes in the number of males in the lek centers implies 3 independent variables out of original 57: ratio of cuttings on the 4 km^2 area with center on the display grounds, intensity of tourism (recreation activities) and the intensity of forest management (in the area with the radius 80 m around the lek center). Some of the lek centers with higher number of individuals are directly affected by the forest management. Large-scale deforestations and intensive tourism have a considerable negative impact on capercaillie numbers in Romania. As the anthropogenic activities appear to be the strongest indicator of male numbers in the lek centers, potential anthropic threat was scored by "index of anthropic threat". The value of index 5 (expected extinction) was attributed to 3 localities, two in Maramureş Mts. and one in Harghita Mts.. Value 4 (expected strong decline) was attributed to 6 lek centers in Maramureş Mts.(1), Rodnei Mts.(1), Harghita Mts.(2), Diham (1), Bucegi Mts. (1). The value of index 3 (a little decline) was attributed to 7 lek centers, value of index 2 (fluctuation) was attributed to 3 localities and value 1 (expected increase) was attributed to only one locality in Călimani Mts.. The index of anthropic threat was used as a dependent variable in GLM analysis; the index of the anthropic threat was influenced considerably by one variable with strong impact, namely the presence of the clear-cuts covering the area larger than 200 ha. The value of the index increased significantly within the clear-cuts covering the area of over 200 ha. Clear-cuts of this size are present in Harghita Mts. and Maramureş Mts.. A correlation analysis was used for better understanding of the relationship between the environmental variables and capercaillie numbers (Pearson´s correlation coefficient). There is a significant positive correlation among the number of males in the lek center and a primeval spruce forest, number of tree species, raspberry (*Rubus idaeus*) cover, average height differences in the microrelief, blackberry (*Rubus fruticosa*) cover, *Calamagrostis arundinacea* cover, number of the tree species and shrub cover.
Discussion: The model explaining capercaillie numbers and model for the variable „index of anthropic threat“ clearly demonstrate the negative impact of undirected logging and tourism on the capercaillie population in Romania. During 2 years of research, an extinction of two lek centers was observed. Continuing forest fragmentation will lead to abortion of the habitat connectivity. Sufficient size and the quality of capercaillie´s habitat together represent an assumption for a viable population (Grim & Storch, 2000). Therefore, to assure the long-term survival of the capercaillie population in Southern and Eastern Carpathians, it is necessary to conduct assessment of the capercaillie´s habitat suitability (to create a habitat suitability model), identify the size of suitable habitat, elaborate steps leading to the creation of capercaillie-friendly forest management in order to maintain and enlarge capercaillie´s habitat; re-rout some of the tourist paths and to monitor the number of predators.
The received data were also analysed by multidimensional analysis, 3 groups of gradients of the arrangement of variables variability were found using the NMDS analysis. One of the gradients is the gradient of habitat carrying – capacity along with the gradient of human impact (exploitative versus symbiotic). On one side it is exploitative (high ratio of spruce trees, low number of the tree species, and ratio of the glades, ratio of the buildings) and on the other side, there is the symbiotic human impact (pastoralism, higher number of types of biotopes, number of snags, number of dead wood, raspberry cover). This gradient leads to the following question: Is it possible to combine the human demands with the maintenance of a suitable capercaillie habitat?

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Potential Distribution of Non-Native, Highly Invasive Plant Species in the Ukrainian Carpathians: Habitat Suitability Modeling under Scenarios of Climate and Land-Use Change

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The Ukrainian Carpathian Mountains have attracted international attention due to the high levels of biodiversity and richness of natural resources found in the region and as such mirror the ecological and economic importance of the whole Carpathian ecoregion. However, increasing anthropogenic pressures on ecosystems in form of deforestation and unsustainable infrastructure and settlement development as well as long-term climatic shifts starkly decrease the resilience and resistance to change of natural plant communities and facilitate the spread of invasive plant species. Meanwhile, despite the documented negative impacts invasive species have on the natural flora in the invaded range, studies assessing the potential (future) spread of invasive plants are largely missing for the Ukrainian Carpathians.
The 11 most aggressive invasive vascular plants in the Ukrainian Carpathians are: *Acer negundo* L., *Ambrosia artemisiifolia* L., *Echinocystis lobata* (Michx.) Torr. & Grey, *Helianthus tuberosus* L., *Heracleum sosnowskyi* Manden, *Impatiens glandulifera* Royle, *Reynoutria japonica* Houtt., *Reynoutria x bohemica* Chrtek.& Chrtková, *Robinia pseudoacacia* L., *Solidago canadensis* L., and *Solidago gigantea* Aiton. For each species (or taxa in the case of *Solidago* spp. and *Reynoutria* spp.) several hundred georeferenced locations (at least 200) are available from herbarium specimen and field-sampling records. The aim of the study is to predict suitable habitat for the species to become established in the Ukrainian Carpathians (study area), given the presence of ecologically relevant descriptive (predictor) variables. Modeling is accomplished with species distribution models (SDMs), which relate field observations of the occurrence of a species to environmental predictor variables by formulating statistically or theoretically derived response surfaces. Because habitat suitability maps often differ not only based on the descriptor variables used for modeling but also based on the models themselves, two conceptually different software packages, Maxent and BIOMOD, are used for modeling.
A set of six predictor variables is selected based on the review of similar ecological studies that chose the optimal variables to reflect limiting factors controlling the eco-physiology of a species (e.g. extreme temperature events), natural or human-induced disturbances (e.g. floods, traffic), and

resources that can be assimilated by organisms (e.g. water, light energy). The variables are: average minimum temperature of the coldest month (mintcold), average maximum temperature of the warmest month (maxtwarm), sum of active temperatures > 10°C (sat), Euclidean proximity to water (sdist_water), and Euclidean proximity to settlements and roads (sdist_sett_r), and slope (slope). Predictions of habitat suitability under current environmental conditions are projected onto four future scenarios: (i) climate change/low economic development by 2050; (ii) climate change/high economic development by 2050; (iii) climate change/low economic development by 2100; and (iv) climate change/high economic development by 2100. Climate-change scenarios assume an increase of average maximum/minimum temperatures and sum of active temperatures; scenarios of economic development assume different levels anthropogenic development and thus potential increases in proximity of any given pixel in the study area to settlements and roads. The significance of predictions and projections is tested with the Wilcoxon ranked sum test and paired Wilcoxon signed-rank test.

Under current climatic and land-use patterns, all algorithms predict most suitable habitats for establishment to be aggregated in the southwest, east, and northeast along large rivers and roads at elevations up to approximately 600 m above sea level. Taking correlation between climatic variables into account, the spread of species is primarily limited, based on their ecologies, by warm temperatures or proximity to humans, and the aggregation of favorable values of both groups at low elevations in the southwest, east, and southeast explains the spatial patterns of habitat suitability predictions. For all future change scenarios, suitable habitat ranges are predicted to increase significantly. The net gain of novel suitable habitat is significantly higher under scenario (ii) and (iv) than under (i) and (iii), respectively, suggesting that the higher the proposed rate of human development, the more suitable habitat is projected to be gained by all species. The differences between algorithms are significant for some species when projecting, but a general trend is discernible: species that become established in a variety of habitats and are not strongly limited by several predictor variable (i.e., *Acer negundo*, *Helianthus tuberosus*, *Robinia pseudoacacia*, and *Solidago* spp.) tend to gain more suitable habitat under future scenarios than more specialist species establishing exclusively along rivers and limited by a multitude of environmental variables in their distribution (i.e., *Echinocystis lobata*, *Impatiens glandulifera*, and *Reynoutria* spp.). All species are expected to migrate to higher elevations along linear habitats and to expand laterally from habitats predicted as suitable for current conditions at low/middle elevations.

The eleven invasive plant species have already established viable populations in the regions predicted to contain suitable habitats. Invasion of protected areas is likely if current trends continue, and monitoring of areas of high conservation values can be efficiently accomplished using the results of this study as guides to prioritize monitoring efforts. Furthermore, inquiries of why a species is predicted to occur at a certain location and which high-risk locations (in terms of invasibility) are in need of particularly sensitive natural-resource management that reduces anthropogenic pressures can be answered by analyzing the relative importance of predictor variables to habitat suitability. Lastly, the maps produced in this study can be utilized to educate the general public and demand forestry practices and forms of tourism development that minimize the chances of the invaders to spread farther into the mountains.

Ground-Based Estimation of Aboveground Live Biomass in Spruce Forests of the Carpathian Mountains, Ukraine

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Introduction. Accurate estimates of forest biomass are central to developing regional carbon budgets (Kuemmerle et al. 2011) and often require field sampling, particularly when quantifying biomass responses to alternate management scenarios. However, field-based estimation of aboveground biomass stocks in different forest types and growing conditions requires an understanding of variability in tree growth forms as a function of canopy position and degree of dominance vs. suppression. Our study investigated a simplified ground-based methodology which can be used by foresters to quantify and validate stand-level carbon sequestration and storage estimates (Keeton et al., 2011), such as those made remotely (Main-Korn et al. 2011).

Methods. We conducted our study in mature spruce stands in 259,000 ha Cheremoch watershed in the Carpathian Mountains of western Ukraine. Norway spruce (*Picea abies* (L.) Karst.) dominates on more than 80% of the forested area. Sample plots were representative of mature, managed, predominantly naturally regenerated stands, spanning a range of dominant tree ages (60 - 150 years).

Sample trees were selected using tree size criteria, based on a trees' relative diameter, height, and canopy position. Here we present *canopy position* as a cohort of trees situated in a defined canopy layer (Kocher, 2007). Our work focused on trees in dominant, co-dominant, and intermediate canopy positions, excluding emergent and suppressed trees. We hypothesize that this selection can improve stand level model accuracy by averaging multiple canopy positions.

We used whole tree measurements, based on sectional dry weights, to develop predictive equations for spruce aboveground biomass. We measured diameter at breast height (dbh) and average height of all tree species on 30 sample plots. At each plot, an average (co-dominant) model and additional dominant and intermediate sample trees were felled. A total number of 100 sample trees were measured in this way. Every sampled tree was divided into 10 equal sections. At each section, we measured diameter and bark thickness at the beginning and end lengths of the section, and the number of branches was recorded. An average (by size) branch was identified and sampled and measured for each section. Second order branches were treated as additional sections. All branches with diameters < 7 mm were cut and weighed with needles attached. Volumes for stem, bark, and large limbs were calculated as was the mass of small limbs with needles. Biomass was estimated based on previously developed wood density functions and dry matter coefficients (Karabchuk, 2000).

We applied this estimation procedure to biomass fractions at the limb, tree bole, crown, total aboveground tree, and stand levels. Relationships between different biomass components (stems, limbs, etc.) and site-specific environmental conditions (canopy layer, elevation, site productivity, etc.) were tested. Finally, we compared our derived allometric equation with those reported previously for Norway spruce (Zianis, 2005; Lakida, 2002; Jenkins at al., 2003).

Results. In our preliminary results the aboveground biomass of individual spruce trees ranged from approximately 95 kg in intermediate to 1452 kg in dominant trees. After applying the averaging multiple canopy positions method, the aboveground structure of biomass of an average spruce tree (with dbh 31.0 cm and weight 500 kg) was found to be: stem wood – 70.7%; stem bark – 11.0%; main (first order) branches – 7.2%; additional branches (of 2nd order and above) – 3.9%; needle – 7.1%.

Aboveground biomass at the stand level depended on local climatic conditions and elevation, tree density, species composition, and stand age. Estimated total live tree dry biomass ranged from 99 Mg ha^{-1} in stands with lower productivity to 368 Mg ha^{-1} on highly productive sites. Stand biomass estimates showed that in highly productive sites with an elevation between 850 and 975 m above sea level (masl.) the average dry biomass equals 253 Mg ha^{-1}; on medium productivity sites (elevation from 925 to 1075 masl.) 179 Mg ha^{-1}; and on poor sites (above 1520 masl.) only 164 Mg ha^{-1}.
The results include both allometric and volumetric equations. In both cases the greatest amount of variability was explained by power equations. Estimated r^2 value for the volumetric equation was higher than for the allometric based formula (r^2=0.99 vs. 0.93). Allometric aboveground biomass estimates were similar for our equation in comparison to those previously reported, despite lower number of sampled trees per sample plot used in this study. In most cases, previously published equations required a greater number of sample trees spanning the entire diameter distribution.
Discussion. Previous research has shown a positive correlation between stand age and biomass accumulation (Keeton et al. 2010). However, we found that within more narrow tree age ranges (i.e. variability within single cohorts), this relationship did not hold true. We attribute these differences to canopy position, with lower strata generally have slower growth and thus lower biomass. Moreover, trees from different plots would be expected to have even bigger differences, running counter to a simple generalization relating age to biomass. For example, an intermediate tree from a 79 year old stand weighed only 180 kg, compared to a younger dominant (73 y. old) tree from a different plot with a weight of 1452 kg. It can be concluded that within age cohorts, spruce tree productivity depends mostly on site conditions and inter-stem competition (canopy position), which results in different tree sizes and wood density.
Different ground based methods can be used to estimate whole tree aboveground biomass measurements. However, our results show that estimates of comparable accuracy can be generated using simple techniques, thereby saving time and resources in field investigation and validation. The results of this research will help scientists account for inter-stem competition, effects of canopy position on growth form and biomass development, and other controlling influences such as climate. The study also will help inform forest carbon projects in the region, for instance by allowing more precise biomass estimation and mapping of carbon storage potentials.

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POSTER PRESENTATIONS

Species diversity of grassland in the Veľká Fatra National Park

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The Veľká Fatra National Park is located in the north-western part of central Slovakia. It stretches over the regions of Turiec, Liptov and Banská Bystrica, ranking among the greatest and highest mountain ranges in Slovakia. In areas above the forest line ("hole" in Slovak) in the Veľká Fatra mountain range, avalanche gullies are botanically the most attractive. Avalanches, typical for this mountain range and occurring on a regular basis, have proved to be as one of many ecological factors. Unique habitats within avalanche gullies are characterized by a great variety of species and rare plants.

Over 2010 and 2011, the monitoring of semi-natural grassland was performed at the Kráľova studňa site in the Veľká Fatra National Park. Botanical composition of sward was evaluated by an estimation method of the total reduced projective dominance and was determined the forage value. Some of the protected plant species were recorded in the sward monitored, e. g. *Viola lutea* subsp. sudetica (Willd.) Nyman, *Anemone narcissiflora* L., *Soldanella carpatica* Vierh. and *Trollius altissimus* Crantz, *Gentiana clusii* Perr. Et Songeon,.

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Vegetation biodiversity assessment in Retezat LTER-sites

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The aim of this paper is to present the results of the vegetation survey realized in 8 Long-Term Ecosystem Research sites (LTER) located in the Retezat Mountains of the southern Carpathian Mountains in Romania.
The permanent LTER sites were established in 2000 within and outside Retezat National Park boundaries, in forest zone at elevation ranging from 800 to 1300 m.
Each LTER site represents an area of 0.7 ha and consists of five circular permanent sub-plots (PSPs) of 500 m^2 apiece according to the methodology developed for long term ecological research (Badea 2008).
The realized phytosociological survey combines the Braun-Blanquet (1964) method with numerical syntaxonomical analyses (cluster and principal coordinates analysis).
Numerical analyses were performed using the PAST v. 2.12 (PAlaeontological STatistics) (Hammer et al., 2001) and SYN-TAX 2000 (Podani 2001) packages.
The phytosociological survey has been realized in each PSPs and include a list of plant species by layers (A, trees; B, shrubs; C, higher plants; D, mosses). The percentage coverage has been measured for each layer by using the Browne Blanquet method. These data enabled identification of plant communities for each research site
The clustering analysis (using the Bray-Curtis similarity index) of all 40 relevés separates them into 8 groups that can be gathered into two large sections according to different floristic kengroups. The section one enclosed relevés with pure beech forests. The section two enclosed relevés of pure spruce forests and mixed forests with spruce, fir, beech and other conifers and broadleaved species.
The principal coordinates analysis (PCO) grouped all 40 relevés into 8 groups and highlights their grouping according to the types of forest ecosystems and to the human impacts. The anthropogenic stress is highlighted by proximity of relevés abundant of nitrofile and ruderal plant species.
Nomenclature: Tutin et al. (1964–1980) has been followed for taxa.

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Brebu cliffs (Romanian Sub-Carpathians) ecological researches – scratch line for practical approaches

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Brebu Cliffs (Brebului Gorges) are located in the hilly area of Southern Romanian Sub-Carpathians on Doftana River Valley, at 535 m above sea level. Brebului Gorges are massif vertical cliffs formed by Inferior Miocene conglomerates. Our studies were developed in the period 2008-2010 starting with plants and animals inventory, continuing with studies on plants and invertebrates communities associated with different cliff expositions, structures and micro-climate.

Not many cliff researches have been performed around the world. As primary habitats for many plant species cliffs represent some of least disturbed habitats of the earth and contribute more to the biodiversity of a region. Cliffs are unique environment that can support a specialized group of plants (many endemic or rare species), serve as refuges for native flora and fauna and also are core habitat for the wide variety of birds and other wildlife that are particularly sensitive to disturbance. Along the decades, cliff studies in Romania were reduced to general description of the flora and vegetation or focuses on particular organisms or specific aspects of cliff habitats: distribution and conservation of some saxicolous plant species or phytocoenologic aspects.

The abundance and distribution of the plant and invertebrates species on the surface of the cliffs is influenced by geological and geomorphological characteristics of the cliffs. All these factors act synergetic with heterogeneity of cliff surface, the degree of solid rock disintegration and climatic factors. Cliffs support plant communities amenable to physiological constrains due to limited soil availability, micro-climatic extremes and water stress, and provide unique environment for species adapted to these conditions.

Cliff's ecological researches have implications in: conservation of plants and animal species living into this unique habitat and management strategies; the rehabilitation of stone quarry slopes that should resemble the natural as much as possible, the final landform created must confound with the surrounding landscape; using natural ecosystem as templates for green roofs design.

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Estimation of riparian vegetation's growth in upper Vistula river basin

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Every year one can notice visible growth of shrubs, trees and other vegetation in the flooded areas. On the one hand the volume of vegetation, especially during high vegetation season, can significantly decrease the total volume of the river valley. On the other hand various species are very important for biodiversity and sustainable river management. Last years brought a few significant floods in upper Vistula river basin (Poland). Regional instututions responsible for water management every year conduct local visions to check changes. The procedure is very time consuming and expensive.
Last years brought huge development of remote sensing techniques - high-resolution ortophotomaps and very high resolution laser data (Light Detection and Ranging /LiDAR/, especially Airborne Laser Scanning /ALS/). Combination of these data brought new methods of assessing changes in vegetation monitoring. The study is about to show how LiDAR and high resolution optical data can be used to distinguish areas where vegetation needs to be cut/reduced.

Diversity of landscape corridors in low mountain area (Bieszczady Mountains, Eastern Carpathians)

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Corridors are the part of a landscape spatial structure and they play important role in functioning of environment. In this study corridors were defined as all linear landscape features which enable movement of energy, matter, organisms and humans (conduit function). The aim of the study was to identify and map all linear landscape features with transportation function and to recognize transported objects in detail. Bieszczady Mountains region (Eastern Carpathians) was selected as the study area.
Landscape corridors longer than 50m were mapped in the field (Nasicznianski catchment test area) in 2010 (August, September) using GPS CSx60. Some of the corridors were distinguished using topographic maps, orthophotomap and digital terrain model. Both natural and human origin corridors were considered. The characters of the individual corridors were collected with the form (both in the field and later from the maps): width, depth/height, length, shape, the altitude above sea level of the beginning and the end of each corridor, gradient, the landform, the visibility and the vegetation and land use of the surroundings. Objects transported along the corridors were identified during field observations considering actual and potential possibility of transportation. They were assessed according to the processes and their effects observed in the field.

During field work and map analysis 389 corridors were recognized and described. Most of the corridors had natural origin (92%). The density of the corridors is $8.23 km \cdot km^{-1}$. Among them, following objects were identified: valleys, streams, dry gullies, rills, vegetation stripes, riparian corridors and game paths. The rest of the corridors were human originated: asphalt roads, dirt roads, footpaths and touristic trails. Abandoned dirt roads were analysed as well – although they do not play the role of a corridor for humans, they were considered as the corridor for rainwater and meltwater.

The corridors were classified according to Forman (1995) classification as disturbance, remnant, environmental and regenerated corridors. Most of them were classified as environmental (valleys, streams, gullies, rills) and remnant corridors (vegetation stripes, riparian corridors). 86 corridors in the study area can be considered both as environment and remnant corridors (streams with riparian stripes). Spatial pattern of the corridors is connected with geological structure (net of gullies and valleys) and former human activity (remnant vegetation stripes, roads).

In view of the corridors' width, they were classified as line corridors (less than 5m in width) and stripe corridors (more than 5m). About a half of the mapped landscape features were rather narrow (linear). 46% was classified as stripe corridors.

Types of transported objects were identified. Streams transport sediments, organic particles, whole beech leaves, branches, parts of plants, as well as plant seeds and small animal organisms. Gullies transport sediments and organic particles (leaves, branches) but usually only after heavy rain or during melting season. Buffer stripes and riparian corridors enable forest plant species to migrate. Wild animals use them to move to their feeding and reproduction areas (e.g. *Ursus arctos*, *Capreolus capreolus*, *Cervus elaphus*, *Canis lupus*). Game paths were created by animals (mainly *Capreolus capreolus*, *Cervus elaphus*) in the forest, especially on steep slopes, to make movement easier.

Anthropogenic corridors are intended to enhance humans transportation. Asphalt roads are used by local people and tourists. Dirt roads in the pastures are exploited by the farmers, sheep and cattle. Foresters and national park workers maintain forest dirt roads to look after the trees. Local people use it as well in purpose to collect forest fruit. Footpath and touristic trails serve for tourists visiting Bieszczady Mountains. Human origin corridors can also act as episodic ways of rainwater, meltwater, sediments and energy transportation but it depend on their location in view of the slope. Some of the tracks in the forest are abandoned. Although they are not used as corridors for humans, they enable water, matter and energy to be transported during wet seasons.

Corridors have much more functions than only enabling a matter, energy, organisms and humans to move. They can act as habitat, filter (barrier), source and sink (Forman 1995). They regulate processes and connectivity in the environment, improve its geodiversity and biodiversity, likewise they enhance visual diversity of the landscape.

The spatial distribution of birds in lowland agricultural landscape of the SW part of Slovakia

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We examined birds distribution, spatial structure, and their relationship to environmental conditions in an agricultural landscape in SW Slovakia. The objective of our study is to create distribution maps representing the relative likelihood of the nest-site habitat of chosen bird species and to quantify relationships between birds and environmental factors using Maximum Entropy (Maxent). Maxent is a method for modeling geographic distributions of species with presence-only data, for making predictions or inferences from incomplete information (Phillips et al., 2004, 2006, Elith et al., 2011).
We used data from 453 grid squares, each of 1 km^2. We determined the presence of all investigated species and calculated the values of independent and joint effects of spatial variables, landscape structure and habitat cover on the occurrence of birds. Environmental parameters were associated with occurrence data using GIS.
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ORAL PRESENTATIONS

Can selective deer browsing be considered as damage in Carpathian forests?

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In the past decades we may have experienced the expansion and substantial increase of deer species throughout Europe, including Carpathian countries. Expansion of deer (red deer, *Cervus elaphus*, roe deer, *Capreolus capreolus* and fallow deer, *Dama dama*) populations is obvious in Hungary, too. Growing deer populations can have serious impacts on forested and agricultural areas. The varied ecological and economical consequences of the interactions between ungulates and their environment, particularly the game damage they cause, generate contradictory, emotion-filled debates among forest and game managers and conservationists. In Hungary the compensation paid for forest and agricultural damages can reach 200 and 1600 million Hungarian Forints per year, respectively (Csányi and Lehoczki, 2010).
Selective browsing effects of deer can both stabilize or destabilize forest ecosystems and influence biodiversity. Deer impacts on forest biodiversity are generally considered to be negative. Excessive effects of deer populations can negatively influence different plant species, songbirds, mammalian herbivores or forest invertebrate populations, too. In turn other studies suggest that management actions taken to regulate deer densities could have the unintended effect of reducing local diversity of ground-dwelling herpetofauna and invertebrates (Greenwald et al., 2008). Some of model simulations conclude that the effects of forest management on natural forest regeneration can be much more profound than that of ungulate browsing. Moreover, they state that there are relatively small differences in the effects of the ungulates at very low to very high densities (Kramer et al., 2006).
Selective browsing of ungulates can modify the interactions between competing species and thus change the overall pattern of plant diversity in forests. However, no classification of woody species according to browsing by deer exists in Europe, with some rare exceptions (Boulanger et al., 2009). The relative sensitivity of the woody plant species to browsing will strongly shape the later ecological and economic outputs.
Although nature-based forest management started in and around Central Europe as a response to forest overexploitation and degradation more than 100 years ago, even-aged timber management is still common in this region. These solutions homogenise forest habitats (one tree species, one age class, understory destroyed), which will be more sensitive to other human and natural impacts, such as the effect of large herbivores. In a homogeneous even-aged forest with closed canopy and scarce or removed understory vegetation red deer has no chance to follow its optimal food selection rules. It has to consume what it can find. In the lack of diverse understory and mixed-species plantations or regeneration sites saplings of the target tree species will be mainly damaged.
Our study aim was to reveal the background of the great extent of estimated forest damages on the target tree species in Hungary. Our question was whether high damages of target tree species are

the consequence 1.) of their attractiveness to game browsing (these are preferred species) or 2.) of the low diversity food supply in the understory.
We have collected data on the species composition of the understory and the browsing on it in different Hungarian even-aged and uneven aged forested areas. Based on these investigations the most preferred species were the economically less or not relevant species, e.g. elderberry (*Sambucus* spp.), blackberry (*Rubus* spp.), dogwood (*Cornus* spp.) or ash (*Fraxinus* spp.) species. Among target tree species the non-native black locust (*Robinia pseudoacacia*) was preferred, meanwhile the native target tree species (beech, *Fagus sylvatica*, oak species, *Quercus petraea, Q. robur, Q. cerris*) were avoided. These relative preferences to those plant species will influence the later damage in the changing forest areas. We have to consider the herbivorous pressure of ungulates and their feeding preferences in planning our future multifunctional Carpathian forests. Resilience of the ecosystems due to their diverse structure and functions decrease the probability of ecological surprises with catastrophic effects on human societies. Our results clearly show that establishing a multi-species understory layer can be a good solution to diminish the attractiveness of beech or oak species.
In case of a moderate selectivity and intensity of deer browsing herbivory can become a natural regulator mechanism of vegetation development and can stabilize forest ecosystems and maintain biodiversity. Nevertheless if the forest stand is highly susceptible to deer browsing –e.g. in a mono-species plantation there is no alternative food to choose and/or the main tree species can be preferred –, then the browsing impact can reach an ecologically and economically disadvantageous level.
Increasing conflicts about game impacts on ecosystems can be considered one of many important constraints to move towards close to nature forest management which process has already started in Hungary and other Carpathian countries. Parallely with these alterations we urge to revaluate the definition of forest game damage from a biological and a legal point of view. Comparing the judgment of deer populations and their effects on the forest vegetation in the Carpathian countries we could find the best practice to measure the damages caused by deer in the Carpathian forests, but also we could reveal the benefits of selective deer browsing on forest ecosystems. We also suggest to collect the results of the studies and to carry out investigations on the negative and positive effects of browsing on the growing and survival of woody plant individuals. This knowledge can be a basis of the future well-established management of Carpathian forest ecosystems and forest resources.
We are grateful to the Gemenc, SEFAG Forestry and Timber Industry, Egererdő, Ipoly Erdő and Pilisi Parkerdő joint-stock companies for cooperation and financial support and to the Game Management Foundation of the Ministry of Agriculture and Rural Development (FVM 73028/2002) and to János Bolyai Research Scholarship of the Hungarian Academy of Sciences (to Katona, K.) and South East Europe Transnational Cooperation Programme (SEE/B/0010/2.3/X) for financial support.

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Diversity of the epigeic spider communities of the historical structures of agricultural landscape in Slovak part of Carpathians

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Diversity of the epigeic spider communities was studied on 3 spatial levels (sampling plots, locality, regional - cadastre) in 3 model areas. These areas represented 3 types of the traditionally used agricultural landscapes in Slovak part of Carpathians, particularly landscape of vineyards in Svätý Jur (Malé Karpaty Mts.), mountain agricultural landscape with dispersed settlement in Hriňová (Poľana Mts.) and landscape of the mountain meadows and pastures in Liptovská Teplička (Nízke Tatry Mts.). Spider communities were studied by pitfall trap method on 55 study plots on 14 localities from April 2009 to April 2011. Selected study plots represent 3 types of characteristic historical structures of the Carpathians in Slovakia. From structural perspective there are mosaic of small-scale arable fields, pinned vineyards, meadows, pastures and permanent agricultural cultivations. Their size, shape, orientation, distribution, utilization, agricultural forms of relief (balks), margins of cross field tracks, stony walls and other characteristics as well as regional or local differences are results of interactions among natural conditions, geographical position, cultural-historical and economical development.

During two years of the research 23165 spider specimens from 333 species were captured. Ecological relationships and composition of spider communities were analyzed and evaluated according to individual historical agricultural structures. Also spider diversity assessments for all 3 levels were done. The highest diversity was in model area Svätý Jur. Many localities from studied structures create very good living conditions supporting high diversity of spider fauna and presence of many rare and threatened spider species. From identified species 43 species are listed in the Red List of Spiders of Slovakia in different categories of threatening (e.g. *Dysdera crocata*, *Ero tuberculata*, *Dipoena erythropus*, *Robertus neglectus*, *Acartauchenius scurrilis*, *Agyneta cauta*, *Ceratinopsis stativa*, *Erigonella hiemalis*, *Gonatium rubens*, *Megalepthyphantes pseudocollinus*, *Meioneta saxatilis*, *Meioneta simplicitarsis*, *Panamomops inconspicuus, Peponocranium orbiculatum*, *Pocadicnemis juncea*, *Theonina cornix*, *Troxochrus scabriculus*, *Walckenaeria acuminata*, *Walckenaeria alticeps*, *Scotina palliardii*, *Altella lucida*, *Clubiona saxatilis*, Zora *distincta*, *Echemus angustifrons*, *Gnaphosa modestior*, *Haplodrassus dalmatensis*, *Phaeocedus braccatus*, *Zelotes gracilis*, *Xysticus kempeleni*, etc.). The most important finding was capturing critically endangered and legislatively protected species *Zelotes puritanus* on xerotherm stony mound with poor plant coverage in Liptovská Teplička.

For all plots certain environmental variables were evaluated by Canoco program. Species richness and composition of spider communities of agricultural historical structure depended on complex of factors which corresponds with abiotic factors, habitat type, orientation and method of cultivation. Traditionally cultivated landscape elements like vineyards, orchards with unconsolidated stony walls, extensive meadows with mowing and grazing showed high richness and occurrence of rare and threatened species.

To summarize, high richness of spider fauna and occurrence of rare and threatened species in studied plots pointed out high biotic value of these historical agricultural structures in agricultural landscape.

Presented results together with results from further research of historical structures of agricultural landscape will serve as a base for preparation of documentation or legislation aiming to protect these biotopes. A reason for this is real risk that in near future, due to abandonment of these structures, following succession of forests and urban pressure, decline or even irreversible loss of biodiversity linked to such specific biotopes will be the result.

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Scree slopes vegetation monitoring, a tool for habitats management in Piatra Craiului National Park (Romania)

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Introduction. Piatra Craiului National Park, located in Central Carpathians, holds a high variety of plant species and habitats. The impressive scree slopes, shelter the protected habitat - 8120 Calcareous and calcshist screes of the montane to alpine levels (*Thlaspietea rotundifolii*) (Vezeanu et Pop, 2010).
Piatra Craiului National Park's Monitoring Plan contains monitoring protocols designed to asses the effectiveness of the management actions in protecting the scree slopes vegetation (Pop, 2005). The monitoring plan, based on biological indicators, was designed to provide a basis for long-term assessment of the status of biodiversity (Pop et. al, 2010).
The data presented in this paper are the results of an ongoing vegetation monitoring study. The study is designed to identify and measure the deviations from a baseline situation recorded in 2003, to a present situation, in order to evaluate scree slopes' vegetation change over the time and, to assess the effectiveness of management actions in conserving the habitat.
Methods. The data used for the habitat map (1: 2 000) were obtained from satellite imagery, using the Normalised Difference Vegetation Index (NDVI), correlated with higher-resolution orthophotoplans and field verifications. The habitat surface was identified based on GIS maps analysis.
The scree slopes monitoring was focused on vegetation composition and surface in permanent plots. The surface of the habitat patches was monitored by field mapping correlated with orthophotoplans. In order to asses the habitat quality and dynamics, a total number of 100 permanent plots, placed in 18 different study areas, were selected. The obtained data were analyzed using advanced statistics.
In order to identify the vegetation natural succession, there was conducted a micro-sites identification, based on soil proprieties, and geological features, correlated with vegetation type (scree slope vegetation, meadow, shrubs, forest) using multivariate analysis DCA.
For phytocoenosis classification there were used: cluster analysis based on their similarities using Relative Euclidean Distance (Ward Method); for each group (cluster) of botanical samples (releve) there was calculated the mean of vegetation cover, the mean cover of each taxa, the standard deviation and the frequency; the Kruskal-Wallis test was used.
In order to identify which groups are different from the other, for each of the component species the Scheffé test was used.

There were used for monitoring some of the attributes which define the "Favorable Conservation Status" of the habitat: habitat extent (by mapping); vegetation cover (in 100x100 sqm permanent sample plots, using a 100x100 cm gridded quadrate); species richness; species composition.
Results. The characteristic vegetation associations of the habitat 8120 - Calcareous and calcshist screes of the montane to alpine levels (*Thlaspietea rotundifolii*), for Piatra Craiului, are *Cerastio lerchenfeldiani-Papaveretum* Boşcaiu *et al*. 1977 and *Cerastio transsilvanici-Galietum lucidi* Boşcaiu *et al.*
The results of GIS mapping, showed that the scree slopes habitat covers 78.8 ha from 1,283 m to 2,196 m altitude (with the highest surface at 1,745 m altitude). There were identified 6 types of micro-sites, using multivariate analysis DCA. Based on „cluster analysis" there were identified 12 groups of botanical samples including samples from the surrounding habitats (forest, shrubs and meadow); the Kruskal-Wallis test showed a significant difference between the 12 botanical sample groups ($P \leq 0{,}050$) for 163 taxa.
Throughout the 7-years monitoring study, no significant changes in habitat's surface were observed.
Change in vegetation evolution was observed in 20 plots towards progressive directions (meadow or forest habitats) and 5 showing regressive direction (bare scree slopes).
1. The monitoring plot MG9.II showed a vegetation natural progressive succession from scree slope to meadow: the higher plants cover increased from 30.9% (2003) to 51.6% (2010); the Bryophytes cover increased from 2.2% (2003) to 7.8% (2010); plant species number increased from 23 (2003) to 36 (2010); the cover of dominant and ediphicator species *Carex sempervirens* and *Sesleria rigida ssp. haynaldiana*, increased from 6.1% (2003) to 15.6% (2010) and from 7.3 (2003) to 12.2% (2010); the cover of scree slopes characteristic species (*Galium lucidum, Senecio rupestris, Thymus pulcherrimus etc.)* decreased.
2. The monitoring plot MG19.IV showed a vegetation *(Cerastio lerchenfeldianii-Papaveretum)* natural regressive succession caused by geomorphologic events: vegetation cover decreased from 15.2% (2003) to 8.5% (2010); decreasing of species cover *(Linaria alpina* and *Papaver alpinum ssp. corona-sancti-stephanii)*; decreasing of species number from 19 (2003) to 13 (2010); species disappearance (*Aubrieta columnae ssp. platycarpa, Biscutella laevigata, Dianthus spiculifolius).*
In some cases the geomorphologic events, as gelifraction and avalanches leaded to vegetation destruction - regressive succession. But, sometimes avalanches are a beneficial factor for the survival of this habitat by preventing forest spread (Munteanu et. al, 2011a; Munteanu et. al, 2011b).
3. The monitoring plot MG.22.V showed vegetation *(Cerastio lerchenfeldianii-Papaveretum)* natural progressive succession to meadow, caused mainly by a management error. The area was used by tourists as a "shortcut" of the main tourist trail. The tourist access was forbidden by a management decision of the National Park Administration in 2005. Consequently, the vegetation cover increased from 48.8% (2003) to 70.4% (2010); the species number was almost the same, 51 (2003) and 53 (2010), but the cover of Carex *sempervirens*, *Sesleria rigida* and *Poa nemoralis* increased. The vegetation succession will lead in time to forest installation, thus, this fragile habitat and its protected species will be lost.
In this case, closing of some tourist trails, crossing the scree slopes, which was meant to preserve the habitat, led, in time, to the loss of scree habitat in favor of meadow habitat. A certain amount of tourist pressure producing the scree slope mobilization proved to be beneficial for this type of habitat. In this case, the tourists' pressure was beneficial for habitat conservation. Taking into account these results, the trail was reopened for tourists' access.
The global climate change is likely to have its effect, as well, allowing the meadow and forest plant species to colonize more easily the scree slope habitats.

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Dispersal of Plant Diaspores along Carpathian River Corridors

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Rivers are amongst the most important natural corridors within the landscape (Forman, 1983; Forman & Godron, 1986; Puth & Wilson, 2001). Understanding the mechanisms dispersal of organisms between landscape elements is a growing branch of ecology (Forman & Godron 1986; Hanski & Gilpin 1991). Although the role of river corridors as dispersal vector has been extensively studied, up to now, only few studies have investigated the importance of dispersal by water in determining species composition and community structure of ecosystems (Nilsson et al. 1991a; Rydin & Borgegård 1991). But it has not yet been shown whether differences in floating ability among plant species influence the composition of the riparian flora. That is why the interdependence between species composition in diaspores and vegetation composition need more study.

This study was carried out in floodplain ecosystems of Ukrainian Transcarpathia (Zakarpatska province; neighboring Hungary, Slovakia and Romania). In total, 31 sampling plots (16 along Uzh River and 15 along Latorytsa River) were positioned across three different zones - high mountains, volcanic mountains and lowland plain. The sampling plots are situated on the river shore, exposed national flooding.

A permanent vegetation quadrate of 200 m² was established at each sampling plot. Vegetation composition was determined during August 2010, using the Braun-Blanket methodology. Among the species that make up the floristic composition of a community, some are better indicators of a given community than others. The approach seeks to use those species whose ecological relationships make them most effective indicators of the community; these are diagnostic species. In our study, we split all species into two groups; diagnostic and other species. The diagnostic species of these riparian vegetation communities only comprised of a small subset of 9 species out of 198 species encountered in this study: *Salix fragilis, Salix purpurea, Salix* x *rubens, Alnus incana, Alnus glutinosa, Agrostis stolonifera, Phalaris arundinacia, Petasites hybridus, Bidens tripartita* (Schubert, Hilbig & Klotz 2001, Vicherek et al 2000; Willner & Grabherr 2007).

The composition of the seed bank was determined by sampling and carefully digging up the sediment using a standard 6.9 cm diameter and 6.3 cm height metal cylinder (volume is 235,46 sm^3). The seed bank was sampled in five replicates at each of the thirty one plots. The five samples from the same plot were mixed and one averaged sample of soil was prepared. All samples were sieved through a 5 mm mesh and a 1mm sieve, which was only slightly larger than the mean particle size of the sand.

Even though we calculated only alive parts of plants that had been driven to shore, we found 78 species as diaspores in thirty one sampling plots: 45 as vegetative propagules and 53 as seeds. Among these species 14 of them occurred in both groups.

The vegetative propagules included seven out of the nine species that had been defined as diagnostic species - *Salix fragilis, Salix purpurea, Salix x rubens, Agrostis stolonifera, Phalaris arundinacia, Petasites hybridus* (perennial plants) and *Bidens tripartita* (annual plant). The diaspores of *Agrostis stolonifera, Phalaris arundinacia, Salix* sp., *Rumex sanguineus* and *Carex riparia* were the most numerous and are common riparian plants and well represented in the above-ground vegetation. This seems to show the importance of hydrochory for these diagnostic species, but more detailed analysis showed differently (see below).

Comparing species compositions we found that only 19% of species present in the above-ground vegetation were found in seed bank. In total, the seed bank included 34 species, of which four diagnostic species – *Salix fragilis, Agrostis stolonifera, Alnus incana* and *Alnus glutinosa*. Like in case with vegetative propagules, only few seeds were found of five invasive species: *Fraxinus pennsylvanica, Helianthus tuberosus, Impatiens glandulifera, Parthenocissus inserta* and *Solidago canadensis.*

On the other hand, eighteen species that we found as seeds were not present in the established vegetation community. Among them we noted 6 non-native spontaneous species – the water promotes dispersal of seeds of agriculture plants in the far distance where they can naturalize in native ecosystems. Their absence in established vegetation can be explained by fact that these kinds of plants are not adapted for environment conditions in riparian ecosystems and may therefore often not be able to reproduce. Their abundance in the vegetation composition thus depends on a permanent supply of new seeds.

As with the majority of other seed bank studies (except perhaps some agricultural weed investigations), observations of the above-ground vegetation in riparian systems are rarely found to be a good measure of the quality and quantity of seed in the soil beneath (Berge and Hestmark, 1997; Beismann et al.,1996). In this research were showed low identity species found as diaspores (that can be dispersing by seeds or vegetative propagulas) and establish vegetation composition. Our results confirm the effectiveness distribution by flood for long-term dispersal of high number of species but also suppose that local species composition in relevees is rarely link with dispersal diaspores along river corridors.

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Creating a Network of Knowledge for biodiversity and ecosystem services

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Knowledge about biodiversity and ecosystem services is well advanced in the European scientific community,as demonstrated by many excellent projects and their scientific impact. However, on the global as well as theEuropean scale, there is a failure to communicate the knowledge gained into the policy-making process andsociety as a whole. Such communication efforts, must ensure that all relevant knowledge is accessible and thatall existing biodiversity research communities and other knowledge holders are involved in a network structurethat is linked to decision making bodies.

The **KNEU** (**K**nowledge **N**etwork for **EU**ropean expertise on biodiversity andecosystem services) project builds on concepts on how to develop and organisescience-policy interfaces for addressing complex environmental issues and how knowledge is deliveredto them. KNEU acknowledges the different forms of information and knowledge needed to tackle currentand future problems arising from global change. At the same time the knowledge used needs to meetthe objective of high quality and reliability of the analyses done with this knowledge and ensuring itspolicy relevance

The main objective of the project is to develop a Network of Knowledge (NoK) for biodiversity and ecosystem services in order to provide information-flow between the scientific community and policy-makers in Europe.

This Network of Knowledge has to take into account different challenges. It has to identify and make accessible the best available knowledge and personal expertise in a timely andflexible manner. It should ensure that the network-process is open and transparent and it takes into accountpractical and local knowledge, especially with regards to management questions. It has to ensure that knowledge providers (including generators of primary data as well as collators andsynthesizers of knowledge from these data) are sufficiently acknowledged for their input whilebeing encouraged to provide their information in forms relevant to society. At the same time, the approach needs to be carried out through a continuous dialogue with knowledge users – who are the clients for the expertise identified and processed within the Network ofKnowledge and may include policy makers but also other decision makers in the private sector and civilsociety organisations.The development of the NoK thus needs to be achieved through a practical, "learning-by-doing"approach, since many of the issues outlined need to take account of different perspectives andapproaches as well as to be negotiated among the different involved groups (requiring a level ofinclusivity far beyond the project consortium). KNEU is therefore designed as an open process which will (1) deliver a NoK prototype; (2) test it through a number of case studies; and (3) use this experience todevelop a recommended design for a future NoK as the main project outcome.

Nok will develop links to relevant clients to support the science-society interface in Europe and beyond. The first step of the project is to provide an overview about the expertise and knowledge holders in Europe, to map potential clients for the NoK outputs and to screen technological options for use in the NoK prototype.After mapping the biodiversity knowledge landscape in Europe, a prototype NoK is developed involving a wide number of institutions and networks in biodiversity research and policy. This prototype will be used as a vehicle to carry out case studies in relevant policy fields (agriculture, biodiversity conservation, marine issues) in order to test its functioning and effectiveness. Following the evaluation of the gained experiences as a final outcome of the project a potential future Network of Knowledge will be developed.

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(http://www.biodiversityknowledge.eu/)

POSTER PRESENTATIONS

Altitude effect on small mammals (*Eulipotyphla, Rodentia*) in the High Tatras National Park

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The small terrestrial mammal´s research was realized in the Belianske Tatras Mts. and the High Tatras Mts. between 2009 and 2011 and 709 individuals of 13 small terrestrial mammal species (*Sorex araneus, Sorex minutus, Sorex alpinus, Neomys fodiens, Apodemus flavicollis, Apodemus sylvaticus, Clethrionomys glareolus, Microtus agrestis, Microtus subterraneus, Microtus tatricus, Chionomys nivalis, Sicista betulina, Muscardinus avellanarius*) were caught. The aim of contribution is to specify the effect of altitude on small terrestrial mammal´s synusias (species richness) in the conditions of the Tatras (High Tatras National Park).

When altitude increased, the changes of synusias of small terrestrial mammals were observed as the occurrence of qualitative rebuilding, or species composition change of small mammals´ community in catching lines and series. The software tool *GRASS GIS 6.4* was used for the creation, editing and visualization of spatial data. The output maps, which express the relationships between altitude and species number (eventually individuals number), were created by reclassification of digital elevation model ASTER GDEM. Input map was split to six zones according to altitude.

Species richness of small mammals is different in various altitudinal zones of Tatras. There was found 6 species of small mammals between 800 and 900 m a.s.l., 9 species in 901-1000 m a.s.l., 6 species in the next altitudinal zone (from 1001 to 1200 m a.s.l.), then number of species increased to 8 species (in the zones 1201-1400 m a.s.l. and 1401-1600 m a.s.l.) and in the zone from 1601 to 1800 m a.s.l. declined to 4 species.

The species of small mammals are divided into several categories in connection with altitude: 1. Species preferring higher positions – High Mountain species (*Chionomys nivalis, Microtus tatricus*); 2. Species of higher positions – Mountain (*Sorex alpinus, Sicista betulina, Microtus agrestis*); 3. Species independent on altitude but elusory of higher positions (*Apodemus sylvaticus, Muscardinus avellanarius*); 4. Species total independent on altitude (*Apodemus flavicollis, Clethrionomys glareolus, Sorex araneus, Sorex minutus, Neomys fodiens, Microtus subterraneus*).

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Significance of Habitat Characteristics of Amphibians

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Adult amphibians are influenced apart from physical and chemical factors of water environment also by other factors, such as food offer, hiding and migration options, and predation. These are environmental factors on the level of landscape ecosystems.

Fast response of amphibians to habitat changes is used for environmental bioindication. To clarify the sensitivity of bioindication it is necessary to test significance of habitat characteristics. During the years 2006 – 2008, we carried out a research for habitat preferences for 9 species of amphibians (N = 392). In agricultural and urban lowlands we tested, in 20 water habitats, the significance of water area constancy, absence or presence of macrophytes vegetation, species of macrophytes like sedges, rushes and reeds, presenceof forests, presence of roads, predation and urban areas. Mentioned factors were evaluated in the area of 2.2 km from water bodies with confirmed amphibians reproduction. We used the Canoco ver. 4.5 program. Using Correspondence Detrendet Analysys (DCA) we calculated the lenghts of the gradient (= 3.55). Results of Canonical Correspondence Analysis (CCA) confirmed the preference of "green" frogs *Pelophylax ridibundus* and *P. esculentus* to permanent water bodies. On the contrary, these species have a negative correlation to forests. *Bombina bombina* and *B. variegata* have a negative correlation to water constancy factor. *Pseudepidalea viridis* is positively correlated with urbanized areas, *Hyla arborea* with macrophyte vegetation and *Bufo bufo* and *Rana temporaria* are forest species. We tested the statistical significance of selected environmental factors using the Monte Carlo permutation test with 449 permutations (CanoDraw 4.12). In the first step of testing was statistically significant (pα = 0.05) factor forest (its distance from the water area, p value = 0.004). On border of the statistical significance was “don´t dry out” factor (p value = 0052). Evaluated habitat factors do not correlate together. The highest value of inflation factor that was 2.65 had "roads" and 2.11 were for "forest".

Cumulative percentage of explained variation in species data was on the 1st ordination axis 23.9% (the 4th ordination axes 51.5%). For environmental data it was 43.8% (the 1st ordination axis) and 94.3% (the 4th ordination axis). According to our results, from evaluated landscape types is statistically significant factor the distance from forest. Most amphibians live in forests out of their breeding period. Another important factor is a passage facility of corridors to enable amphibians to get to reproduction water bodies. Our results are significant for assignment of appropriate amphibians' management at the regional level.

Soil mite's associations (Acari: Mesostigmata: Gamasina) from natural forests from Bucegi Massif – Romania.

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Natural forests are complex and stable ecosystems. Over time, the structure and function of a natural ecosystem should remain relatively stable, even in the face of disturbance. These characteristics are due to factors that provide ecosystem's stability, as: species diversity (interactions, life strategies), trophic complexity (food web structure) and nutrient or energy flux. On soil level, interrelations between soil microarthropods, influence physical, chemical and biological processes (Lavelle et al., 2006). These microarthropds are characterized by a great diversity, one of the most abundant groups being predatory soil mites (Acari: Gamasina) (Koehler, 1999; Ruf, 2000; Krantz & Walter, 2009).
In present paper, mite associations were studied from soil of three natural forests from Bucegi Massif: *Picea abies, Abies alba* and *Fagus sylvatica*. Bucegi Natural is situated on the east side of Meridional Carpathians and includes whole Bucegi Massif. This is developed in an amphitheater shape with a wide south opening and limited by the peaks, which often reach to 1000 m altitude, in comparison with limitrophe areas. The Bucegi Natural Park has a total area by 32.663 ha. It is one of the most important protected areas from Romania, having a reach diversity of flora and fauna. In period 2001-2003, 97 mite species were identified, with 23,441 individuals. The mites samples were collected using a random stratification method, with a square metal core. The soil samples were divided in two layers: litter - fermentation and humus. Base on species frequency and relative abundance, stable gamasid associations were established (using an original hierarchically clustering method), on both soil layers. In litter-fermentation layer, the percents of these species varied as: 5.88% in fir, 7.84% spruce and 6.86% in beech forest. In humus layer, these were lowest: 4.08% in fir forest; 3.92% in spruce and 2,94% in beech forest. In the same time, we observed that some species have grouped in monotonically associations. The dependence between these groups of species was tested using Spearman test. Analysing the rank correlation values in all three areas, we observed that these varied from 0,5 to 0.92 on communities from litter-fermentation layer and from 0.54 to 0.77, on those from humus.

An original research concerning one of the soil biological components of the terrestrial ecosystem constitute an important database for the forest conservation. Predatory soil mites are the main regulatory mechanism for other soil invertebrates (springtails, nematodes, enchytreides, oribatids), which are the main decomposers of the organic matter. Specifically environmental conditions determine characteristic gamasid population structures for each investigated ecosystems. Any disturbance determine semnificative quantitative (abundance) and qualitative (species composition) modifications on soil mite communities. These modifications are specifically "signals" for damaged soils and for forestry practices.
This is the reason that the gamasids could be considered one of bioindicators group for terrestrial ecosystems. Any research concerning mite's communities from soil of natural forests provides precious informations concerning one of the most important invertebrate groups, which play role in ecological reconstruction of the damaged forest ecosystems, taking account that a "natural forest" composition model is the main goal of present-day management plans**.**

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Results of research of *Psocoptera* (*Insecta*) in the Carpathians Mts. - a model group for biodiversity study in forest ecosystems

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The Order Psocoptera is a little studied group of insects that includes the world about 4000 species. In Central Europe it is only 80 species. A complex psocopterological research was initiated recently in territory of the Czech Republic and Slovakia in 1997 (database currently contains approximately 10,000 database items in nearly 25,000 specimens of Psocoptera (cf. Holuša 2003, 2008).
The aim of the study of psocids conducted was to define the species diversity and characteristic species composition of psocids in different types of forest ecosystems, also determine whether it is possible Psocoptera used as 'a model group'. As a framework for study were used vegetation tiers (Plíva 1971) in zoocenological studies. Significant factors, that determine the occurrence and composition of taxocenoses of psocids, were identified by statistical methods (DCA, DvClA).
The network of research areas have been laid out in the Western Carpathians in the Czech Republic and Slovakia, and in the region of Eastern Carpathians Mts. in the Bukovské vrchy Hills in Slovakia, at the massive of Pop Ivan Maramurešskij Mt. in Zakarpastkaja oblast region and in foothills and in the massive of the Horhany Mts. in Ivano-frankivskaja oblast in the Ukraine.
The results of DCA analysis show influence significant factors: influence of vertical zonality and hydricity. The results DvClA and DCA-analysis show the environmental groups of psocids that are characteristic of certain types of forest ecosystems (except units - vegetation tiers, category of

hydricity, also recent tree species composition). Characteristic species combination of Psocoptera was found for each vegetation tier.
The following indicator species were identified in the range of species of psocid: *Stenopsocus stigmaticus, Stenopsocus immaculatus* and *Caecilius despaxi*. An important indicator is the "value" of *Caecilius despaxi.* Dominancy of this species in the vegetative tiers is same as the dominancy of *Picea abies* in natural forest ecosystems.
Psocoptera satisfy the requirements for characteristics of the model group. Existing material can in future be used as a comparative basis for evaluating the dynamics of forest ecosystems and changes due to climatic factors of potential global climate change.
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What do we know about the largest European dragonfly *Cordulegaster heros* (Odonata: *Cordulegastridae*) in the Carpathian Mts.?

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Cordulegaster heros belongs among the three species of the genus *Cordulegaster* occurring in Central Europe. Its size is one of the largest dragonflies of Europe. Its was described by Theischinger (1979) from Niederösterreich (Andrä vor dem Hagnethal). *C.heros* occurs in a part of the Eastern Mediterranean – the Balkan Peninsula up to central Europe – foothills of the Alps in the eastern Austria and uphills of the Carpathians Mts.
The species was found by extensive survey of streams in the area of the Czech and Slovak Republic in the years 1997-2011 in 2001 in the Slovak Republic and in 2009 the Czech Republic.
Cordulegaster heros is now known from the territory of Slovakia from 65 localities (Blaškovič et al. 2003, Holuša & Kúdela 2010, Holuša nepubl.) in four regions – the Borská nížina lowland, the Malé Karpaty Mts., the Revúcká vrchovina Hills and the Stolické vrchy Hills. Localities (including published data) are located at an altitude of 160-516 m above sea level the center of gravity within the range of 201-300 m a.s.l. Species was found at 3 localities on the southern foot of the Chřiby Hills in the Czech Republic, sites are situated at an altitude of 253-309 m a.s.l.
Factors of species habitat were tested by statistical methods. It can be said that combinations of following factores explain the species occurrence: depth of stream basin – shape of stream basin (partly straight stream) – altitude – representation of soil fraction (5-20mm) – representation of organic material – slope of stream.
The boundary of species area in Central Europe is still unclear, it appears that the area is disjunctive - separate small areas are probably the Chřiby Hills in the eastern part of the Czech Republic, the

Borska nížina lowland and the Malé Karpaty Mts. in the western Slovakia and the Revúcká vrchovina Hills and the Stolické vrchy Hills in the central Slovakia.

The species *Cordulegaster heros* is included in the list of species in Annex II and IV of Council Directive 92/43/EHS, therefore the population monitoring is required also in the territory of the Czech Republic, primarily to assess their potential threat.

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Polypores from the Eastern Carpathians (Transylvania, Romania) I. Polyporaceae s. l.

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Polypores are mostly wood-inhabiting fungi, which play an extraordinary important role in forest ecosystems. Most polypores are saprotrophic and utilize dead wood as a food base. Other groups are able to attack living trees so some species being remarkable such as forest pathogens (e.g. *Heterobasidion annosum, Porodaedalea pini, Fomitopsis pinicola*). Several of them have practical importance for human beings as foods or medicines (e.g. *Ganoderma lucidum, Trametes versicolor, Fomes fomentarius*). Additionally, many polypores are listed in European red data books and are important targets for conservation. Unfortunately in Transylvania, most of the forests are under intensive management, so it unfavorable for the polypore diversity.

The first polypore data (*Polyporus squamosus*) from Transylvania was published in 1778. Only sporadic data of these species were documented from the Eastern Carpathians up to 1998. In the literature some rare species have been found, which grow mostly on deciduous trees (e.g. *Buglossoporus pulvinus* (Pers.) Donk 1971, *Grifola frondosa* (Dicks.) Gray 1821, *Hapalopilus croceus* (Pers.) Bondartsev & Singer 1941, *Polyporus umbellatus* (Pers.) Fr. 1821, *Rigidoporus ulmarius* (Sowerby) Imazeki 1952). The first author and his colleagues started systematic field surveys from 1998 in various forest habitats of the territory, resulting the documentation of **56** polypore species. The species recorded were documented with fungaria. The taxonomic revision and the compilation of the data published before were also made. Nomenclature used was those of MycoBank database. Beside, the description and habitat characterisation have been also completed, based mainly on the author's fungaria. The known polypore species number documented from the Eastern Carpathians is 69, with 329 occurrence data.

In this study we present some occurrence data of rare species was documented, such as *Ganoderma carnosum* Pat. 1889, *Leptoporus mollis* (Pers.) Quél. 1886, *Onnia triquetra* (Pers.) Imazeki 1955, *Polyporus tubaeformis* (P. Karst.) Ryvarden & Gilb. 1994 and *Pycnoporellus fulgens* (Fr.) Donk 1971.

Protection of the biodiversity of meadow communities on the territory of the Uzhansky National Nature Park

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One of the priorities of national parks is to preserve their biodiversity. Uzhansky National Nature Park is located in Ukraine, and is part of the International Biosphere Reserve "Eastern Carpathians". More than half of the floristic and phytocoenotic richness of Uzhansky NNP is concentrated in meadow phytocenoses, including 19 rare species listed in Red Data Book of Ukraine (Red Data Book of Ukraine, 2009).

Grassland phytocenosises occupy only 30% of the total area of national park. These phytocenoses, resulting from centuries of human activities and their existence depends on systematic management and in its absence require active protection. In most cases in areas where economic activity stopped one can see the process of spontaneous succession, leading to depletion of floristic richness of plant communities, meadows overgrowing the trees and bushes, transforming them into bushes. To stop or slow down the succession of changes and to preserve rare meadow species active measures should be taken to protect meadow plant communities.

Groups of mountain meadows occupy the highest position of mountain ranges. To slow down the succession changes and to protect rare phytocoenotic fund of plain valleys, a regular mowing with the intensity of 1 in every 3 - 5 years from July 15 to the end of September should be carried out in the places of concentration of rare species.

Mesophilic meadows and pastures are the most common in the Uzhansky NNP, here are included all forest meadows and meadows near the territory of the village, used as hayfields and pastures. For data protection of plant communities it’s proposed to conduct an annual mowing, clearing of trees and shrubs.

Hydrophilic grasslands are common on moist soils, mainly in the valleys of mountain streams. For their protection it is necessary to carry out one mowing every 3 years, clearing of trees and shrubs.

Phytocenoses of *Sphagnum* and *Eriophorum vaginatum* belong to strongly humidified groups. For their protection it’s necessary to provide the hydrological regime.

In the Uzhansky NNP there was set up a permanent test area for conducting long-term monitoring to study succession of changes, determining the intensity of overgrown trees and shrubs bow.

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Effect of experimental warming and nitrogen deposition on alpine grassland ecosystem in the Low Tatra Mts., Slovakia

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Grassland ecosystem responses to interacting global changes differed greatly from simple combinations of single factor responses, what confirms the importance of a multifactor experimental approach to understanding ecosystem responses to global change. However, there are few studies of temperature (T) and nitrogen (N) interactive effect on alpine grassland ecosystems and the main findings and hypotheses come mainly from the case studies in arctic tundra. Warming can exert a complex effect on microbial activity, nutrient availability and net ecosystem production (NEP). Increased N deposition can further contribute to a complex interaction among ecosystem processes leading to many discrepancies in ecosystem responses and uncertain contribution to C sequestration. We present here a new research project located in the alpine grassland ecosystem in the Low Tatra Mts, Slovakia. The studied effects are simulated by using of open top chambers and N fertilization in the field conditions. We would like to enrich the knowledge of warming and N deposition effects on key components of NEP including net primary production, litter decomposition rates, soil N availability, as well as individual plant species response and impact on vegetation structure. All project activities and preliminary results are presented on the poster.

ORAL PRESENTATIONS

Physical and chemical parameters of water springs in the immediate vicinity of the fertilized soils in the spruce stands on experimental plots in the Beskid Śląski and Żywiecki Mts.

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The study of water springs was conducted in the period from September 2008 to October 2011 in five sampling series for each sampling point (in spring 2008 and in spring and autumn 2009 and 2011). The analyses were carried out in six springs located in the immediate vicinity of the experimental plots where, in autumn 2008, full-surface mineral fertilization with dolomite, serpentinite and magnesite had been performed. Because of differences in bedrock lithology, conditioned by the geological structure of the study area, the experimental plots were set up within two nappes of the flysch Carpathians: the Magura Nappe (Ujsoły Forest District, Ujsoły Forest Division), with thin-bedded sandstone with a share of clayey shale and inclusions of the Łącko Marls, producing loamy rock-mantle with meso-/eutrophic soil, more buffered and more resistant to chemical degradation; and the Silesian Nappe (Wisła Forest District, Wisła Forest Division) in the Barania Góra massif, composed of the Lower Istebna Beds with thick-bedded sandstones and conglomerates, producing sandy and clayey rock-mantle with oligotrophic soils, susceptible to chemical degradation.

In both areas, three springs were selected, from which water samples were taken on seven dates. The water samples underwent laboratory analyses that included the measurement of pH, conductivity, the concentrations of ions: Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, NO^{3-}, SO_4^{2-}, and the total concentration of selected metals: Al, Fe, Mn, Zn, Ni.

Next, for the results obtained, the basic statistics were calculated and the values of particular parameters of water springs were compared between both study areas for each sampling period, before (autumn 2008) and after the application of fertilizers (spring and autumn 2009, 2010, 2011).

The analysis of selected physico-chemical parameters of water from the springs located in the Wisła Forest District indicates a slight increase in pH and base cations between the period of fertilizer application (autumn 2008) and the beginning and the end of the growing season. A significant increase in the concentration of chloride, nitrate, sulphate and zinc was observed, especially after the spring thaw. Similar values and trends were recorded previously in other regions of the Beskid Śląski Mts. (Małek, Gawęda 2006; Astel et al. 2008; Małek, Krakowian 2009a, b, Małek et al. 2009).

Higher values of all analyzed parameters of spring waters (especially base cations and nitrate) in the vicinity of the experimental plots at Ujsoły, compared to the waters near the experimental plots in Wisła, reflect a richer habitat and an accelerated pace of fertilizers and organic matter mineralization (Małek et al. 2008). The analysis of selected physico-chemical parameters of water from the springs located in the Ujsoły Forest District indicates a slight increase in pH as well as chloride, magnesium and potassium content between the period of fertilizer application (autumn 2008) and the beginning and the end of the growing season in subsequent years. A significant increase in the concentration of nitrate in the spring water in this area was observed, especially after the spring thaw. This is probably related to the accumulation of this anion in the snowfall. The concentration of sulphate, calcium, sodium and iron increased significantly between the beginning and the end of the growing season, which should be attributed to the application of fertilizers that contain these metals. No presence of nickel was noted in the spring waters.

In accordance with the Regulation of the Minister of the Environment of 20 August 2008 concerning the classification of the condition of uniform parts of surface waters (Journal of Laws No. 162, item 1008), the limit values for nitrate content in the studied waters flowing from the older stands in both locations were exceeded, especially in the autumn of 2010 and 2011 in three springs: No. 52, 55 and 1, which should be attributed to an intensive process of nitrification, which occurs in the upper levels of soil.

Excessive concentrations of nitrate in the spring waters are associated with pollution present in the snow cover. This is suggested by the lack of dependency of occurrence of the excessive concentrations of this ion on any of the studied characteristics of the environment, including altitude and the plant cover. This phenomenon has been similarly explained by other authors (cf. Humnicki, 2007 and the literature cited therein). By analyzing nitrate concentrations in 2009 in air monitoring stations in Żywiec, Bielsko Biała and in the stations of the Upper Silesian Industrial Region (http://stacje.katowice.pios.gov.pl), from where pollution also reaches the Beskid Śląski Mountains, it can be observed that they exceed their permissible concentration by several times (30 $\mu g/m^3$) in the winter until the end of April. A significant influx of nitrogen into the Beskid Śląski region was also noted by Małek and Astel (2007, 2008). Moreover, as explained by Astel et al. (2008), the early vegetation period is marked by intense outflow of nitrate from the basin, which subsequently decreases due to the nitrate uptake by plants.

Acknowledgement

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Some insights into present evolution of river morphology - case study of braided and mixed bedrock-alluvial river

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The present time is characterized by impacts of climate change on natural landscapes as well as on human activities. Increasing magnitude and frequency of flood events results in morphological and morphodynamic changes of river channels. It is a challenge for the fluvial geomorphology to highlight the morphological response to these events, because the knowledge of the morphological-sedimentological attributes of the river channel is the first step in pursue of a comprehensive knowledge of the riverine landscape and impact on its sustainable development. Research of the spatial variability of landforms and the regime of processes creates an appropriate template for other sciences interested in the riverine as well as terrestrial systems. Research of braided rivers in fluvial geomorphology, particularly the partial themes of interaction between the channel morphology, water flow-stage, sediment transport, bar evolution and vegetation in braided rivers are frequent in specialised literature. These issues can be successfully investigated by a suitable selection of methods for the comprehensive exploration of the multi-thread river patterns. The non-channelized Belá River (23,6 km in total length) begins at the confluence of two mountainous streams (244 km^2 of catchment area with very asymmetric river network, average annual discharge 6.8 m^3 s^{-1} at mouth, Strahler ord. 4) and is situated in the northern part of central Slovakia in the Liptov Basin. It has a gravel bed and braided to wandering planform and it is characterized by a laterally unconfined setting and dynamic behaviour. Data evaluated by the historical maps and aerial photos (1837–2009 in nine time horizons) from the comparable discharge conditions have been used for the analysis of the lateral channel activity and channel landform changes (evolution of bars and islands) in the ArcGIS. The research concentrates on the evolution of contemporary erodible corridor area, braiding index and node density changes of the flow divergence and convergence, heterogeneity of cross-section parameters, bar sediment and vegetation variability. Erodible river corridor area, where the maximum and minimum values were observed in 1823 and 1992 respectively, was measured in the study river reach. A decreasing trend in nine time horizons was identified. Braiding index and node density defined as a number of flow convergences and divergences were computed for the same river reach. Thirteen non-stable cross-sections were established for the whole study area. Attention was paid to analyses of the braidplain width, number of bars and channels and the bar and channel width along them. All minimum values were reached in 1973 what points to the stagnation of flood events. Sediment sampling has been conducted across the lateral and longitudinal bar cross-section for a detailed analysis of this type of channel landform. Effects of the riparian vegetation succession phases on channel evolution were verified with mostly negative regressive reaction. The question about the evolution trend in future remains open, but it should be expected that the Belá River would convert from a very wide braided channel to an incised sinuous channel. This comprehensive approach provides the opportunity for a much better understanding of the interaction between the dynamic of landform changes, processes, forms and evolution of the river system. A consistent research of the local behaviour and global features may enlighten the variability of the channel morphology in selected river reaches in the past and the present.

Another example of our study is the analysis of channel pattern changes of the 72.5 km long segment of the Topľa River (115 km in total length, 1506 km^2 of catchment area, average annual discharge 8.08 m^3 s^{-1} at mouth, Strahler ord. 4-7) as a relatively little channelized and laterally partly confined, mixed bedrock-alluvial, cobble/gravel-bed river with flysch geology situated in the north-eastern

Slovakia. Three time horizons of the remote sensing imagery (1987, 2002 and 2009) have been analysed using GIS, with the reference time horizon of 1987. The analysis consists of identification and delimitation of an active channel bank line and the delimitation of the channel bars in the mentioned series of imageries. The active channel width, area of channel bars, lateral channel shift and area stricken by bank erosion were studied via overlaying layers. The last attribute showed a significant increase: during the 1987-2002 period 32.6 ha of floodplain area was eroded, whereas during the following period (2002-2009) of frequent and intensive floods up to 70.0 ha was eroded. Likewise, the maximum channel shift was 260 m and 443 m in 1987-2002 and 2002-2009 periods, respectively. The key results are not only the values of these parameters, but mostly their spatial distribution, which corresponds to the distribution of the geomorphological processes. The study reach has a piedmont character where these processes increase in the longitudinal direction, reach a morphodynamic apex and decrease further downstream. This river segment is represented by the presence of gravel bars and flow bifurcation, thus the river tends to be braided, but it does not reach it due to the insufficient slope. The contemporary flood events elongated this hyperactive segment delivering excessive sediment loads downstream. On the river reach level, the spatial distribution of increased processes is constricted by the tectonic and structural predispositions, which control them.
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Without data to knowledge?, without knowledge to practice: poor effects of the 20th-century management of Polish Carpathian rivers

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At the turn of the 20th century, Carpathian tributaries to the Vistula River, overloaded with sediment delivered from their deforested and intensively cultivated and grazed catchments, were typified by significant lateral instability. Carried out from the 1900s to the 1930s, channelization works focused on middle and lower river courses and resulted in narrowing and straightening of the channels. The artificially-induced increase in transport capacity of the rivers caused slow bed degradation that was stopped or even reversed if bank-reinforcement structures were destroyed (Wyżga, 2001). Channelization works on the Carpathian tributaries to the Vistula were resumed in the 1950s and continued in the following decades, especially in the upper and middle course of the rivers. The channels were straightened and significantly narrowed; multi-thread reaches were eliminated and replaced with artificial, single-thread channels. This phase of channelization works resulted in rapid bed degradation in the rivers; over the entire 20th century, Carpathian tributaries to the Vistula incised by 1.5-4 m and the incision has considerably increased the flow capacity of their channels (Wyżga, 2001, 2008). In many reaches, the whole thickness of alluvium was dissected transforming the alluvial channels into bedrock ones.
The loss of vertical stability of Carpathian tributaries to the Vistula, accompanying their channelization, was a consequence of errors in designing the channel regulation schemes and later river mismanagement. The Meyer-Peter and Müller formula for bedload transport was used to calculate the dimensions of stable regulated channels; however, the applicability of the formula for

the Carpathian rivers had not been verified with field measurements (Wyżga, 2001). Changes in channel morphology caused by the channelization considerably increased transport capacity of the rivers (Wyżga, 2001, 2008) and the increase was concomitant with a decrease in sediment supply to the rivers. The latter change was clearly reflected in textural changes of channel sediments: decline in the formation of loosely packed gravels in favour of openwork gravels, an increase in mean grain size of bed material and development of bed armour (Wyżga, 2001, 2008). The reduction in sediment supply to Carpathian tributaries to the Vistula was forced by land use changes, with a considerable proportion of arable land in the catchments turned into pasture and meadows or afforested, and was further strengthened by direct human impacts on the rivers such as limiting bank erosion due to stabilization of channel planform or river partitioning with check-dams and dam reservoirs. Finally, a deficit of material available for fluvial transport was aggravated by large-scale gravel mining from river channels. For example, the amount of bed material removed over two decades from the middle and lower Wisłoka channel was so high that it could only be replenished by natural transport from upstream in about 500 years (Wyżga, 2008). All these factors have not been taken into account during the design of channelization schemes on the rivers.

Channelization and subsequent incision of Carpathian tributaries to the Vistula had several adverse effects. Straightening of the river channels shortened travel time of flood waves and the retention of flood water in floodplain areas was reduced following enlargement of the channels; both effects have led to increased flood risk in lower river courses (Wyżga, 1997, 2008). Decreased heterogeneity of riverine habitats, often associated with the loss of longitudinal connectivity of the river ecosystems, results in a deterioration of hydromorphological river quality, a decrease in the abundance and diversity of fish fauna and lowering of the taxonomic diversity of benthic invertebrate communities (Wyżga et al., 2011). Under the pretext of flood protection of floodplain areas, channelization works are still being undertaken on Carpathian streams and rivers in unchanged manner and at the same time, restoration projects are rare. In this situation, achieving the good ecological status/potential of Carpathian rivers, required by the Water Framework Directive is unlikely.

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How to get environmentally meaningful results from hydromorphological assessment of rivers?

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The last two decades brought a recognition that river health depends on both water and hydromorphological quality. As various human impacts substantially alter physical habitat conditions and thus riverine ecosystems, several methods were developed for the assessment of river hydromorphological quality. Elements of the physical structure of the river ecosystems that are evaluated range from river channel and floodplain features to watercourse connectivity and potential for biota migration, water flow and sediment transport as well as modifications of the flow regime. Majority of these features require in-the-field assessment which is time consuming and requires involvement of expert staff.

The recently published European Standard EN-15843 (CEN, 2010) provides a methodology for quantitative, faster and presumably more cost-effective map-based assessment performed by trained staff but without geomorphological background. It seems, however, that expertise in fluvial geomorphology is indispensable at least at the preliminary stage of defining reference conditions for the physical structure of the river ecosystems, a key point for further appropriate assessment of the degree of modification. Next, solely relating deviation from reference state to the percentage or length of modified feature in a reach yields clear numerical results, but entirely neglects the degree of modification. As such, it does not recognize the existence of partially modified reaches where fluvial processes typical of undisturbed ecosystem are still operating as the modification of the hydromorphology was not complete. Such a situation is common in mountain rivers with formerly extensive braided channels, which were narrowed but not altogether eliminated, it can also be exemplified for a range of assessed features (banks, riparian zones etc.). Moreover, with the growing complexity of the assessed system and its features, the degree of generalisation forced by this new approach rises so as to produce quantitative yet environmentally meaningless results. For the purpose of river restoration projects, hydromorphological quality assessment should not merely reflect the status of the physical habitat but also indicate which of its features need improvement in the context of other, interdependent features of that particular dynamic ecosystem.

An alternative assessment approach (Wyżga et al., 2010), based on the European Standard EN-14614 (CEN, 2004), was applied to the Biała River, Polish Carpathians. Based on the expert assessment, we determined the hydromorphological quality of the river in 10 representative pairs of unmanaged and channelized cross-sections located between significant tributaries. The rationale behind the choice of the area was to determine the hydromorphological state of the river at the beginning of a restoration project and to identify the features most needing improvement. For each cross-section, 10 groups of features of the channel, river banks, riparian zone and floodplain were assessed, according to the specification in the European Standard EN-14614 (CEN, 2004). Since considerable land use changes that occurred in the Biała catchment over the last century preclude the use of historical river state as reference, it was defined as the state that would exist under present environmental conditions in the catchment but without human influence on the channel, riparian zone and floodplain of the river (cf.

Wyżga et al., 2009). The assessment was performed by a group of river science experts (in hydrobiology, fluvial geomorphology and hydraulic engineering) and was preceded by a field survey and preliminary discussion based on the data on the present state and historical changes of the assessed features in particular cross-sections. Ground photos and orthophotos alongside with maps and morphological profile for each cross-section were used and extreme states (near-natural and entirely modified) for all assessed features were indicated, with the remaining spectrum left for expert opinion. Each specialist performed the evaluation independently and expert scores were later averaged for each cross-section and calculated as a mean of the scores for 10 assessed categories. The final, aggregated scores were then divided into classes of hydromorphological quality.

Statistically significant differences were found between the unmanaged and channelized cross-sections both in the overall hydromorphological quality and its particular categories. Salient differences between both types of river cross-sections related to changes in channel geometry and flow hydraulics, the presence of erosional and depositional features in the channel, bank structure, vegetation in riparian zone and the degree of lateral connectivity and channel mobility. Differences in habitat quality resulting from characteristics of bed substrate, in-river vegetation and organic debris, and modifications to longitudinal river continuity were reasonably low but still significant. In general, the unmanaged cross-sections obtained scores between 1.36 and 2.14, and with the mean of 1.85 were classified into Class 2 of hydromorphological quality. The lowered quality mostly reflected depletion of vegetated islands and woody debris and modified land use structure on the floodplain. Channelized cross-sections were scored between 2.90 and 3.55, falling into Class 3 (mean score: 3.18). Degradation of hydromorphological quality in the channelized cross-sections mostly reflected constraints on lateral channel mobility, disruption of lateral connectivity of river and floodplain, and modifications to channel geometry, bank structure and land use in the river corridor.

The method exemplified above uses information from a range of sources and requires involvement of a number of experts, which may be time-consuming, expensive and fairly difficult in terms of organisation, if the assessment is to be performed on a basin-scale. However, the method also provides reliable and environmentally meaningful results, facilitating precise identification of the ecosystem features that need to be improved. As such, the method can effectively support restoration projects whereas the methodology suggested by the new European Standard EN-15843 may be more time- and cost-effective way of generating simplified reports on the river integrity on a national scale.

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Monitoring system for torrent-control hydrotechnical structures

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Increasing the availability and quality of water resources and their sustainable use in the EU countries are some of the objectives of the Water Framework Directive (adopted by the European Commission in 2000). Romania, joining that Directive, adopted the National Flood Risk Management Strategy at the end of 2005, modified in 2010, with one of purposes being the investigation of the operating capacities of torrent-control structures.
During the period 2008-2011 an extensive research regarding the behaviour of the torrent-control structures used for catchment management in Romania was carried out. The research was part of the project GEDEFOR (Sustainable Management of Forest Ecosystems in the Context of Global Environmental Change) funded by the Romanian Ministry of Education, Research, Youth and Sports.
Parts of the project were an inventory of 3854 torrent-control structures (located on both sides of the Carpathian chain) and the substantiation of a ranking system for these hydrotechnical works according to their condition. For physical inventory, forms have been prepared containing identification data, geographical location (longitude, latitude) and the description of damages incurred in their exploitation. All structural damages were assessed and categorized for all the construction parts (body, apron, abutments, and cut off wall).
There were defined 23 damage types for the dams and 14 for the drain channels. All behavioural events reported were aggregated and statistically analyzed, with the notice that some of them (12 of dam's damages and 6 channel's damages) are rare events according to the Poisson distribution law.
A methodology for establishing a condition rate (Ys) for all the torrent-control structures was substantiated considering only the events with a significant occurrence frequency, using multi-criteria analysis. Introducing the damage measurements in a simple software, a computer returns the value of this parameter, giving a score for each structure (from 0 for a destroyed structure to 100 for a structure in a very good condition, with no significant damage).
By extending this methodology to the whole torrent-control system, anyone using it is able to quickly establish the repair order of particular structures or the addition of new ones to the system (where applicable), in order to avoid endangering the human and material objectives protected by them. To solve this point, the values of the condition rate are included in five classes, appropriate to the repair order:

- very bad condition (code red) $Ys \leq 20$;
- bad condition (code orange) $20 < Ys \leq 40$;
- average condition (code yellow) $40 < Ys \leq 60$;
- good condition60– $< Ys \leq 80$;
- very good condition$Ys > 80$.

Field personnel in charge of surveying the behaviour of the torrent-control structures, by filing a simple paper form and placing data in an electronic form, can establish the intervention order for each valley, without consultation of catchment management specialists.
All collected data are stored on a server that allows, through a GIS application, to use the monitoring system at different decision-making levels (local, county, regional and national). At each level, priorities of intervention for larger areas may be established. The data system defines three types of users depending on the access level needed (reader, editor or administrator).

The information system contains linked tables, some with spatial reference (unique code of the structure, geographical location and water divides of the catchments), and others that store descriptive information of the structure (general data, damages incurred, etc.).
Stored data are shown using a web mapping application, which allows overlapping data on WMS type services provided free (Google, Bing, OpenStreetMap, etc.).
The information system uses simple menus (Navigations, Info, Info and Actions WMS) that allow an optimal exploitation of stored data, depending on the user type and desired reports.
The designed system ensures the uniqueness of collected data, eliminating human errors resulting from the data collection by many researchers. It uses multiple base maps, depending on the availability and needs of the beneficiary. It works using any operating system (Windows, Linux etc.) and any Internet browser (Bing, Firefox etc.).
The paper provides an overview of the whole monitoring system for torrent-control hydrotechnical structures. Due to its simplicity, the system is addressed to a wide range of users, managing to meet all levels of decision-making. It offers a modern tool for surveying structures that protect a wide range of social and economic objectives in the Carpathian area.

POSTER PRESENTATIONS

Multifaceted approach of the state of shallow karstic lakes on the Aggtelek and Slovak karst (Hungary-Slovakia)

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Monitoring of some karstic lakes in the area of the Aggtelek and Slovak karst (Hungary-Slovakia) has shown that these shallow lakes are considerably influenced by anthropogenic activity and climate extremes. The aim of the study is to show the effects of weather events on water quality and quantity as well as to evaluate the efficiency of the rehabilitation project which was carried out on Lake Aggteleki since its nearly complete filling in the early 2000s. Water quality and changes in the state of the karstic lakes were monitored between 2008 and 2010 to determine the causes of accelerated eutrophication affecting these lakes in the last decades. Various contamination sources and the climatic effects play prominent roles in this process, the latter showing greater influence during the extreme events over the last few years. This paper attempts to determine, with drought indices, how climate affects water quality and quantity of the lakes.
The amount of precipitation decreased after 1980 when compared with the previous years, and according to the Standard Precipitation Index (SPI, McKee et al. 1993), the number of drought periods was also higher than the number of wet periods.
A strong, significant correlation was found between water quality parameters and various drought indices, which affect them in different ways depending on the state and position of the lake. In the case of a more significant inflow or a larger catchment area with more rainfall, concentration of inorganic components (eg. NO_3^-) is higher, while organic pollution becomes diluted (eg. KOI_{ps}, NH_4^+) and the trophy and saprobity degree tends to be lower (Lakes Aggteleki, Kender, Vörös). Most of the

investigated parameters (eg. KOI_{ps}, NO_2^-, NH_4^+, Ca^{2+}, hardness, transparency) are correlated with medium duration SPI indices (6-12 months) implying that this time interval is very significant for these water bodies. In the case of Lake Aggteleki, almost all major changes in ion concentration are related to this time interval. Especially, the values of the parameters for Lake Tengerszem are correlated with the shorter-term indices as this lake has the most constant inflow. Except for Lake Farárova jama, Cl^- concentration remains constant. As the changes in the amount of Cl^- are very slow, it was correlated with the 25-month SPI. Being temperature-dependent, dissolved oxygen and oxygen saturation were correlated only with those drought indices that also include temperature. There were some parameters that correlated only with the SPI (thus the shorter- or longer-term rainfall conditions). These include PO_4^{3-}, Mn, transparency, hardness, K^+, HCO_3^- and chlorophyll-a. Other parameters showed connections in both cases. Therefore temperature changes had a greater impact on the first group of variables, while the second group was equally affected by the rainfall amount and by temperature, and rainfall had greater influence on the third group. Since most water chemistry parameters are affected by extreme weather events, their increasing frequency could cause sudden extreme changes in water quality and quantity triggering irreversible changes in the case of these shallow and unstable lakes (Samu, Bárány-Kevei 2010).

Based on a larger-scale perspective, both positive and negative extreme values of water quality parameters can be associated with weak or breaking-up warm fronts passing over the region. On the contrary, the role of anticyclones or anticyclone ridge weather situations is supposed to be irrelevant. According to the average ranks of importance of the meteorological variables in determining the water quality, temperature and relative humidity are the most significant, while air pressure and global solar flux are the least relevant.

Our studies indicate that the rehabilitation project of Lake Aggteleki has not been effective and further analysis is now being undertaken to improve rehabilitation project designs for that lake. Bayesian Networks, increasingly often used tools in analysing complex systems like ecosystems, may be used for that purpose. Their advantage is that causal connections can be defined with conditional probabilities, therefore anthropogenic effects can be incorporated easily, and expert knowledge can be used in the modelling process. Consequently, measured data is not needed for every part of the model but only for the model validation.

Our model demonstrates what would be the costs of a treatment which is aimed to protect the lake from the external load and costs of an appropriately implemented rehabilitation project. The model incorporates the factors of the eutrophication, including human activity and the extreme weather events.

With the help of sensitivity analysis (an in-built tool of the software), we can analyse the effects of each variable on the final result or on any chosen variable, and check the suitability of the model structure (which has special importance in the case of networks defined based on expert knowledge).

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Identification of basins prone to flash flood generation in the context of flood risk management: example of the Ciężkowice Foothills area (Outer Flysch Carpathians).

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European Flood Directive requires all Member States to identify catchments at the risk of flooding. Usually, hydro-meteorological data and historical information about flooding are used for evaluation whether a catchment is at the risk of flooding or not. Such information is missing for many small catchments suffering from flash flooding. In this study, 83 Carpathian basins, where flash floods occurred, were investigated in the context of transformation of rainfall into outflow. The CN parameter allowed to evaluate transformation of rainfall into excess rainfall, whereas GIUH model enabled to assess a reaction to excess rainfall. Results revealed that basins studied had a high value of CN parameter (on average 82.8), what indicates that almost all volume of precipitation is transformed into excess rainfall (overland flow). Furthermore, quick transformation of the excess rainfall to outflow was typical of the catchments. Average values of 1 mm excess rainfall unit hydrograph amounted to: tp = 2.6 h, tb = 9.8 h, Qmax = 0.9 $m^3 \cdot s^{-1}$. Cluster analyses, in which a hydrological response of the basins was studied, indicated that the basins were similar in terms of transformation of rainfall into outflow. The results showed that if a certain type of catchment is affected by heavy rainstorms, then there is a high probability that flash floods occur. Therefore, types of the catchments prone to flash flood generation were distinguished (Table 1). The types differ in terms of rainfall/outflow transformation as well as catchment reaction to excess rainfall. Basins included in Type A are the most prone to flash flood generation, contrary to basins classified in Type C. Minimum and maximum values of the parameters considered (Table 1) led to the identification of 22 natural basins in the Ciężkowickie Foothills area, that fitted the distinguished types. Investigations have confirmed that the catchments identified had been previously affected by flash flooding what may suggest that the identification method will be a valuable tool in flood risk management in the region. In those catchments, flood hazard maps should be successively prepared and local development plans should contain information about the spatial distribution of inundated areas.

Table 1. Types of basins prone to flash flood generation

Types	$\bar{x}$	x_{min}	x_{max}	$\bar{x}$	x_{min}	x_{max}	$\bar{x}$	x_{min}	x_{max}	$\bar{x}$	x_{min}	x_{max}	$\bar{x}$	x_{min}	x_{max}
	CN [-]			tp [h]			tb [h]			Qmax [$m^3 \cdot s^{-1}$]			q max [$m^3 \cdot s^{-1} \cdot km^2$]		
A	83.9	81.6	87.9	1.8	0.9	3.0	7.1	3.6	11.0	0.8	0.3	1.1	0.09	0.05	0.15
B	82.5	80.3	86.2	2.8	2.0	4.5	11.1	7.7	17.6	0.6	0.3	1.0	0.05	0.03	0.07
C	77.3	75.7	78.2	4.0	3.2	4.7	15.2	13.4	17.9	0.7	0.5	1.0	0.04	0.03	0.04
D	80.3	76.5	82.3	2.7	1.7	3.5	10.1	6.3	13.3	1.5	1.1	2.1	0.06	0.04	0.09

Source: This study.

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Appraisal of the ecological state of a mountain river based on pre- and post-flood data

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Assessment of the ecological status of rivers is key to monitoring the achievement of the environmental goal of the EU Water Framework Directive and the success of restoration projects. However, the results of assessment surveys may reflect the occurrence of extreme flow conditions, such as floods or droughts, and their effect on the river's ecological status. In 2009 and 2010, repeated assessments of the physical habitat conditions and fish and benthic invertebrate communities were performed in 10 unmanaged and 10 channelized cross-sections of the Biała River, Polish Carpathians, as an initial inventory for a restoration project aimed at delineation of an erodible river corridor. Between the two assessment surveys, an extreme flood event with a recurrence interval of at least tens of years occurred, significantly changing both habitat characteristics and river biocenoses. In unmanaged cross-sections, active channel width increased, whereas the degree of cross-sectional variation of flow velocity decreased. In channelized cross-sections, the increase in active channel width and the cross-sectional variation of flow velocity was accompanied by a decrease in mean grain-size of bed material. Prior to the flood, unmanaged cross-sections hosted three times more benthic invertebrate taxa than the channelized ones, whereas after the flood, the number of taxa was reduced to such a low level that both types of cross-sections became similar in terms of the taxonomic richness of benthic invertebrate communities. In comparison to pre-flood conditions, the abundance of fish juveniles in unmanaged cross-sections was reduced nearly by half; before the flood they hosted 5 times more juvenile individuals than channelized cross-sections and only twice as many after the flood. These differences indicate that assessment carried out prior or after a large flood event may yield significantly different results for the quality of abiotic and biotic elements of the ecological status of a river. This can seriously affect the appraisal of measures aimed at improving river health or the success of particular restoration projects. Therefore, it seems vital that the final assessment be based on repeated surveys of abiotic and biotic elements of the river ecological status to balance the effect of single, extreme hydrological events.

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Hydrodynamic parameters in the vicinity of large woody debris accumulation: an example from the Raba River, Polish Carpathians

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The poster presents research on chosen hydrodynamic parameters in the vicinity of large woody debris accumulation formed in the lowermost section of the Raba River (the tributary to the Vistula River). The large woody debris was deposited in the middle of the river channel after a spring flood and was composed of several tree trunks. Additionally, in the study we show and analyze changes of hydrodynamic parameters downstream and upstream of obstruction gravel bars, which were formed in connection with the accumulation of woody debris. Here, velocities measured (mean velocities were between 0.005 and 0.564 m s^{-1}) in the field allowed to calculate shear velocities (between 0.0005 and 0.049 m s^{-1}), shear stresses (between 0.0002 and 2.447 N m^{-2}) and other hydrodynamic parameters, which are characteristic of the observed phenomenon. The results show that the accumulation of large woody debris on the river bed strongly influenced initiation and further development of two channel bars and changes in the hydrodynamic parameters within the study reach.

ORAL PRESENTATIONS

DPSIR indicators of the Beskydy forest landscape as a tool for the Data-Knowledge-Action cycle

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Introduction. The DPSIR can be defined as a "causal framework for describing the interactions between society and the environment". Social and economic developments (Driving Forces, D) exert Pressures (P) on the environment and, as a consequence, the State (S) of the environment changes. This leads to Impacts (I) on ecosystems, human health, and society, which may elicit a societal Response (R) that feeds back on Driving Forces, on State or on Impacts via various mitigation, adaptation or curative actions (Smeets and Weterings, 1999).

The DPSIR framework could be described and partially quantified by using various types of indicators. Environmental indicators are indicators that report on the natural environment in the widest possible sense. They typically include physical, biological and chemical indicators and generally comprise indicators of environmental pressures, conditions and (societal) responses. Ecological indicators are sometimes distinguished to differentiate between changes in physical or chemical attributes or composition within an ecosystem and the biological processes and components that are affected (Seják et al., 2010). Agri-environmental indicators measure of a key environmental condition, risk or change resulting from agriculture, forestry or of management practices used by producers (Dale, Polasky, 2007). DPSIR framework is concerned usually with environmental indicators in their widest sense (Niemeier and de Groot, 2008).

According to some opinions, the DPSIR framework is considered to be a relevant tool for structuring communication between scientists and stakeholders, while it is inappropriate as an analytical tool (Maxim et al., 2009). Therefore Niemeier and de Groot (2008) suggested that a causal network, rather than a causal chain, could be a more appropriate concept to effectively deal with the complexity of real world interactions.

The similar framework has been developed by Global Land Project activity, having main objectives i) to identify the agents, structures and nature of change in coupled human-environment systems of land, and to quantify their effects on coupled system and ii) to assess how the provision of ecosystem services is affected by these changes (GLP, 2005).

Methods. The aim of this contribution is to propose and verify a system of environmental indicators which can be used for describing and explaining the present situation concerning the effects of increased demand for forest ecosystem service use on the example of Moravsko-Slezské Beskydy Mts. (Protected Landscape Area). A combination of classification in terms of subject/issue with classification in terms of the position along the causal chain/network was used as a one of the most effective form of indicator reporting.

Our procedure consisted of following steps:

1) To write out a list of the most important social-economic and environmental problems in the studied area, caused by high level of various driving forces upon landscape exploitation.
2) To propose the wide list of indicators of the most important environmental issues along the causal chain (Driving Force – Pressure – Stress – Impact – Response).
3) To select the most effective indicators, filling "indicator selection criteria" according to Dale and Polasky (2007).
4) To quantify selected indicators under present environmental conditions of the Protected Landscape Area Moravsko-Slezské Beskydy Mts., preferably in time rows.
5) To evaluate the equilibrium between past and present Driving Forces and Pressures, arising from the need of human society to exploit this territory, the capacity of its ecosystems (State and Impact) and effectiveness of compensation measures (Response), realized in last years.

Results and Discussion. More or less specific indicators were selected to characterize the most actual situation in the framework DPSIR in the Moravsko-Slezské Beskydy Mts. Afterwards, the most effective indicators were selected for all links of a few of the causal chain (Driving Force – Pressure – Stress – Impact – Response).

For example the following specific indicators of forest ecosystem responses (elaborated more in detail) to exceeding of the pressure of human exploitation were chosen for quantification:

Driving forces of society

- Demand for wood
- Demand for drinking water
- Demand for recreation
- Associated human activities in the studied area

Human activity pressure

- Long distance atmospheric pollution
- Water pollution
- Tourist facilities rise

Ecosystem state and response to impacts

- Fragmentation of forest cover: area of undivided forest stand [ha]
- Percentage of dead trees [ha]
- Canopy cover reduction by sanitary cutting [%]
- Stem increment reduction [%]
- Crown retrospective damage: defoliation of primary structure [%]
- Crown regeneration: percentage of secondary shoots [%]
- Mycorrhizal species reduction [%]
- Mycorrhiza development (5 phases) and vitality decrease (3 classes) [%]
- Root regeneration change [%]
- Soil solution toxicity: ratio of Al concentration to BC concentration
- Plant species diversity reduction [%]

Society response to deteriorated environmental conditions

- Atmospheric pollution decrease (Kjoto protocol)
- Stricter hygienic regulations
- Regulation of "hard tourism"
- Stricter nature protection (creation of areas without any management)
- Forest restoration measures

On the basis of results obtained, the equilibrium between past and present pressures for this territory exploitation, the capacity of its ecosystems and effectiveness of compensation measures was considered. These results could enable more relevant discussions between scientists, National Protection authorities and remaining stakeholders (landowners, state administration, municipality, resident population, recreational visitors, hunters and fishers) in this territory.

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SEBI (Streamlining European Biodiversity Indicators) initiative A Pan European example on how the knowledge can be used to support policy on Biodiversity and Ecosystems

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Following the 2004 decision of the Convention of Biological Diversity, the council of the Pan European Biological and Landscape Diversity Strategy (PEBLDS) and the EU Environment Council decided of the urgency to develop a set of common biodiversisity indicators in the context of the 2010 target. A process called SEBI -Streamlining European Biodiversity Indicators was implemented in order to streamline definition and developement of indicators along the different European scales and to help the countries as well. Framed in the new context of 2020 targets adopted in Nagoya through the CBD COP decisions X/2 on Aïchi targets and X/30 on Mountain biological diversity, the results of this initiative will be presented.
SEBI 2010 was established in 2005 as a process to select and streamline a set of biodiversity indicators to monitor progress towards the 2010 target of halting biodiversity loss and help achieve progress towards the target.
The activities addressed by SEBI 2010 are explicitly linked to four policy contexts:
1. Global: the European biodiversity headline indicators are derived from the Convention on Biological Diversity (CBD) indicators, adopted as part of CBD decision VII/30 in 2004, and customised to European needs and data availability. SEBI 2010 works in conjunction with the 2010 Biodiversity Indicators Partnership to ensure consistency with the work on indicator development at global level.

2. Pan-European: SEBI 2010 is consistent with the action plan developed as a follow-up to the Kiev Resolution on Biodiversity and hence responds to requirements under the UNECE Environment for Europe process and the Pan-European Biological and Landscape Diversity Strategy (PEBLDS).
3. European Union: SEBI 2010 responds the EU Council Conclusions (June 2004) by developing, testing and finalising a first set of EU headline biodiversity indicators. It also underpins and ensures consistent biodiversity indicators and information required under the sustainable development strategy, the EU Habitats (92/43/EEC) and Birds (79/409/EEC) Directives and the biodiversity strategy.
4. National: many countries have also developed indicators to monitor their biodiversity. SEBI 2010 proposes indicators that may be adopted at national level if this has not yet been done. However, there is no obligation for countries to do so.
The outputs of SEBI are:

- to provide an initial set of indicators available at EU and pan-European levels
- to provide proposals and guidance on the development, production and delivery of agreed indicators;
- to provide proposals, guidance, recommendations and information for presentation to the appropriate European governance groups developing biodiversity policy for formal adoption;
- to provide information to the CBD Secretariat, advisory and governance processes on the results of the work being undertaken.
- to provide a recommendation for an approach to using the agreed indicators for measuring the progress of national governments, the EU and the pan-European community towards achieving the 2010 target;
- to provide advice on relating changes in biodiversity at EU and pan-European level to policy measures adopted at these levels, so as to help the EU and countries to adjust or strengthen the measures concerned.

We will discuss the importance of indicators as a tool, before presenting the results produced in 2010.
Indicators serve four basic functions: simplification, quantification, standardisation and communication.
They summarise complex and often disparate sets of data and thereby simplify information. Their selection should be based on logical frameworks and comparable scientific observations or statistical measures. Moreover, they should provide a clear message that can be communicated to and used by decision makers and the general public. Indicators differ from raw data and statistics in that they should relate the past, current or future state with a reference or baseline value. Reference values can be threshold values, a historical year, a target, or a particular ideal or maximum state. Reference or baseline values put indicators into context but are not yet available for all proposed indicators. However, given the target of halting biodiversity loss by 2010, the temporal trend of an indicator without a reference value can still be meaningful.
Indicators provide a link from monitoring and research to support evidence-based policy making. Scientists and policy makers select a set of relevant indicators, which reflects both scientific and societal perspectives. Policy makers set targets and measures, while scientists identify specific parameters and establish corresponding monitoring programmes, baseline values and cause-effect relationships. The current state and trends are determined from monitoring, while models of cause effect relationships provide information explaining trends, showing the effectiveness of measures and suggesting possible responses. The choice of time frames and spatial scales for monitoring and modelling is often crucial for ensuring that the indicators are relevant for policy objectives and decisions-making, and are cost-effective.
Indicator-based information must also be communicated quickly in a simple and intelligible way. In addition, a set of indicators helps to take action by providing several elements of information.
Definition of indicators dedicated to a specific area delimited by any administrative boundary or geographic conditions will be based on the same approach, the difference will be the selection of

targets and/or critical issues specific to this area, ie mountain area. And the production of indicators will rely on datasets specific to this area as well. Results of the process at several scales, use of SEBI approach and interest of the countries will be presented as well as concrete examples of use of these indicators by decision makers.

This summary was prepared by Sophie Condé, European Topic Centre on Biological Diversity MNHN on the basis of the following reports:

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Species occurrence database of Nature Conservation Agency - biodiversity documentation instrument: example of oribatid mites (Acarina, Oribatida) in Czech Carpathians

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Species occurrence database of Nature Conservation Agency (NDOP) enables gathering, validation and use of occurrence data of all organisms of the Czech Republic (and even outside of its borders). The database is originally intended as data storage and analytical instrument for the purposes of nature conservation: e.g. surveillance of the species of Community interest, mapping and documentation of occurrence of the endangered and rare species, but thank to its universal character, it serves for data collection of all species. Thank to the precise location enables - among others -also analyses of Carpathian biodiverzity in the area of Czech Republic. The location within NDOP could be punctual, linear or polygonal (e.g. municipality area or protected site). Validation process sis enabled through the role of guarantee, e.g. expert in particular group. The official validation is aimed at protected species, which is covered by internal processes within Nature Conservation Agency (expert governmental body of the Czech Republic). The validation outside of the scope of legally protected species is a issue of expert revisions.
The data are inserted via specialized application or the databases could be transformed and imported as bloc. Taxonomy, one of the crucial topics of the biodiversity research, follows newest standards and recent publications. Due to the central coordination, the database is open to sparing within groups of collaborators and also official bodies and authorities of Czech nature conservation.

NDOP consist recently of 8,3 million of records, out of it approx. 600 thousand records of legally protected species, 1,5 million those of red-listed species. Importance of non-endangered species records to the analyses of general biodiversity development is constantly growing.
As an example, the oribatid mites were selected. This group is interesting form many reasons: it is lesser known and it is a part of "invisible" species diversity (in CZ 521 species). As a group of bioindication potential and Central Europe (incl. Carpathians) is one of the centres of its research. Next to the database also its use on the example of analyses of oribatids is intended to be presented.
The records of oribatid mites include in database are based on checklists by Starý (2000a, b), all records were revised on the basis of Weigmann (2006), and the improbable or undocumented records were omitted.
Therefore recently NDOP presents also instrument to analyses of oribatid distribution in the Czech Republic. Till now (as the data processing is not finalized yet) is the Czech Carpathians (according to the Carpathian Convention) known nearly 900 records of 144 species. There are approx. 44 localities in complete Czech Carpathians (out of it: 7 in Pálava, 15 in Beskydy, 12 in Bílé Karpaty)
The overview of distribution of selected species, important or interesting form the zoogeographical or ecological point of view, is presented. The presentation will emphasize instruments and application of NDOP: the zoomable distribution maps, grid distribution maps, detailed maps and record sheets.

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Bridging the gaps among knowledge, policies and practices to link nature protection with the socio-economic development in the Ukrainian Carpathians

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Human influence on forest ecosystems of the Carpathians, during the 18-20th century, led to deforestation and forest degradation that still challenge the environment and landscape's stability. There is a tendency to decrease logging in the mountains and enhance the protection of biodiversity. However, the Carpathian forests remain threatened by poor timber harvesting practices, over-harvesting in the past, overgrazing resulting in the decline of forest sustainability. Moreover, forest use has been strongly driven by short-term financial considerations, whereas overall long-term reasoning to sustain and enlarge forest resources and services has often been overlooked.

Environmental requirements and needs of local people call for innovative practices that would put emphasis on the sustainable, multipurpose use of forests, and their integration with other land uses into an overall landscape context.
Sustainable mountain development requires policy measures and practices that would lead to a desired goal by using the best knowledge base as a foundation. However, there are gaps between policy and its implementation, between documents and existing knowledge, and between scientific knowledge and traditional local wisdom.There is a need to increase the interaction between policy making and the knowledge base, and to strengthen science-policy interface in the light of sustainability objectives. Traditional for this region land use and settlement systems, and the distinctive use of forest products are important elements of local forest related knowledge which are yet almost missed from policies and decision-making processes.
Through a series of workshops with stakeholders, and interviews we seek to comprehend how the overall knowledge can best be generated and transformed into useful guidance for policy makers and practitioners; and how to make this knowledge be efficient to make a difference on the ground. Empiric research has been done by method of expert survey. Standardized „face-to-face interview by employment place (forestry specialists); by employment or residence place (community representatives). Field data has been collected in three administrative districts, which are known by high forest cover and significant role of forestry in regional economy development. In each of respondents' categories (forestry professionals; local community representatives) 200 persons have been interviewed. Criterion for selection of experts: sufficient level of competence in the problems of study, which has been evaluated by following parameters: a) work on positions requiring special training and managing positions in state and private structures (forestry specialists); b) residence and work on the territories of local communities (district capitals, towns, villages) in the regions where the research has been made; social activity. According to respondents' answers their attitudes concerning forests and forestry, access to forest resources and the significant threats to forests identified. Analysis of the responses and its comparison with current forest policy priorities (national policy, international agreements and projects), dominated practices, and statistics on local communities' well-being allows identifying the gaps in their correspondence and building strategies towards bridging the gaps.
The way to sustainability in remote mountain areas lies through a knowledge based use and management of ecosystem services, and developing of social capital and institutional capacity building with a more active involvement of local communities in decision making and policy implementation. A policy will not be sound and well-targeted, and cannot be implemented if the stakeholders' knowledge is not embedded in it and end-users engagement is dysfunctional. A proper integration of nature protection with the socio-economic development in the Ukrainian Carpathians depends on the participation of policymakers, end-users (including local communities) and scientists holding the knowledge base. A wider knowledge-based participation will avert the observed in some localities chaotic spatial development and unsustainable management of natural resources and redirect the development towards the greening of economy and strengthening the resilience of mountain communities. This research suggests on ways to improve the dialogue between stakeholders by bringing together policy makers, scientists and people on the ground.

Identification and analysis of representative landscape types in the Slovak republic

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In October 2000 the European Landscape Convention - also known as the Florence Convention, was adopted. The Convention aims to promote landscape protection, management and planning, and to organise European co-operation on landscape issues. The paper presents the methodology for the creation and evaluation of representative landscape types of Slovakia (RLTS) and provides first results of the analysis. Considering these results the paper points out vulnerability of certain landscape types and discusses management and protection of particular RLTS.

Complex typology of the European landscape was already applied by the Dutch scientists (Meeus et al., 1990; Meeus, 1995), who identified 30 mega-types of the landscape, taking into account land form, soil and climate at one side and regional culture, habits and history on the other side. After ratification of the Florence Convention there are many attempts in Europe for the landscape typology (Bezák et al., 2010). Most of them includes similar criteria based on relief, land use or land cover, which are crucial in presented research too. Besides other partial criteria were used, like settlement structure in Czech republic (Low et al., 2005), hemeroby of cultural landscape types in Austria (Peterseil et al., 2004) or synthesis of European database about climate, relief, soils, potential vegetation and land cover (Washer et al., 2005).

Delineation of the homogeneous units/landscape types in Slovakia was based on a synthesis of two factors: morphological-morphometric parameters (type of relief, quaternary deposits, climatic regions, and soil types) and prevailing land cover (CORINE Land Cover 2006 – CLC). The GIS (Geographical Information Systems) tool created a map of homogeneous areas, which were further interpreted, generalized, and regionalized into a final map of representative landscape types of Slovakia (Lieskovský and Kočický, 2009).

The georelief, as a main abiotic factor for landscape-ecological processes, was considered as the most important abiotic factor for RLTS division (Miklós et al., 2010), which resulted in three basic categories: lowlands, basins and mountains. The mountain landscape is dominant in Slovakia, covering around 53% of the total area, while the lowlands occupy 29% and the basin landscape 18% of the total area. Within each category, sub-categories were specified: 5 (lowland), 3 (basins), 10 (mountains), which closely describe a form of relief. The land-cover categories were grouped into the 18 basic units expressing different types of land use. The defined categories of land cover were relevant in the scale of elaboration (1: 500 000). The dominant element of land cover in Slovakia is agricultural landscape with a prevalence of arable land use. Forests evaluated on the basis of prevailing species composition are also represented significantly. The third most large-scale category is the combined category of the agricultural-forest landscape. The landscape types of Slovakia were defined by the synthesis of the mentioned maps (a map of the georelief and a CLC map). In total, 126 basic landscape types were identified. In the second stage we identified rare and unique landscape types of Slovakia. Unique types include: landscape of cliff zones, volcanic landscapes, the landscapes of depressions and wetlands, the landscape system of river branches, landscapes of World Cultural and Natural Heritage sites. Rare types include: karst landscape of plateaus, the landscape of high mountains, the landscape of stratovolcanoes and the landscape with historical landscape structures.

The subsequent investigation focused on the assessment of these units from the point of view of nature protection, their recent degradation and threats, taking into account global changes in Slovakia, especially development after the Second World War. The concluding impacts of the global changes on the Slovakian landscape during the last several decades have been significant determinants of human activities. Processes like urbanisation, socialistic industrialisation and agricultural intensification impacted mainly the landscape of the lowlands and basins, with the large–area plough land (e.g. Podunajská rovina, Východoslovenská rovina, Juhoslovenská kotlina, Považské podolie). Here, environmental quality of the landscape has been decreased significantly. Furthermore closed basins in between the mountains (e.g. Zvolenská kotlina, Turčianska kotlina, Žilinská kotlina, Žiarska kotlina) are the localities of high absorption of human interventions when considering the natural limits and thresholds. The rate of natural ecosystems does not exceed 30 % of their total area. Due to underestimation of nature protection of the landscape in the lowlands and basins influence of some recent pressures persists. On the other hand, land abandonment is mainly connected to rural settlements in mountainous regions (uplands and highlands or northern Slovakia), including dispersed settlements with land use of the extensive farming-forests mosaic (e.g. Kysuce region, Nová Baňa region). Notwithstanding negative effects of abandonment on the landscape (loss of landscape diversity and biodiversity, decline of farming, etc.) the mountain landscape types possess the highest rate of natural ecosystems, environmental quality and finally nature protection status. Forest ecosystems in the mountainous territories have been stable landscape elements in the last decades, as nature protection has significant status in many locations and forestry is more or less based on constant long-term management.

Data about distribution of the RLTS and their environmental quality contributes to available tools for the regional planning policy and implementation of landscape management practises. Such information can be used as by national authorities and stakeholders (Ministry of Environment, Ministry of Agriculture, Ministry of Construction and Regional Development) as well regional and local administration and decision-makers (environmental departments of district offices, municipalities, etc.). Each landscape type represents a unique combination of land-use in different abiotic conditions and gives a unique environment for natural and cultural development. We suggest that landscape types must be considered individually in the landscape planning to achieve suitable system of their management and protection. In intensively loaded and utilised landscape types it is required to carry out revitalization measures and to prevent their further degradation (Izakovičová et al., 2009). Adaption of sensitive management measures is inevitable in the rare and unique landscape types to maintain their values for the future. We further propose to improve environmental protection status of places with natural and cultural-historical values, however falling under the landscape types with currently poor level of protection (e.g. urban landscapes, less protected vineyard landscapes, some agricultural-forest landscapes, some mixed and coniferous landscapes).

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POSTER PRESENTATIONS

Green innovations in agriculture and cultural traditions in the Ukrainian Carpathians

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Facts in brief:
- The Ukrainian Carpathians have less developed infrastructure comparing with other Carpathian countries, less integrated into the European market;
- The Ukrainian Carpathians still have more traditional life style practices and cultural heritage than mountain regions in other European countries;
- Traditional agriculture in the Carpathians, destructed during Soviet and transformation times, needs to move away from communist traditions toward reconstruction of traditional agricultural businesses, for sustainable development of the region according to the Carpathian Convention requirements;
- Destruction of the traditional agriculture is a reason of biodiversity losses: for surviving local people, for example, doing uncivilized business on fishing, forest products, not caring about nature conservation, even in protected areas;
- Destruction of traditional agriculture means loss of cultural traditions and environmental friendly life style;
- Global losses are connected with cultural problems;
- There is an urgent need to develop supporting schemes for local traditional businesses, especially in the field of agriculture, based on cultural traditions, sustainable development and green innovations.

Main problems recognized:
- loss of traditional agriculture;
- luck of support for the local attempts to reconstruct or preserve traditional agricultural production;
- luck of interest and motivation at local level to keep agricultural traditions, which fail in competition with a global market;
- luck of knowledge about innovative tools and successful practical experience.

We are sure, that it is possible to support local initiatives aimed to the traditional agriculture developing and the Carpathian nature conservation using innovative approaches based on international experience, including mechanisms of a Green Economy.
We collected examples of successful small businesses (during several years of previous activities) based on cultural traditions and respect of nature, using modern technologies as well. There are not many of such examples, they are unusual for Ukraine, innovative, and we see them as practical examples of implementation of green economy approaches, even if those people don't think about Green Economy. Together with those people (we call them "green economy initiators") we prepared a moving training, "people-to-people" practical courses, which started in October 2011 in two neighbor Carpathian regions (village level). The trainings included investigation of local traditions and needs, possibilities for developing of successful small traditional businesses, practical examples and consultations. These trainings were focused at milk/cheese businesses, drying forest production (mushrooms, berries, herbs), environmentally friendly tourism in rural area, wooden handicrafts. Topics on environmental management, nature conservation and green economy were given as theoretical part of the trainings.
We met a number of active people in the regions, ready to use existing experience learned from the neighbors; some steps forward were already done by them after trainings. In such way we create a network of green economy initiators in the Ukrainian Carpathians. All participants of our project are sure that this experience may be used as a practical example for other mountain regions.
In parallel with the trainings Green Dossier experts provided a research on creating Carpathian trademark for support local traditional businesses. About 120 people took part in this investigation. The main result is that Carpathian producers working in accordance to sustainable production principles need to be supported by creating the Carpathian brand, are ready to collaborate and come to common agreements for building a relevant system. The consumers in Ukraine, from the other side, need to have clean production and services from the Carpathians and trust to them, the Carpathian trademark will give them a guarantee.

Background
International Charitable Organisation Information Center “Green Dossier” was established in 1994, based in Kyiv, has representatives in regions of Ukraine, including 4 Carpathian regions, ANPED member).

Relevant Carpathian projects and publications:
- *Journalists for Sustainability in the Carpathians* (implemented through “Environment and Media” all-Ukrainian network, moderated by Green Dossier, 2004 - 2005): a number of press-clubs, CD collection of the participants’ publications.
- *Sustainable Development in the Carpathians: from Local Needs to International Rules* A round table and publication; held in a partnership with the Centre for Public Initiative (Kosiv) and ANPED, supported by OSCE.
- Ethnographic and environmental TV-cycle *“Carpathian features”:* documentaries "Muzyky" and "Molfar”, awarded at All-Ukrainian broadcasting competition "Discovering of Ukraine!"
- *Building Capacity for Practical Participation and Implementation – Carpathian Convention in Ukraine* (2005 – 2007; in partnership with LEAD International (UK) and NGO Center of public initiatives, funded by the UK “Environment for Europe Fund”. Publications: Plain Language Guide for the Carpathian Convention implementation, which consists of 2 books (a common overview of the Convention and examples on how concrete Convention Articles may work in practice).
- *Building links between protected territories for conflict resolution* (2007): National workshop in Kosiv, in cooperation with “Future in the Alps”.
- *Strengthening Public Participation in the Implementation of the Carpathian Convention* (2005 – 2006, ANPED). Developing of environmental/cultural agendas with a view to the creation of entry points for the promotion and realisation of public participation; investigation and

assessment of cultural heritage in Ukraine, Poland, Slovakia and Romania., organising cultural celebration at COP1.
- Creating an educational program - performance for children on the Convention and video-lesson.
- Investigation on sustainable consumption and production in Kosiv (review on food item) for UNEP report "Sustainable Consumption and Production in SEE and EECCA", presentation event "Traditional food production in mountain regions".
- International World Music and Land-Art festival "Sheshory'" (2003 - 2008): raised awareness about Carpathian cultural heritage, initiated similar events in other locations.
- ANPED campaign on *Carpathian Cultural Heritage Inventory (since 2008):*
  - *Identification, Protection and Promotion of Carpathian Heritage*": a consultation process with stake-holders from the regional and national level. ANPED recommendations presented and approved by the COP2.
  - *Pilot Actions in 4 targeted regions in Ukraine and the Czech Republic (2010-2011)*: a mechanism of the Inventory creation was established, tested and presented to COP3 (May 2011).
  - Organising Ukrainian performance at cultural event at COP3.
  - Presentation at the International Hutsul Festival (Kosiv, August 2011).
- Czech - Ukrainian project «BUILDING A BRIDGE IN THE CARPATHIANS FOR COMMON SUSTAINABLE DEVELOPMENT» (2009 – 2010), supported by Soros Foundation. Products: network established, "Trails of sustainable development" publication; participants from 20 organisations developed a scheme and criteria for establishing of regional brand..
- Green innovations for reconstruction of traditional agriculture in the Ukrainian Carpathians (2011 – 2012, MATRA): training tour "people-to-people", educational tools for practitioners.
- Research on creating Carpathian trademark (financed by Swiss State Secretariat for Economic Affairs SECO and FIBL, 2011).

The Methodology of Cultural, Historical and Social Topography (CHST) as a precondition for the preservation and maintaining of natural, historical and cultural identity and diversity in the mountain areas

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The main objective of the *cultural-historical and social topography* (hereinafter referred to as "*CHST*") is to renew and maintain harmony between the man and its environment which the man uses and governs. CHST deals with the protection and conservation of historical and cultural values and phenomena in a harmony with environmental structures. This is determined by a basic thesis that the conservation of diversity of live on the Earth is not possible from sustainable development point of view without the protection and conservation of cultural and societal diversity and cultural identity.

The CHST presents a systemic, interdisciplinary approach to identification, assessment, mutual influence and application of basic elements and structures of historical heritage and the environment which play a fundamental role in the overall identity of a concrete territory, environment or community.

Practical fulfillment of the main objectives is represented by a systemic and multi-sectoral application of the CHST in coordination of territory's development and in mobilization of human resources for creation of development strategies and policies, spatial and regional plans, in urban, architectonic and conservation practice in public administration performance as well as in awareness raising, information and education.
In the framework of spatial-planning practice and regional development documentation the CHST has a specific position as it seeks to identify historical and cultural values, phenomena and structures of a landscape in a monitored territory and to propose possible conservation, renewal or continuation in specific cultural phenomena, structures and values on a concrete territory through correct interpretation of this heritage.
The CHST was applied and can be applied on local, regional or trans-regional levels with most frequent use on the micro-regional and regional levels.
Based on this general methodology and within the framework of Carpathian Project realization (INTERREG III B CADSES, 2006-2008) a cultural-historical and social topography of a concrete territory has been worked out for a part of the White Carpathians region – 14 municipalities: Bohunice, Bolešov, Borčice, Červený Kameň, Dulov, Ilava, Kameničany, Krivoklát, Mikušovce, Pruské, Sedmerovec, Slavnica, Tuchyňa and Vršatské Podhradie which together constitute a region Sources of the White Carpathians (SWC).
The publication Monograph of Cultural-Historical and Social Topography of the Micro-region Sources of the White Carpathian (REC, Bratislava 2008) describes the objectives, application and form of CHST processing, as well as the procedure and outline of CHST methodology, evaluation of assumptions of the pilot Micro-region Sources of the White Carpathian (SWC) development and formulation of recommendations and proposals for the development of the SWC micro-region in terms of methodology CHST.

An example of transport of the scientific knowledge in the real practice

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The poster will present the example of the transfer the scientific knowledge to the real practice by application of new non-traditional methods "We are learning together". It is based on the participation of the different groups in the solution of the common project. The basic goal of this project was establishment of the new model elements of the territorial system of ecological stability and Environmental natural laboratory. The project was realized in the village Suchá nad Parnou. The basic target groups were: Environmental experts (employees of ILE SAS and Distelverein Deutsch Wagram) who elaborated verified and applied a new model of environmental management of territory. Teachers, experts and environmental activists established ecolaboratory and applied new system of environmental education. Representatives of local authorities and interest groups who utilized specific outputs raising from Model of management ecologisation. Schoolchild of elementary school and kindergarten represented model group for testing new forms of environmental education. The basic results of project were following: A/ Elaboration of the model of the Ecological management territory and its application on the study area. B/ Realization of the model elements of territorial system of ecological stability – biocentre and biocorridor. C/ Environmental natural laboratory, which consists from the three together, interactive basic parts: Eco-laboratory, Educational path and Eco-centre.

ORAL PRESENTATIONS

Soil respiration in Norway spruce forest after large-scale natural disturbances in the High Tatra Mts

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Soil respiration is an important component of the global carbon cycle. Annually soil releases 68-80.10^{12} kg of carbon (C) into the atmosphere, what is tenfold C emitted by fossil combustion and deforestation (Sultzman et al., 2004). Even small changes in global carbon fluxes might significantly influence energy balance and chemistry of atmosphere with great influence on CO_2 concentration and possible climate changes (Reich et Schlessinger, 1992).

Forest ecosystems store nearly 46% of their carbon in terrestrial biomass, detritus and soil. In recent years frequency and intensity of natural disturbances have increased and became a serious threat for C storage (Baldocchi 2008). Forest damaged by fires, windstorms or bark beetle attacks turns from carbon storage into carbon source (Sano et al., 2010, Usbeck et al., 2010).

A large windstorm in 2004 hit the forest in the High Tatra Mts region and laid down 2.3 mil. m^3 of mostly Norway spruce on an area of 12 000 ha. Consequent bark beetle outbreaks till now caused dieback of another 7 000 ha of natural forest. This event initiated international interdisciplinary ecological research named “windstorm research” (Fleischer 2008). In 2010 research infrastructure became a part of the EXPEER project under 7th EU FP.

Since 2008 soil respiration has been monitored in Norway spruce – European larch forest on localities with different disturbance and management regimes. Monitoring sites represent disturbance caused by wind, wind and fire or bark beetle. According to management the sites represent managed sites (fallen wood was removed) and unmanaged sites (fallen wood left intently non-extracted). Reference site represents stand unaffected by windstorm in 2004 with similar site conditions (altitude, orientation, slope, geology, soil, vegetation) and stand structure before windfall (spruce-larch semi natural stand, 80-120y old) like the windfall area.

Respired CO_2 has been measured by closed chamber technique (dark PVC, d=30 cm, V=17 dm^3) on permanent collars (7-9 per site) using Vaisala MI70 hand-held instrument equipped with GM222 IR sensor. Measurement time on each collar was 10 min, concentration was recorded in 5 s intervals. On each site precipitation, air temperature and relative humidity (0.5 and 2 m height), wind speed and direction (5m), global and NET radiation, soil temperature, moisture and heat flux (8 and 16 cm) have been automatically recorded in 60 min sum or interval. During measurement soil temperature in 2 cm was recorded manually. The measurements were performed from early April to late November on 10 day visit average. Most of measurements happened at noon when respiration culminates. Daily course was derived from several all day long measurements allowing recalculation of daily average from single CO_2 concentration taken at any day time.

During vegetation periods (May-September) average soil respiration on monitored sites ranged from 4.0 to 5.9 μmol $CO_2m^{-2}s^{-1}$, what was equal to 0.5 – 0.7 kg $C.m^{-2}$ y^{-1}. The highest values were detected in reference forest (standing, green) and in dying forest severally attacked by bark beetle. Both extracted and non-extracted windfall sites showed nearly identical values. Seasonally soil respiration culminated in July-August. There is no overall inter-annual trend. Soil respiration decreased on windfall areas but increased in both standing green and dead forest compared to the period 2008-2010.

Soil respiration correlates well with soil temperature in standing forest (R^2>0.6 in gaps, <0.5 beneath dense canopy), on windfall R^2 ranged from 0.2 to 0.8. Significant differences we identified among vegetation types (P< 0.001), which indicated some site conditions (esp. soil depth and structure). Annual biomass production correlated with soil respiration on windfall sites, but not in standing forest. Generally lower correlation we found with soil moisture. Based on direct measurement we derived index $Q_{10,}$ describing soil respiration sensitivity to increasing temperature. The values ranged from 1.5 to 1.8 in standing forest and 1.7-2.0 on windfall.

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Modelling the influence of reforestations on landslide susceptibility Case study: the Topolița hydrographic basin (Moldavian Subcarpathians, Romania)

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Landslides represent one of the main physical land degradation processes from the Subcarpathian regions, with negative impact on economic, transport and touristic activities. Landslides are wide spread in the Moldavian Subcarpathians, their occurrences being related to geological (the dominance of loose rocks belonging to the Carpathian Molasse, the alternation of clay, sand, sandstone and conglomerate layers), topographic (relief energy and fragmentation, angle and orientation of slopes), hydrological, hydrogeological, climate conditions and land use characteristics. In Romania, 10-30% of the Moldavian Subcarpathians area presents high and very high susceptibility to landsliding (Bălteanu et al., 2010) and there are some tendencies of increase in the number and surfaces of landslides, especially in the case of the shallow slides.

During the last century, it is noticed an increase in the influence of the landslide triggering factors such as intense or prolonged rainfall, earthquake, rapid snowmelt (Reichenbach et al., 2004). This relates to the increased terrain sensitivity for landsliding, due to the human pressure manifested by changes in land use (especially with respect to the forested areas) and infrastructure development (Wan et. al, 2010). The analysis of maps produced for different historical periods reveals the close relationship between the contemporary landslide distribution and the deforestations from the last 120 years (Mărgărint et al., 2012).

Among the measures which may lead to landslide mitigation, the reforestations represent the most practical approach, with important effects on other aspects (ecological, touristic etc). The present study attempts to explain and model the spatial and temporal variation of landslide susceptibility in a medium size hydrographic basin from the Moldavian Subcarpathians, by quantifying the only component which can be changed by humans: the land use structure, meaning the inventory (for past and present) and simulation (for future) of surfaces with different uses.

The Topolița basin, situated in the north-east of Romania, covers a surface of 207.5 km2 in the subcarpathian sector, the altitudes ranging from 290 m to 1010 m. Using remote sensing data and field survey, there were identified over 120 active ladslides, mostly shallow, with areas varying from 0.1 ha to 2 ha; the deep landslides have much greater extents and may exceed 40 ha. The assessment of landslide susceptibility was performed in GIS environment, using TNTMips 6.9, ArcGIS 9.3 şi SAGA 2.0.8 software packages. The logistic regression method was used to derive the Landslide Susceptibility Index (LSI), which might be the best method for large areas (Van Westen et al., 2006); it departed from a series of qualitative – geology, land use, soil types and quantitative predictors – slope inclination, slope height, aspect, plan curvature, profile curvature, mean curvature, wetness index, distance to drainage and distance to roads. The geomorphometrical parameters were derived by means of the Digital Elevation Model, computed from the altitude isolines with an equidistance of 10m from the topographical maps at scale 1:25.000. There were obtained maps of LSI refearing both to the present situation and future scenarios, in which the land use variable is subject to changes, especially when the distribution and extent of forests are concerned (Philips and Marden, 2004). In this respect, the starting premise is that through reforestations, many shallow landslides will stabilize. Therefore, the present landslide areas subject to reforestations will be eliminated from the computation of the landslide susceptibility. The simulation of reforestations is based on both the terrains displaying high LSI values and the terrains owned by local administrations (mostly covered by pastures) and which, from a legal point of view, could be much easier integrated into forestry.

At present, the percentage of forests covering the study region is about 14% and the terrains included into the high and very high landslide susceptibility represent more than 25% of the total area. Considering an increase in the degree of forestation up to 21%, the two susceptibility classes would reduce to about 21% of the basin surface, and if the degree of forestation were double, the two susceptibility classes would cumulate only 19%. Taking into account that numerous shallow slides are reactivations of old delluviums, the protection of forests will lead to a considerable increase in their reactivation time. Apart from the aspects related to the reduced LSI values, the reforestations in this region will bring important benefits for the mitigation of other geomorphological processes, such as sheet and gully erosion, in the context of some possible perturbations induced by the global climate changes. Moreover, the growth of the forested areas will have a positive impact on landscape and on touristic activities implicitly, taking into consideration that the region already has an important natural and human potential.

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Interdisciplinary investigations of the laminated sediments in the Iezer-Feredeu and Bolătău-Feredeu lakes, Romania

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Introduction. An interdisciplinary study (toponyms, old maps, sediment, radiocarbon analysis and microfossils analysis) of Iezer and Bolătău lakes, small and shallow and previously unreported water bodies in north eastern Romania illuminates the environmental history of the northern Romanian Carpathians and human impacts in the Obcinile Bucovinei Mountains during the last millennium. The first recorded historical reference to Iezer lake was in 1594 and to Bolătău lake in 1806. Furthermore, two sediment cores of over 4 m (4.2m for Iezer and 5.4m for Bolătău, respectively) of finely banded lake sediments and a radiocarbon date at Iezerul Lake provided additional evidence of the absolute age of these lakes and indicated that their origin relates to landslide activity. Consequently, they may represent the oldest landslide lakes in Romania providing an important perspective on past environmental conditions in the region via lake sediment based study. It is therefore proposed that these two landslide-dammed lakes be defined as scientific reserves to ensure their protection and to enhance their use as an educational resource.

Methods.

1. Historical records. In order to evaluate the age of the lakes we have used historical documents, comprising mainly of estate registers, where the estate boundaries where etablished based on elements of the local topography and other elements of the landscape, such as rivers, lakes and springs. Due to an enduring monastic life in northern Romania, several monasteries were built and endowed with land properties in the surrounding areas. One of these monasteries, located in Gura Humorului, previously owned an estate in the area where the lakes have formed and they were both mentioned in the official records as a part of the property boundaries. Consequently, the first recorded historical reference to Iezer Lake was made in 1594, and to Bolătău Lake in 1806, respectively. In this context, historical documents, such as monastery registers or other sources may prove to be very valuable for environment and climate reconstruction in northern Romania during the last five centuries.

2. Maps. In order to document the evolution of the two sites based on cartographic sources, we used the maps of Bucovina (historical region) made during the Austro-Hungarian rule were used. They were devised mainly for military use, and thus contained valuable cadastral data. The topographers were instructed to find and mark all the elements (buildings, forests, rivers and roads) on the detailed maps, as it was necessary to be aqcuainted with the territory, according to Emperor Joseph II, who emphasized that „If one is to rule countries well, one must first know them exactly" (Kain & Baigent, 1992). Consequently, the first set of maps made for Bukowina during the late 18th century were on a scale (1:28,800) which was suitable enough for detailed representations of numerous elements of the landscape and contained a large density of toponyms.

3. Sediment logging. The identification of deposition layers was based on a digital analysis of the images of the 60 cm cores. In this respect, grayscale images were used (digital gray-scale analysis), and the graphic processing was performed using the UTHSCSA Image Tool 3.0 software and several scripts specifically designed to identify and analyze lacustrine varves, at the Department of Geology, University of Tufs, USA (Ridge, 2011). The methodology involved drawing several longitudinal profile lines (with a thickness of 10 pixels) for each core, and identifying the mean value corresponding to intersected pixels. Obtained RGB values indicate the presence – in relation to depth – of several darker or lighter layers (from 0 – black, to 768 – white). By plotting these data onto a Microsoft Excel spreadsheet, the colour contrasts between the layers were highlighted (determined by the succession of seasons, extreme climatic or hydrological events, etc.), but also the layers' thickness (for the images we used, 1 pixel is equivalent to 0.03 cm).

4. Sediment analysis. The sediment cores (sections of 60 cm long) at both sites were taken from the frozen surface of the water body using a Russian corer. Each sediment core was sub sampled (1 cm intervals) and subjected to a range of analyses to determine its properties and investigate the possible causes of the layered effect. The particle size was determined by laser based HORIBA Partica LA-950V2. To estimate the organic matter the samples (1 cm) were dried overnight and combusted for 4 h at 550°C. The weight loss is expressed as percentage loss of the original weight. To assess the input of minerogenic material into the basins the sedimentary sequences were screened with a magnetic susceptibility loop (1 cm) using a Bartington Instruments Ltd MS2 system. SIRM (Saturation Isothermal Remanent Magnetisation) was induced in a Molspin Ltd Pulse Magnetiser at 1000 mT and measured in a flux gate magnetometer. Ti content was determined by field portable XRF (Niton Analyser XL3t).

One radiocarbon (^{14}C) measurement was performed on *Picea* wood found at 386 cm at Iezer Lake (lab-code: UBA-18397) using the accelerator mass spectrometry facility at the Belfast Radiocarbon Laboratory, Northern Ireland. The obtained radiocarbon age (913±21 ^{14}C) was converted into calendar years AD with Calib Rev 6.0. (Stuiver et al. 1993) using the INTCAL09 data set of Reimer et al. (2009). This suggests a calibrated date range of AD 1035- 1176 cal year BP (100 % probability distribution at 2 sigma) with a mean value of 1105 AD.

5. Microfossils analysis. Analyses of sediment of the lake Iezer revealed that in the top 160 cm of sediment several groups of animals were present in the lake with different abundance. The most

common are remains of Cladocera: three benthic (*Pleuroxus truncatus*, *Alona affinis*, *Alona guttata*) and one planktonic species (*Daphnia* cf. *hyalina*), along with some other groups of animals (incl. Bryozoa, larvae of Chironomidae). Distribution of remains along the core are un-even, indicating a lot of fast and radical ecological/hydrological changes in the lake.
Presence of planktonic organisms (g. *Daphnia*) indicate that at some stages the lake was deep enough to support planktonic community. At the same time rather abundant remains of benthic organisms (g. *Pleuroxus*, *Alona* spp.) indicates well developed littoral zone, while the presence of Bryozoa indicates a lot of suspended material in the lake. Remains of *Daphnia* and Bryozoa were common below 60 cm of the sediment core, along with remains of *Pleuroxus* and *Alona* spp. Above that depth remains of all mentioned groups are less abundant or un-even. In the top 25cm of sediment *Daphnia* remains are very rare (indication of fish presence), *Pleuroxus* remains are completely absent while *Alona affinis* remains are present in low numbers. Both information indicates intensive input of non-organic sediments (erosion) which is supported with relatively high presence of fine sand.

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The analysis of relations between land surface morphometry and spectral characteristics of ecosystems in Ukrainian Carpathians

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Spatial planning in mountainous areas requires the careful consideration of relations between abiotic conditions and various ecosystem properties. Abiotic conditions that influence the latter include the geologic substratum, relief, climate, soils, and hydrologic processes. While detailed spatial databases of these, as well as detailed ecological databases built on field data are still lacking for many regions, satellite data is the indispensable source of the spatially distributed detailed ecological information. However, satellite data mostly provides only indirect indicators and clues, posing a problem of correct and effective interpretation of data to derive ecologically meaningful and valuable information.
Two major types of satellite data are available for the task: digital elevation models (DEMs) and multispectral images. Both types of data are presently available free of charge, with spatial resolution and quality sufficient enough for regional ecological studies.
SRTM v. 4.1 DEM and LANDSAT 7 ETM+ image set were used (after their reprojection to common UTM 34N coordinate system and 90 m resolution) to analyze relationships between land surface morphometry and its spectral characteristics. While the former is the product of geomorphological processes and geologic structure, the latter is indicative of the vegetation cover structure, the composition and state of forest stands, as well as the land use structure.
The area of the case study was the 90*70 km rectangular region in the central part of the Ukrainian Carpathians. The axis of the rectangle roughly matches with the axis of the Carpathians arc, thus the

study area encompasses parts of its northern and southern macroslopes and the surrounding foothill planes.

Several analytical and statistical techniques were applied to analyze the relationships. The elevation values provided by DEM were used to derive the values of local slope, profile and plan curvature, as well as several composite indexes that relate to solar radiation influx, water redistribution, and mass movement potential. LANDSAT spectral bands were transformed to 3 orthogonal principal components that capture almost all of the spatial variation in land surface reflectivity. The multiple linear regression analysis and the canonical correlation analysis were used to analyze the relationships between these principal components and the DEM-derived topographic characteristic and indexes.

The first principal component shows pretty strong correlations with the most of the spectral bands, thus corresponding to the overall “brightness” of the surface. It also strongly correlates negatively with elevation values, thus the increase in the surface elevation in the area is often accompanied by the decrease in its reflectivity. Visual analysis of its spatial structure and comparing it with the topographic maps shows its strong negative relations with the presence and density of the forest stands. It is also negatively correlated with the slope values and positively – with the solar radiation influx.

The second component also negatively correlates with the elevation values, but its relations with other topographic characteristic and indexes are very different from the first component: e.g., it is positively correlated with the slope values. This component appears to discriminate well between deciduous and coniferous forests. It also shows strong (r = 0.95) correlation with the well-known Normalized Difference Vegetation Index (Rouse et al., 1973), often used to indicate plant productivity and biomass. The first and the second principal components also correspond rather well to the two first components of the tasseled cap transformation (Crist, Cicone, 1984). The second component also better differentiates between different anthropogenic land uses and land cover types. The third component shows very weak linear correlation with the topographic characteristic and indexes, yet the visual analysis has revealed that its high values strongly associate with the subalpic meadows. This component can thus effectively be used for the mapping and monitoring of the location and extent of valuable subalpic grassland communities with a number of rare and endangered species.

Canonical correlation analysis was used to analyze the relations between these components and the set of topographic characteristic and indexes. Most of the variability in the two sets of variables has been explained by the first canonical root, strongly correlated with the elevation values. The second root positively correlates with the slope values and the mass movement potential and negatively with the solar radiation influx. The analysis of the spatial distribution of the canonical factors scores and residuals can indicate the state of vegetation, the degree of its correspondence to abiotic factors and conditions, the character and degree of anthropogenic disturbances.

The results of these study prove the existence of rather strong relations between the land surface morphometry and its spectral characteristics. These relations imply the more fundamental relations between ecosystem distribution and properties and abiotic conditions. The availability of spatially detailed satellite data makes it a useful tool for analyzing these relations, as well as the analyzing and monitoring of anthropogenic changes and disturbances in mountain ecosystems. While the present study mostly analyzes local dependencies, the inclusion of non-local measures (e.g., the averages and variances of variables calculated inside moving windows of variable sizes) and also texture measures can possibly provide more insights onto the spatial relations and structures in mountainous landscapes.

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Availability of soil mineral nitrogen in alpine meadow at the Salatín locality in the Western Tatra Mts.

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High mountain alpine meadow ecosystems, which were previously lacking in nitrogen, are now due to anthropogenic deposition overloaded with it. Increased input of nitrogen to alpine ecosystems has caused changes in microbial activities as the microorganisms are the first who are reacting on these deleterious changes. Previous studies have found that the imbalance between the demands of plants and microorganisms for nitrogen and increased input of nitrogen with slightly prevailing oxidized forms are indicated by an increased amount of nitrogen, which is leaching from the ecosystem in the form of nitrates. This leads to losses of basic cations associating with nitrates, with the consequence of acidification. The process of acidification might be accelerated by the process of microbial nitrification in soil. Presented field studies were carried out at the Salatín locality in the Western Tatra Mts. (Slovak republic) on experimental plots designed as; control treatment, treatment with different nitrogen loads as well as the treatment with an increased input of phosphorus. The availability and movement of mineral nitrogen was measured by "in situ" method with using ion exchange resins (IER) applied in special covers in growing and non-growing seasons. Using the method of IER application "in situ" we can evaluate amounts of available mineral nitrogen in the soil in the form of ammonium (NH_4^+) and nitrate (NO_3^-) and so we can assess the efficiency of nitrogen utilization by microbial and plant roots activities. Generally, this study examined the strategies of soil microbial communities in soil with the surplus of nitrogen. Microbial communities are involved in the nitrogen transformations in the cycle of N as the key players. Basic step by which is nitrogen cycling driven is the depolymerization of N-containing polymers by microbial extracellular enzymes. There exist enough evidences that in the ecosystems with balanced nitrogen cycle are the demands of plants and cooperating rhizospheric microorganisms covered by the N-containing monomers produced by depolymerization. In the alpine ecosystems overloaded with nitrogen are of increasing importance the processes of microbial ammonification and nitrification which have determining influence on the amount of released H^+ ions. Microbiologically produced available mineral nitrogen in the soil in the form of ammonium (NH_4^+) and nitrate (NO_3^-) together with the mineral nitrogen from atmospheric deposition could be immobilized into new formed cells of microorganisms and plants. Immobilization of N ions leads to a reduction in the amount of mobile forms of nitrogen in the soil environment, to a reduction of acidification. Based on the results we can conclude that increasing nitrogen load were accompanied by increasing amount of trapped mineral nitrogen into IER in the respective variants. In contrary, the lowest amount of trapped mineral N was found in the variant with the phosphorus addition. The values of trapped nitrogen ions in the control treatment show nitrogen saturation and depletion of storage capacity of soil environment. The limiting factor for immobilization of nitrogen compounds has been proved to be phosphorus. The variants with the addition of phosphorus showed reduced availability of nitrogen ions relative to controls. The phosphorus addition has increased plant primary production and thus likely the amounts of rhizodeposition released into the soil. Higher offer of carbon substances has supported microbial activities and leaded to a decreased availability of mineral nitrogen in soil, more in the ammonium form. There was documented increased availability of mineral nitrogen in non-growing season corresponding with reduced demand of plant and microbial communities for them.

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Evaluation of soil resilience to anthropopressure based on Multicriteria Landscape Assessment and Optimisation (MULBO) method in Ropa Municipality (Beskid Niski Mt.) – preliminary results

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Agreement on proper land use is nowadays a challenge for different stakeholders such as planners, investors, local communities who often have opposite expectations. It is especially crucial within mountain environment which is more fragile to different kinds of anthropopressure than any other type of environment.
There are many different approaches used to support spatial planning system. One of them is Multicriteria Landscape Assessment and Optimisation (MULBO) created by R. Graubaum and B. Meyer (1998) and then developed (Meyer, Graubaum 2007). It is a GIS-based method for landscape assessment and optimisation to support decision-making process in spatial planning. It was originally devoted to agrarian landscapes in Saxony (Germany). Evaluation of specific landscape elements taking into consideration different types of risk is an important task towards proper land use because it helps to distinguish environment units of different level of resilience to anthropopressure.
Aim of this presentation is to show the preliminary results of soil resilience to anthropopressure evaluation which was conducted for the part of Ropa Municipality. Considered risk included water and wind erosion of soils as well as soils immobilization and filtration capacities.
Models of specific properties assessment proposed by R. Graubaum et al. (2005) were adapted to mountain environmental conditions and available data. Data used in analysis included above all: agrarian and soil maps, digital elevation model and data derived from them. Also a trial to involve meteorological data was undertaken.
Apart from evaluation models proposed in the manual of R. Graubaum et al. (2005) research procedure was supplemented by study results of different scientists. K. Korelski (2008) conducted research on relief factors which influence water erosion and X. Yue-qing et al. (2009) implemented a tool to describe soil erosion quantitatively and spatially. What is more, many studies on soil pollution and its filtration and immobilization capacities were conducted e.g. E. Malinowska (2004).
However, the main advantage of presented approach is the combination of different types of soil risk. On the one hand one type of pressure could have various results dependent on soil properties and on the other hand the impact of different types of anthropopressure on soils is considered.

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POSTER PRESENTATIONS

Fundamental surface elements on digital elevation models

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As particular case of land-surface objects, landforms define boundary conditions for processes operative in the fields of geomorphology, hydrology, ecology, soil science and others (MacMillan and Sharry, 2009). Yet automated identification of specific types of landforms remains difficult (Evans, 2012). Progress in this direction is hindered by the lack of a unifying theory of land-surface form (Gessler et al., 2009). While data, computer power and processing techniques have improved relentlessly in the last decade, translation from continuous models of elevation and its derivatives to landform divisions is still conceptually ill-defined. One path to a theory of geomorphometry lies through the 150-year-old concept of *Flächenelemente-surface elements* or *elementary forms* (Gessler et al., 2009).

The main objective of this project is to develop a methodology to segment DEMs into fundamental surface elements (FSE) relative to scale. FSEs are defined as data-driven homogenous areas at given scales delineated by topographic discontinuities. We hypothesize that FSEs be aggregated as building blocks in classifications for multiple purposes via specific semantic models (Hypothesis 1). A derived objective of this research is exploring suitability of surface elements in optimizing sampling in soil-landscape modeling. As surface elements incorporate scale, spatial autocorrelation, anisotropy and non-stationarity in their definition of homogeneity, they could provide a stratification of landscape into relatively homogeneous divisions in terms of the main soil forming factors including parent material. Thus, the second hypothesis to be tested is that **sampling and regression models would be improved by using FSEs comparing to actual approaches in soil-landscape modeling (Hypothesis 2).**

The work towards achieving the main objective is based on the technique of *image segmentation*. Initially developed for the purposes of classifying medical and satellite imagery, image segmentation techniques have increasingly been used to generate objects based on the concept of heterogeneity. This is a region-merging technique to create objects from pixels through an optimization process that minimizes the internal weighted heterogeneity of each object at a given scale. These objects are then merged or split to create objects at consecutive scales, either higher, created in a bottom-up approach, or lower, created in a top-down one. The most known algorithm is multi resolution segmentation (MRS) (Baatz and Schäpe, 2000) as implemented in the eCognition® software. Drăguț and Blaschke (2006) and van Asselen and Seijmonsbergen (2006) introduced this algorithm to the analysis of DEMs. This approach has lately been increasingly used in delineation of landforms or land entities (for a review of these applications see Drăguț and Eisank, 2011). Based on the recent work of Drăguț et al. (2011), image segmentation will be used to delineate FSEs from DEMs, which capture the full breadth of land-surface characteristics. Therefore, we will integrate the basic attributes of the land surface (elevation, gradient, aspect, profile convexity and plan convexity). The theoretic schema of Minar and Evans (2008) will guide the integration process.

The experimental work to achieve the derived objective will be carried out in the Ebergotzen test area, where a 25 m resolution DEM as well as a point dataset consisting in lab measurements of sand, silt and clay (all expressed as % of mass in the 0-30 cm layer of soil) are available. Based on this data we will simulate two sampling schemes to predict the respective soil variables from the basic land-surface variables. The first sampling scheme consists in one point sample randomly selected per each FSE polygon, while the other one includes the same number of points as in the previous scheme, but selected randomly for the whole test area. The remaining points in the dataset will be used for validation. The values of basic land-surface variables will be attached to the attributes of each sampling point and regression analyses will be performed. We expect FSE-based sampling to provide better results at the same number of samples, as redundancy and spatial autocorrelation are dealt with. Predictions based on individual variables as well as multivariate analyses will be evaluated statistically with the aid of the validation points.

To check the assumption that FSEs account for non-stationarity, we will compare the result of GWR (Geographically Weighted Regression) where predictors are nominal values of land-surface variables with OLS (Ordinary Least Squares) where predictors are mean values of land-surface variables (averaged within FSE polygons), based on the same samples as above. I expect at least similar result given that local averages are likely to capture local variation in the land surface, therefore the variation in the relationships with soil attributes.

If hypotheses of this project prove true, the results are likely to make an impact in physical geography and related scientific fields by improving the basis of terrain-based environmental mapping and modeling. The concept of FSEs would facilitate translation from continuous values to discrete features of interest, which is increasingly important in the context of availability of high-resolution DEMs (e.g. LiDAR DEMs with metric or sub-metric resolutions). Defining surfaces of interest on such detailed data becomes quite a challenging task with current concepts and methodologies. From this perspective, the expected results would directly contribute to geomorphologic mapping. FSEs would also contribute to better understanding and modeling of the complex distribution of soil over space.

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Object-based detection of planation surfaces from Digital Elevation Models. Case study Tarcu Mountains, Southern Carpathians, Romania

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This study presents a method for the semi-automated detection of the planation surfaces in Tarcu Mountains (Southern Carpathians, Romania) using a 25 m DEM and an object-oriented approach. Semi-automated detection of landforms has developed increasingly in the last years along with the free availability of DEMs at global scale and at different resolutions (Evans, 2012). Recently object-based image analysis has proved useful in the analysis and detection of some landforms (Drăguţ and Blaschke, 2006; Eisank et al., 2010; Schneevoigt et al., 2008).
The method was tested also in another two mountain areas (Török-Oance et al., 2009) and consist of few steps: DEM preprocessing, derivation of land-surface variables (slope, water flow), segmentation into homogeneous objects based on slope, classification of the resulted objects into planation surfaces by using fuzzy functions and taking into account more factors simultaneously (the average slope value, the minimum slope value, the flow coefficient and the altitude).
Results were evaluated against an existing geomorphological map including planation surfaces mapped in the field. The results highlight that using this method we can indentify easily the planation surfaces and with good results and the method can be used as a support for mapping planation

surfaces by shortening the time for the achievement of the geomorphological map especially in rough terrain.

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Consequences of avalanches, debris flows and nivation processes to the alpine landscape changes in the Tatra Mts., Slovakia

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The paper points out the actual results of the research on morphodynamic processes and their impact on landscape structure of the Tatra Mts. The increasing trend in the activity of erosion processes with destructive effects on vegetation and soil-regolith layer has been identified by means of the long-term observations in alpine environment during the last two decades. The avalanches and nivation connected with an intensive snowmelt due to the rapid increase of air temperature, accelerated by rainfalls eventually, represent the most active processes in the area. In response to heavy rainfalls, usual in summer, the high-volume run-offs induce the debris flow processes transporting the clastic material from rocky chutes, eroding the surface of older deposits on slopes and accumulating the material lower at the foots of debris cones or at the valley bottoms. The effects of these processes appear consequently in landscape changes of the alpine and subalpine vegetation zones. The research methods are grouped in three-phase procedure. Firstly, the regular field observations and oblique terrestrial photography and low-altitude aerial photography using helium aerostats are being performed for a selection of representative valley basins in the Belianske Tatra Mts. and the High Tatra Mts. The image database allows time-series analyses of changes in shape

and spatial dimensions of landscape elements created by the observed processes. Secondly, the interpretation of historical and present aerial and satellite image data is being processed to perform the land cover classification of the selected areas. In the third step the correlation analyses of the processed data from field observations and land cover data together with meteorological data from the closest climatic stations are being performed. The frequency of occurrence of the observed processes relates to variability of meteorological parameters, especially the rapid changes of the air temperature and high precipitation values, as it is affirmed by current climatic studies (Hlavatá, Škvarenina, Čepčeková 2011, Holko, Kostka, Danko, Liová 2011, Pribullová, Chmelík, Pecho 2011).

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Assessment of the impact of soil erosion on soil properties in vineyards- case study Vráble viticulture district, Slovakia

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Vineyards represent one of the most erosion prone types of cultivated land. Long term erosion processes could affect soil significantly, and cause direct and indirect environmental damage (the loss of soil production, sedimentation etc.). The aim of this paper is to assess the impact of erosion processes on soils in vineyards in Vráble viticultural distric. For this purpose we have analysed the spatial and profile transformation of selected soil properties measured along the slope transects. Transects were located on slopes under four different types of soil cultivation such tillage, hoeing, rotavating and grass cover. The erosion and deposition rates on these transects were estimated using the levelling method. This method is based on an evaluation of variability of the soil surface against vineyard poles measured between the year of pole insertion and the year of measurement. Our findings confirm strong sheet water erosion influence on morphology and horizontation of soil profiles. Also physical-chemical characteristics have been registered, mainly changes in humus and carbon content.

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The GPR Utilization (ground penetrating radar) for the estimation of the clogging rate of Lake Iezer from Obcinele Bucovinei (the Romanian Carpathians)

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Among the geomorphological processes characteristic to the Romanian territory, the landslides are specific to the slopes of the hilly and mountainous areas. These landslides cause serious changes to both the area where they take place and its surroundings, leading to the formation of natural-dam lakes. Lake Iezer from Obcinele Bucovinei falls into this category, being considered, based on the present information, the oldest natural-dam lake from Romania.
The lakes formed by landslides represent genuine local basins for the accumulation of silt. Their importance in the geomorphologic field, but mainly in the hydrotechnical one, is greater comparing to the man-made lakes because they are older and the estimation of the silt quantity is made along a longer period of time.
The calculation method of the clogging rate of a lake-basin is based on the modelling of both the present environment and the one previous to the formation of the lake.
From a morphostructural point of view, the lake and the catchment area upstream of the lake belong to the flysch area of the Romanian Carpathians, with an acutely folded underlayer constituted from glauconitic slates, compacted clays, striped clays and clays with globular-siderite, rocks that foster the landslides.
The lake is situated at the absolute altitude of 937 m, being presently characterised by an area of 1.63 hectares.
The studies focused on this area have begun in 2009 when the lake-basin and its surrounding area were topographical surveyed with a Leica TCR 1201 total station. Based on these surveys, the numerical terrain model was made, obtaining an extremely-accurate model of the present lake-basin and of the clogged valley-sector upstream of the lake. The utilization of the GPR aimed at the achievement of a carbon-copy model of the initial valley, previous to the formation of Lake Iezer. The overlying of the two relief-models facilitated the estimation of the silt volume presently located in the lake-basin. By dividing the total silt volume by the accumulation period and the area of the basin, it resulted an annual clogging rate of the lake that was smaller than the estimated rate for other flysch areas of the Romanian Carpathians.

Rule-based delineation of landform elements for the Carpathian low-medium mountains using SRTM data

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Landform elements, as discrete topographic units, are used to identify other qualitative land features such as soil, natural vegetation types, and geo-ecosystems. Landscape elements can be efficiently derived via various automated classifications of a digital elevation model (DEM). The SRTM (Shuttle

Radar Topography Mission) 3-arc-second DEM is one of the prime data sources for such a task owing to its global coverage and sufficient spatial resolution, while a rule-based classification, in which all parameters are controlled by the expert, can be easily modified to suite particular requirements and ensures compatibility of the results.
The goal of the study is two-fold: 1. To produce a geo-dataset of landform elements, suitable for further environmental analysis, for the Polish-Slovak-Ukrainian border region, where the Biosphere reserve "East Carpathians" is located. 2. To evaluate the suitability of the SRTM data and of the rule-based classification for landform elements delineation in heterogeneous low- and medium-mountain landscapes.
The study area equals to 4,186 km^2 and embraces several meso-ecoregions with rather contrasting morphology: low and medium flysch mountains, elevated flysch plateau, and a volcanic massif.
The SRTM dataset was re-sampled to a 30 m resolution and projected onto a UTM grid. A topographic position index (TPI) was derived for a 300 m neighbourhood and classified into three categories: 1. Ridge tops, 2. Convex and straight slopes, 3. Concave and foot slopes. The inclination values derived from the SRTM dataset were calibrated using a higher-resolution DEM and classified into four categories. The classified TPI and inclination rasters were merged to produce a dataset of landform elements for the interfluve areas. To delineate valley bottoms, the drainage network was generated, steam orders calculated, and watersheds delineated for the streams of 5^{th} order up. Then, the local erosion bases were calculated for the watersheds, and the valley bottoms were identified as relatively low flat areas. The drainage network and the valley bottoms rasters were merged and superimposed on the classified interfluve raster. The results were validated via area tabulation with manually drawn large-scale landform maps for two areas located on the plateau and in the dissected low mountains. A fuzzy membership calculation was applied to estimate the accuracy.
The accuracy assessment showed 67.1 % and 74.6 % total confidence of the landform elements delineation for, accordingly, the plateau and the low mountain areas. The best results were received for the valley bottoms and ridge tops in the low mountains (90.0 and 88.1 %), while the worst – for the same landform elements on the plateau (68.6 % and 50.1 %).

Landscape dynamics in landslide areas

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The aim of the study was to evaluate the relationship between landscape structure and its spatio-temporal changes and the occurrence of slope failures in Slovakia at different spatial scales. At regional level, the research has been focused on the statistical analysis of spatial data from the national database of landslides (Geofond Register of Landslides) and national land cover datasets (CORINE Land Cover 1990, 2000 and 2006). The joined database has been produced by means of GIS methods to evaluate the correlations of spatial distribution of classified types slope failures and land cover changes. The results indicate an evident dominance of forested areas in all genetic types of landslides at the initial stage in 1990. Based on the classification of landslide activity, the dominance on active forms moves towards the agricultural forms of landscape utilisation. The land cover changes over 15 years indicate decreasing trend in total area of agricultural land on active and potentially active forms towards transitional woodland-scrub areas and forests. This might be a result

of human controlled vegetation recovery measures; however, it is more often the case of natural succession process on abandoned agricultural areas. At local level, a set of five representative areas (4 shallow landslides and earthflows active in the last 50 years and one potentially active area) has been analysed using aerial images, digital elevation models (DEMs) and GIS tools. A series of aerial images from three time periods (since 1950) has been chosen to give an image of the landscape stage before and immediately after the landslide event, in comparison with the present situation. Two landscape characteristics, georelief forms derived from DEM and land cover data, have been tested within the delimited slope failure and 500 m buffer outside of this area respectively. The results represent a spatio-temporal synthesis of three related landscape features; forms of georelief, development of slope failure and changes in landscape diversity. As for natural processes, relative values of spatial and structural changes of landscape elements are more or less similar in all study areas, and reflect the succession of vegetation in changed hydrological regime of the affected landslide area. Major differences between the tested areas reflect mainly the different rate of human impact in each region respectively.

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ORAL PRESENTATIONS

Carpathian integrated assessment of vulnerability to climate change and ecosystem-based adaptation measures: the CARPIVIA project

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The CARPIVIA project aims to assess the vulnerability to climate change of the main ecosystems and ecosystem based production systems in the Carpathian region. It will produce an inventory of climate change impacts and ecosystem-based adaptation measures. By providing access to state-of-the-art information on vulnerability in the Carpathian region and on potential adaptation measures the CARPIVIA project aims to support for the new 'Working Group on Adaptation to Climate Change' under the Carpathian Convention. The CARPIVIA project is funded by the European Commission under the preparatory action ‘Climate of the Carpathian Basin’ approved by the European Parliament. It will run from 2011 to 2013.

This paper will summarise the interim results of the CARPIVIA project for debate with Forum Carpaticum participants. In particular the paper will focus on the inventory of climate change impacts and ecosystem-based adaptation measures in the Carpathian region and the results of the first 'Working Group on Adaptation to Climate Change' where these impacts and adaptation measures will be prioritised. In addition the paper will report on the knowledge system developed for CARPIVIA project.

Background: The CARPIVIA project aims to assess the vulnerability of the Carpathian region primarily to climate change. Based on this vulnerability assessment an inventory will be made of the potential and already implemented adaptation measures. A framework to assess the vulnerability and adaptation measures in the region will be provided. The focus will be on ecosystem-based adaptation measures. Results of the project will be disseminated by a dedicated website, by cooperation with key regional stakeholders, and through presentations at workshops and conferences in the region.

The main objectives of the CARPIVIA project are:

- To gather, in a structured way, information on vulnerability to climate change impacts in the Carpathian Basin, and on that basis identify and assess potential adaptation measures, with a particular focus on ecosystem based approaches. The level of analysis will be based on the availability of data and information from external project;

- To identify knowledge gaps to be filled in by additional field research or case studies. The latter will be executed by a parallel separate framework contract for in-depth assessments of vulnerability of environmental resources and ecosystem-based adaptation measures;
- To contribute to on-going national or regional adaptation strategies or related policy processes, and to the EU Knowledge Base on Climate Vulnerability and Adaptation (among others via the Adaptation Clearinghouse of the EU).

The Third Meeting of the Conference of the Parties (COP3) to the Carpathian Convention (Bratislava, Slovenia, 2011) approved the Terms of Reference for the Working Group on Adaptation to Climate Change by its Decision COP3/15. This Working Group aims to support the Parties to the Carpathian Convention by providing advice on adaptation to climate change in the Carpathian region. The working group will debate the available information on vulnerability to climate change impacts in the Carpathian Region, and provide guidance and recommendations for the development of policy proposals in line with the objectives of the Carpathian Convention and the European Commission's White Paper on Adapting to Climate Change.
More information: www.carpivia.eu

In-depth assessments of vulnerability of environmental resources and ecosystem-based adaptation measures in the Carpathian Region

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The Carpathian region was one of the less investigated areas of Europe, especially of the European Union. Therefore, the European Commission allocated funds for the better and coordinated investigation of the region.
European Commission proposed to focus work on the analysis of the vulnerability of water and ecosystems of the Carpathian region to climate change impacts and other man-made pressures and on identifying potential adaptation measures, focusing on adaptive water management and ecosystem-based approaches in the 2010 plan. This would provide strong benefits to national and regional authorities of the Carpathian Region, and contribute to concrete policy proposals in line with the Commission White Paper on Adapting to Climate Change, such as National or Regional adaptation strategies, or a Danube Climate Adaptation Strategy. The results of this analysis will be strongly interrelated with the work already underway and will also provide a contribution to the forthcoming EU Information System on Climate Change Vulnerability and Adaptation (EU Clearinghouse).
A preliminary assessment of potential climate change impacts in the Carpathian basin identified the following key vulnerabilities 1) lack of water due to increasing drought tendency; 2) increasing frequency of heat waves; with their subsequent effects on ecosystems, ecosystem based production systems (agriculture, forestry, energy) and health. No clear picture can be drawn about possible changes in the flood conditions: it is expected that the frequency of both winter floods and torrential flood events will increase.
A tender call was published with the title 'Preparatory action on climate in the Carpathian region – Framework contract for in-depth assessments of vulnerability of environmental resources and

ecosystem-based adaptation measures' on 14 March 2011. The contract award winner was a consortium under the leadership of Vituki, Environmental and Water Management Research Institute, Hungary (Contract no ENV.D.1/FRA/2011/0006).
According to the outcomes of the CARPIVIA project, the winning consortium has got 6 special requests (SR) for preparing offers individually. The timeframe of SRs are between 15 and 18 months. The contracts for SRs are signed and the practical work begins in 2012. The 6 SRs are the follows:

1. In-depth study on the key climate change threats and impacts on water resources
   Subjects of the study request:
   - Produce maps for projected floods, droughts and changes snow cover
   - Assess projected seasonal shift in water balance and impacts on soils
   - Assess the potential impacts of climate change on the implementation of the water framework directive and flood directive
   - Assess the risk of landslides in relation to changing precipitation patterns and flash floods
   - Impact of changes in ecosystems and adaptation measures on water resources
2. In-depth study on the impacts of climate change threats on ecosystems
   Subjects of the study request:
   - Assessing the risk of forest disease and new pathogens
   - Protective function of montane and subalpine forests against hazards
   - Climate change and forest management practises
   - Changes in species composition
3. In-depth study on the impact of climate change on ecosystem based production systems
   Subjects of the study request:
   - Positive and negative climate impacts on ecosystem services with specific reference to multifunctional landscapes and grasslands
   - Assessment of the vulnerability of the tourism sector
4. In-depth study on adaptation measures
   Subjects of the study request:
   - Ex post evaluation of adaptation measures
   - Supporting costs and benefits studies
   - Ecological networks and ecosystem fragmentation
   - Assessing and tailoring adaptation measures for the Carpathian region
   - Agri-environmental schemes and other farmer support
5. Supporting stakeholder interaction
   Subjects of the study request:
   - series of stakeholder workshops will be organised and managed using knowledge-based facilitation techniques in order to generate: a) a number of action scenarios in relation to the impacts of climate change, based on key impacts and assessments of vulnerability; b) generate a number of adaptation options in relation to these scenarios; c) evaluate the costs and benefits of the options along with their feasibility; and d) identify preferred options and adaptation pathways.
6. Integral vulnerability assessments in focal areas
   Five focal areas have chosen:
   - Tatra mountain, including Zakopane
   - Rodnei and Maramures
   - Tarnava Mare area
   - Irongate national park and foothills
   - Bükk mountains

The presentation will give a more detailed overview about the project and the latest results.

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Assessing capacity for community-based forest carbon projects in the Carpathian Mountain region, Ukraine

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In recent years forest carbon projects have increasingly been used as market-based tools to mitigate climate change under the voluntary carbon market and the Kyoto Protocol's flexible mechanisms (Clean Development Mechanism and Joint Implementation). Much of the current emphasis is on Reduced Emissions from Deforestation and Degradation under the Kyoto or post-Kyoto frameworks, but activity in the voluntary market is increasing dramatically.

Forest carbon projects provide an incentive for forest conservation and protection by providing revenue in exchange for carbon storage. While this is considered an environmental benefit, the rules of the forest carbon project may be at odds with or complementary to the traditional uses of and tenure rights to the forest by local community members. Forest tenure – "the social relations and institutions governing the use and control of forest land and resources" – is often considered a bundle of rights, including access, use, management, exclusion (right to determine who is excluded from use), and alienation (right to sell or lease), as well as other local and/or customary rights (Larson, Barry, Dahal, & Colfer, 2009, p. 1). Forest carbon projects could result in a change to these tenure rights, significantly affecting local communities. Many forest carbon projects attempt to combine rural economic development with environmental conservation and even include sustainable development in their stated goals (UNFCCC, 1998, Article 12.2). In order for this to be successful, however, proper institutional mechanisms must be in place to ensure that the revenue from the carbon project reaches the local community. Since forest carbon projects are often implemented in rural resource-dependent areas (Boyd, Gutierrez, & Chang, 2007), it is important to understand how they will affect neighboring communities to ensure that issues of equity and livelihood are properly addressed.

The Ukrainian Carpathian Mountain region's post-socialist, transitional economy provides strong potential for forest sector investment, yet there is little experience with forest carbon projects. The forests of western Ukraine are currently a carbon sink, absorbing more carbon dioxide than they are emitting, due primarily to recovery from a history of intensive land/forest use (Kuemmerle et al., 2011). Carbon sequestration rates in the Carpathian region can be maintained and possibly increased with improved forest management practices (Keeton et al., In press; Kuemmerle, et al., 2011). Protection of high conservation value forests, restoration of endemic species composition, and use of extended rotations offer opportunities for continued accumulation of aboveground biomass and carbon (Keeton et al., 2010). Farmland abandonment in the post-socialist transition period offers opportunities for reforestation (Kuemmerle et al., 2008) and further increases in carbon sequestration and storage. Ukraine is eligible to participate in the Kyoto Protocol's Joint Implementation flexible mechanism and the voluntary carbon market, making forest carbon projects in afforestation/reforestation, improved forest management, and avoided deforestation possible. Developing forest carbon projects in the Carpathian region could provide opportunities to offset carbon emissions, incentivize restoration and sustainable forest management, and produce revenue in an economically depressed rural area (Kuemmerle, et al., 2011). To explore the potential effects of forest carbon projects in this region, this study seeks to answer the following questions:

1. How might forest use and tenure rights for community members in the Ukrainian Carpathian Mountains change with forest carbon projects?

2. Do requisite institutional mechanisms exist that can facilitate equitable distribution of revenue from forest carbon projects to local communities and forest administrative units? If none, what is the potential for such mechanisms to be developed?

Data was collected through triangulation of interviews, direct and participant observations, and structured literature review. One-on-one, semi-standardized interviews were conducted with community members, forestry professionals, and academics. Interview questions were open-ended and focused on forest uses and tenure rights; how communities access the forest; changes in forest use, tenure, and access over the past several generations; interactions between community members and State Forestry Enterprise representatives; knowledge of the role of forests in climate change; potential for forest carbon projects in this region (benefits, obstacles); revenue distribution mechanisms; and forestry-related organizations and organizational networks.

Forest activities of community members and groups, as well as meetings of organizations involved in forest management were observed. These observations confirmed data obtained from interview participants and provided additional information not disclosed during interviews.

While this research is still in progress, we predict that many forest uses could be compatible with a forest carbon project in the region. Preliminary results indicate that an efficient and transparent institutional mechanism to equitably distribute project revenue is lacking at this time and must be developed before forest carbon projects can become a realistic means to increase sustainable development in Ukraine. The results of this study provide valuable insights into the potential for forest carbon projects in the Ukrainian Carpathians and add to the growing body of literature on the forest carbon project-community nexus. Project designers and forest-dependent communities will find this study useful, as well as policy makers involved in post-Kyoto climate change negotiations.

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Shifts in climatic regions in the Tatra Mts. and the surrounding area based on Köppen and Konček classifications

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Temporal trends of air temperature and precipitation as well as the territorial shifts in climate regions in Slovak part of the Carpathians during the 20th century and at the beginning of the 21st century were studied in Melo et al., 2010. This paper deals with the climate evolution occurred at the alpine territory of the Slovak part of Carpathians (the Tatra Mts.) and in the surrounding area (the Orava, Liptov and Spiš Regions) in 1951-2010 in more detail. The Tatra Mts. is located in the northern part of Slovakia. It has the high-mountain relief features. A characteristic sign of the surrounding area relief are mainly the hollows and the highland and upland relief. Generally, mountain climates exhibit great variation in the number of climatic sub-regions over a short distance due to altitudinal differences and complex topography conditions.

Analyses based on the Köppen\`s and Konček\`s methods are among the most frequently used climatic classifications in Slovakia. The Köppen classification scheme is based on monthly and annual normals of mean air temperature and precipitation totals. Each region is categorized, in a symbolic form, by a sequence of two or three letters. In the Köppen classification of climate, the first letters "A-E" are the dominant. Only "C", "D" and "E" climate types occur in the study area. The "C" climate (warm, temperate, rainy) is defined as one with the average temperature of the coldest month ranging between –3 °C and 18 °C, and with the average temperature of the warmest month exceeding 10°C. The additional (second) letter "f" represents climate where no dry season occurs. The "a" indicates that the warmest month has an average temperature over 22 °C, the "b" – the average temperature of the warmest month below 22 °C and at least 4 months warmer than 10 °C and the "c" – only 1-3 months with an average temperature above 10 °C. The "D" climate (cold boreal forest or snow) is similar to "C" but with the average temperature of the coolest month below –3 °C. The average temperature of the warmest month below 10 °C defines the "E" climate, that between 0 °C and 10 °C the "ET" (tundra) climate.

The Konček climatic classification is based on the Konček\`s moisture index values together with some air temperature characteristics. The Konček's moisture index represents a simplified water balance characteristic. It is given by the formula:

$$Iz = 0.5R + r - 10T - (30 + v^2)$$

where R [mm] is the precipitation total in the growing period (April-September), frequently called the warm half-year; r [mm] is the precipitation total exceeding 105 mm on average for winter season (December-February), the negative deviations are excluded; T [°C] is the mean air temperature in the growing period; and v [m s^{-1}] is the mean wind speed measured at 14 h of MLT in the growing period. The value of Iz > 120 indicates very moist region, Iz ranging between 60 and 120 characterises moist region, Iz from the interval 0-60 is typical for moderately moist region, Iz from -20 to 0 for moderately dry region, Iz from -40 to -20 relates to dry region and Iz less than -40 corresponds to very dry region. Three regions were distinguished: warm, moderately warm and cold. In the long-term average, the warm region has 50 or more so-called summer days (with daily maximum air temperature ≥ 25 °C) annually, whereas the moderately warm region has less than 50 summer days annually and the mean temperature in July is 16 °C or higher. In the cold region, mean July temperature is below 16 °C. The warm region has 7 sub-regions (T1-T7; differing in mean air temperatures of January and Iz). The moderately warm region has 7 sub-regions (M1-M7; with

differences in the mean air temperatures of January and July, and in Iz). The cold region has 3 sub-regions (C1-C3; all considered very humid and differing in the mean temperature of July, with the limits at 12 and 10 °C).
The boundaries between different climate types tend to shift over time. Our aim is to specify climate regions and sub-regions using the Köppen and Konček climatic classification schemes and to identify the shifts in boundaries in this region between the periods 1951-1980 and 1981-2010.
The climate has become warmer in the Tatra Mts. and in the surrounding area during this period. Significant increase e.g. in the mean July air temperature between these two periods was recorded [at Poprad (695 m a.s.l.) from 15.5°C in 1951-1980 to 16.5°C in 1981-2010, at Skalnaté Pleso (1778 m a.s.l.) from 9.5°C in 1951-1980 to 10.5°C in 1981-2010, at Lomnický štít (2635 m a.s.l.) from 3.6°C in 1951-1980 to 4.7°C in 1981-2010].
According to both used classifications, certain shifts in climatic regions and sub-regions towards the higher altitudes were registered in this region between the periods 1951-1980 and 1981-2010. While in the period 1951-1980 according to Konček three sub-regions of the moderately warm region (M2, M5, M7) and three sub-regions of cold region (C1, C2, C3) occurred in study area, in the period 1981-2010 there was four sub-regions of moderately warm region (M1, M3, M5, M7) and the three sub-regions of cold region (C1, C2, C3). According to Köppen new climatic region with the warm temperature and humid zone (Cfb) appeared here in the years 1981-2010. Other three Köppen climatic regions (Dfb, Dfc, ET) were shifted towards the higher altitudes in new period.
The boundary between the cold boreal forest climatic region (Dfc) and the mountain tundra climatic region (ET) (in Köppen classification) shifted to about 160 m higher altitude. The boundary between the moderately warm (M) and the cold (C) climatic regions (in Konček classification) shifted to about 155 m higher altitude. As a result of higher temperature, we can expect similar upward shifts of vegetation zones and advances of altitudinal zones of tree lines here.
(Acknowledgement. The Science and Technology Agency (Slovakia) under contract No. APVV–0015–10 supported this study. In this contribution measured data from the Slovak Hydrometeorological Institute in Bratislava are used.)

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Evaluation of Biothermic Conditions of the Wieliczka Foothills in the Years 1991-2010 Using UTCI Index

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The Wieliczka Foothills is a region within the Carpathian Foothills, located in southern Poland, about 30-40 km south of Kraków. The region has been intensively used for tourist purposes for a long time, especially for weekend tourism. The bioclimate of the Wieliczka Foothills is an important element of its natural resources. The climate changes can affect in the future, among other elements, also the bioclimatic conditions of that region which in turn can modify its tourist functions. The aim of the paper is the evaluation of the present bioclimatic conditions of the Wieliczka Foothills using a new index of human heat stress: UTCI (Universal Thermal Climate Index; http://www.utci.org). The index has been used e.g. to evaluate spatial bioclimatic patterns of selected areas in particular weather conditions (Błażejczyk, 2011) or to evaluate the bioclimatic conditions of a certain locality using long-term meteorological measurement series (Chabior, 2011, Lindner, 2011).

The data used in the paper come from the Research Station which belongs to the Institute of Geography and Spatial Management, Jagiellonian University, Kraków. The station is located in Gaik-Brzezowa (49°52'N, 20°04'E, h = 302 m a.s.l.), in the central part of the Wieliczka Foothills, on a hill top, close to the Dobczyce Water Reservoir. The meteorological data from that station are representative for the majority of the region. The data come from the period 1991-2010, 12 UTC and include: air temperature, water vapour pressure, wind speed, cloudiness and bare ground temperature (0 cm; tg). In order to calculate UTCI, it is necessary to calculate mean radiation temperature (Tmrt) first. Tmrt was calculated using the VDI procedures implemented in the Rayman software (Matzarakis, Rutz, 2005). For the calculation of Tmrt, the tg is needed. However, that parameter is usually not measured at the standard meteorological stations. There are procedures in the Rayman software which allow calculating tg from the standard meteorological data and the solar beams angle. In the present work, a comparison was made between measured and calculated tg, as tg is measured in Gaik-Brzezowa at a site with bare ground of about 3 m^2. The results show relatively little differences between both data sets.

Mean monthly UTCI values in Gaik-Brzezowa vary from -2.8°C in January (i.e. moderate cold stress) to 27.9°C in July (i.e. moderate heat stress). Extreme values observed were classified as extreme cold stress or very strong heat stress. In winter, days with moderate cold stress are the most common (42.3%), in spring and autumn on most days no thermal stress is observed (62.7% and 58.0%, respectively), while in summer the most frequent are days with moderate heat stress (40.8%). In the period 1991-2010, for spring, autumn and the whole year, a statistically significant increasing trend (α=0.01) of UTCI values occurred.

During 42.8% of all days in a year, no heat stress is observed in Gaik-Brzezowa, i.e. the physiological thermoregulation processes are sufficient for the preservation of the heat balance. Days with slight cold stress occur with the frequency of 18.2%, and days with moderate cold stress - 15.3%. Weather conditions generate strong cold stress, very strong cold stress and extreme cold stress very rarely (3.2% all together), while the days with strong heat stress make only 0.3% of all days in a year. Favourable biothermic conditions for practising tourism occur in the Wieliczka Foothills from the third decade of March to the third decade of October. In that period, days with no heat stress or moderate cold stress make over 50% of all days.

According to the bioclimatic classification of Poland by Kozłowska-Szczęsna et al. (1997), the Wieliczka Foothills belongs to the zone with mild bioclimatic stimuli, with increased thermal stimuli. However, comparing to other bioclimatic regions of Poland, the Wieliczka Foothills has good and very good bioclimatic conditions for tourism during most of the warm half-year (only 1.4% days with moderate cold stress and 0.6% days with strong heat stress). It should be used in the future spatial planning of tourism in that region to a larger extent than so far.

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POSTER PRESENTATIONS

Climate of the Carpathian Region, a project for a high resolution harmonized gridded database

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One of the largest problems is the availability of good quality long-term time series in the climatology and connected sciences. This problem is based on the difference in national measuring systems and data managements, the general problem of data availability and it is exacerbated by the relative small territories of the European countries, i.e. the near border data are not interpolated but extrapolated. . Furthermore, the climate data management was taken politically as a national task of the individual countries both on expert and financial point of view. This approach made not possible a powerful international co-operation, because of the lack of the international financing sources. As one of the first examples, the European Parliament accepted to support an international co-operation on the climate of Carpathian Basin in 2008, the practical work has begun in December 2010 and will finish in December 2012.
The main aim of the service is to improve the basis of climate data in the Carpathian Region for applied regional climatological studies such as a Climate Atlas and/or drought monitoring. The service will investigate the fine temporal and spatial structure of the climate in the Carpathian Mountains and the Carpathian basin with unified or at least directly comparable methods.
Participating countries are Austria, Croatia, Czech Republic, Hungary, Poland, Romania, Serbia, Slovakia and Ukraine. The spatial area of interest for the present contract includes the Carpathian Mountain Chain (including the Transylvanian Depression), the Carpathian Basin (i.e. the Pannonian Depression), and adjacent areas, necessary to study the climate of the area. For the production of the digital climate atlas, the resulting climatological grids will cover the area between latitudes 50°N and 44°N, and longitudes 17°E and 27°E, approximately.
The project contains three modules:
Module 1: Improve the availability and accessibility of a homogeneous and spatially representative time series of climatological data for the Carpathian Region through data rescue, quality control, and data homogenisation. (lead by the Slovak Hydrometeorological Service)
Module 2: Ensure Carpathian countries data harmonisation with special emphasis on across-country harmonisation and production of gridded climatologies per country. (lead by the Hungarian Meteorological Service)

Module 3: Develop a Climate Atlas as a basis for climate assessment and further applied climatological studies as well as for drought monitoring in the Carpathian Region (lead by The Republic Hydrometeorological Service of Serbia).
The Module 1 ends by the end of 2011, the Module 2 by mid-2012 and Module 3 at the end of the project.
The set of meteorological variables in daily temporal resolution includes 2 m daily air temperature, precipitation, wind, sunshine duration, cloud cover, global radiation, relative humidity, vapour pressure, surface air pressure and snow depth.
Climate Atlas will contain except the meteorological elements days with threshold value (frost days, summer days, hot days) and drought indices, like SPI3, PAI, Reconnaissance Drought Index, Palmer Drought Severity Index, Aridity index, Moisture index, statistics calculated from the elements, like percentage of days without defrost (ice days), percentage of extremely hot days, percentage of severe cold days, percentage of wet days, percentage of wet days above 20 mm/d, and extreme values like greatest 1-day total rainfall, greatest 5-day total rainfall. Some more important for agriculture indices will be produced as the growing season length, Ellenberg index.
For the project, more data are requested as they are in the electronic databases. Therefore, substantial part of the project is the data rescue part. Large quantity of data is digitalized in most part of the participating countries to support the homogenisation and interpolation activities, improve their accuracy.
The project wishes to solve the large problem of data policies about the international data exchange. Only the minimal number of data will be changed on equal basis in the frame of this project, and the other activities are made by the individual countries. It is suggested in this way, that the largest number of available data will be used in the calculations. The other benefit of the project is the use of common methods for homogenisation, data quality and interpolation. This approach makes the data comparable. The international consistency is planned to fulfil by the near border data exchange, where the meteorological fields of different countries are compared and fitted. In this way, a unified map of region can be created without the influence and modification of national data policies.

The presentation will give an overview about the actual situation of the CARPATCLIM project.

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Precipitation variability in the High Tatra Mts.

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The study provides assessment of changes in precipitation in the High Tatra Mountains in the 1961 – 2010 period. Trends in annual, monthly precipitation, in frequency of dry spells and in selected precipitation indices characterized by frequency of daily precipitation categorized in five intervals are examined using data from eight climatic stations and from accumulative rain gauges located in investigated area. Homogenized time series are used. The precipitation indices are evaluated seasonally. The winter precipitation tendencies are compared with the trends in snow cover depth. Variability in precipitation is evaluated with respect to an altitude and position of investigated stations (leeward, rain shadow). Finally, the changes in precipitation are confronted with detected ascending temperature trends (Pribullova et al., 2010) and change in the climatic stratification and its possible consequences in the investigated mountain area are discussed.

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ORAL PRESENTATIONS

Pixel-based compositing approaches for fine-scale land cover change mapping across the entire Carpathian ecoregion – first results

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The countries of the Carpathian region underwent several phases of major socio-economic restructuring during the post-WW2-era. Most notably, the end of socialism and the collapse of the Soviet Union triggered widespread land-use and land-cover change in this region. Collectivized agriculture and forestry sectors were transformed and market principles were introduced. As guaranteed markets for agricultural commodities within the former Eastern Bloc disappeared and prices for inputs and outputs were liberalized, many farms went bankrupt in the early 1990s. Rural depopulation and the large-scale abandonment of former cropland were the outcomes of these changes. One of the key issues during the post-socialist phase was the question of land ownership and the re-privatization of forest and agricultural land. Individual countries in the Carpathian region followed different strategies to redistribute collectivized agricultural and forest land including the distribution to former farm workers, market-driven auctioning, and the legal restitution to former owners.

As a result, forest cover has changed quite drastically in some Carpathian countries. Ownership changes and generally weakened institutions, have led to increased logging (both legal and illegal) of forests. Drastic changes in forest cover have also occurred in some areas due to, wind throw, the legacies of socialist environmental pollution, and insect damage. Together, these forest cover changes resulted in decreasing forest cover and increasing forest fragmentation in some regions in the Carpathians.

Formerly state-managed agricultural lands were abandoned after 1990 and many of these areas became unmanaged grassland experiencing shrub encroachment. Some of these abandoned areas have been transitioning towards forests again. On the contrary, large areas of abandoned farmland have been recultivated after the eastward expansion of the EU. These processes of land change in the Carpathian region today are of great relevance with regard to issues such as carbon sequestration, food production and security or habitats and biodiversity.

Remote sensing is a valuable tool to assess how land use has changed throughout the region since the dawn of modern earth observation in the 1970s. For the Carpathian region, several studies have successfully employed remote sensing imagery to quantify the rates and spatial patterns of these land use and land cover changes, albeit only for small regions, mostly within single countries. A consistent pan-Carpathian map of land cover and land cover changes at moderately high spatial resolutions is still missing. This represents a major obstacle for land use and conservation planning and for assessing the impact of recent land use changes for ecosystems, their services and biodiversity.

However, until recently remote sensing data were limited due to data costs. Additionally, computational resources did not permit analyzing large areas at Landsat-like resolution, because this involves a high computational costs and storage substantial data volumes. With the opening of the Landsat collections of the United States Geological Survey (USGS) in December of 2009, data limitations related to monetary costs have been eased. Since late 2011, the European Space Agency (ESA) also opened their Landsat archive. Advances in high performance processing environments now permit analyzing hundreds of scenes of satellite imagery and thus extracting the most relevant observations for a certain application (e.g. forest change monitoring, agricultural mapping) from the archives.
Here, we demonstrate a new approach that makes use of the rich information in the entire Landsat archive to facilitate regional-scale, automated land-cover mapping for the last 30 years. Our approach uses a pixel-based compositing methodology to produce cloud-free image datasets of surface reflectance measurements for specific time periods (e.g. ca. 2000). These composite datasets are consistent in terms of reflectance, phenological states, and acquisition dates. We use these pan-Carpathian image composites to derive consistent, across border land-cover analysis. We present first results for pan-Carpathian large area land cover and land cover change mapping. After presenting our methodological approach to produce the regional composites, we illustrate the analysis strategy to derive information on land cover and land cover change. Our results distinguish broad forest cover types (e.g. deciduous forest, mixed forest and coniferous forest) and the change analysis separates logging-based forest change from conversion of forests to other land uses. Our work is the first approach to consistently map land use and cover change across the Carpathian ecoregion at moderate to high spatial resolutions (e.g. 30 m).

Land cover changes in the northern Carpathians with MODIS data

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Land ecosystems are continuously changing. One of type of these changes are land use and land cover changes (LU&LCC) which have powerful influences on e.g. biodiversity. LU&LCC are often distinguish on two types: conversion and modification (e.g. Lambin et al., 2001, Coppin et al., 2002). Conversion of LU&LC is defined as a complete replacement of one land cover/use type by another, whilst LU&LC modification reflects more elusive alteration that affects the character of land cover/use without changing its overall classification (Lambin et al., 2001).
Providing of homogenous information on LU&LCC and its drivers at the pan-Carpathian level is crucial for research and policy (Kozak et al., 2011). In the northern Carpathians there are many small-scale case studies, although still there is only few related to a regional scale. In the Carpathians little attention has been paid to use satellite derived products with high temporal resolution and medium spatial resolution, provided by e.g. MODIS sensor, which ensure large area coverage and opportunity to mark annual dynamics of land cover. Some of MODIS products (like Vegetation Indices) may be successfully applied to monitoring land cover changes in vast regions (Cararo et al., 2007).
The current land cover pattern (mixture of relatively large forest patches and small patches of others) in the northern Carpathians is mainly a consequence of land use legacies from the Habsburg empire and socialist times (Turnock, 2002). However, after the fall of the Iron Curtain in 1989, it has

experienced substantial changes (Hostert et al., 2008, Kozak, 2009, Turnock, 2002). Moreover, a new set of drivers have been triggered after the accession of countries of the region to the European Union (2004). This new situation reflected mainly in agricultural land abandonment leading to forest increase or expansion of built-up areas. Therefore the aim of this paper is to assess land cover change (taking into account both conversion and modification) in the northern Carpathians during the last decade, in large, regional scale, on the basis of MODIS data sets.
To map land cover changes 154 MODIS scenes (Vegetation Indices (MOD13Q1) and Surface Reflectance (MOD09Q1) products) from Earth Observing System (EOS) MODIS data set is used. The images are acquired between April and October (2 points of time for each month) which reflected the vegetation period in the mountainous region, from 2001 to 2011. Ancillary data are CORINE Land Cover (CLC) database for years 2000 (CLC00) and 2006 (CLC06) and Shuttle Radar Topography Mission Digital Elevation Model (SRTM DEM).
Various approaches can be used to reveal land cover change. They can be divided into two groups: bi-temporal change detection based on the snap-shot model and a trend analysis of time series (Coppin et al., 2002). In this paper trend analysis approach is used. Such studies are not prevailing in digital change detection. They are usually used with high temporal resolution products (e.g. AVHRR). Due to reducing differences in comparison of images from different points of time change detection based on development curves (profiles) has been proven to be appropriate for studies in a regional scale (Coppin et al., 2002). What is more, it allows to detect more elusive alterations, describes trend and direction of changes and predict future changes.
Preliminary results show negative trend for the whole analysed region with slight differences between particular years.

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Land surface phenology of Carpathian sub-alpine and alpine grasslands based on 10-year MODIS NDVI Series

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Time series analysis of satellite based vegetation indices as NDVI represents a robust tool for characterization, monitoring and trend detection of ecosystems. Namely, land surface phenology based on annual profile of NDVI attempts to identify specific phenometrics related both to specific timing and quantity of vegetation development. The most common phenometrics are: start of the season (SOS), end of the season (EOS), length of the season (LEOS), maximum value (MAX) and amplitude (AMPL). Furthermore, identification of inter-seasonal variability of these phenometrics and its relation to climatic data represents basic task of land surface phenology. There are many studies using this approach for identification of short term response of ecosystems to climate anomalies and for detection of trends in ecosystem development driven by climatic change. However, due to the low resolution of NDVI satellite products, there are mainly studies at global and continental scales. At regional studies, landscape and land use diversity need to be considered in order to correctly detect land surface phenometrics of specific ecosystems. Specifically, in mountainous regions, rough terrain and local microclimate form a patchy environment with scattered small biotopes, often distinctly varying within short distances. On the other hand, these ecosystems are natural and very sensitive to climate and thus suitable for climate change impact studies. Furthermore, remote sensing of mountainous ecosystems is very difficult for other reasons as missing data for snow, haze and isolated small clouds. Recently, novel approaches and techniques have emerged dealing with similar problems in high latitudes and Alps (Beck et al., 2006). Authors suggest introducing of winter NDVI and double logistic regression fitting methods that reflect well the short vegetation season and a lot of missing data in this type of environment. Busetto et al. (2010) and Fontana et al. (2008) in their comparison study with field data prove that the identification of land surface phenology of alpine grasslands and larch forest is possible even at 250 m spatial resolution of MODIS NDVI product. In our study we analyzed 10 years time series of MODIS NDVI data of alpine and subalpine grasslands of the whole Carpathian mountain range. We aim to correctly characterize land surface phenology of this specific ecosystem. Namely, we identified selected phenometrics and analyzed effect of regional climate anomalies on their inter-seasonal variability. A 10-year series of NDVI vegetation indices was extracted from MODIS product MOD13Q1 (16 days maximum value composite of NDVI at 250 m spatial resolution) along with quality assurance information. Only good quality pixels (vegetation index usefulness good and higher) were selected for analyses. Incomplete time series was later adjusted by curve fitting using double logistic model in TimeSat software (Jonsson et Eklundh, 2004). The following phenometrics were extracted subsequently: start of the season (SOS), end of the season (EOS), length of the season (LEOS), large integral (LAIN), small integral (SMIN). Left derivative (LEDE), right derivative (RIDE), maximum value (MAX), base value (BASE), middle of season (MID) and amplitude (AMPL). Erroneous values of the model (e.g. those exceeding unrealistic maximum NDVI values) were excluded from later analyses. The crucial step for the correct identification of phenometrics was the selection of the homogenous grassland sites. In fact, sub-alpine and alpine grassland ecosystems represent mosaics of grasslands, bare rocks, dwarf shrubs, pine shrubs and open sparse forests near the tree line. Our aim was to select only grassland sites within homogenous MODIS pixels in order to minimize variability due to the mixed pixels occupied with other than grassland vegetation. This was done with the combination of available land cover data and visual inspection of Google Earth. Finally, around 1000 pixels above the 1500 m a.s.l were selected for the study. European climate gridded product (E-obs), namely daily temperature and precipitation at 0.25° spatial resolution was used for the correlation analysis of regional climate and phenology anomalies.

In general, seasonal profiles of NDVI reflect mainly short vegetation period with rapid productivity during this short time. Spatial variation of these seasonal profiles is consistent being the highest in spring and autumn while it is lower in mid-season where NDVI becomes saturated. All phenometrics inter-correlate a lot, with AMPL, SOS, LAIN, BASE being the most explanatory. Inter-annual variability of regional temperature anomalies better correlated with SOS anomalies than precipitation anomalies. Inter-annual variation of AMPL was spatially less consistent, that can be explained by different grassland vegetation types in particular mountain ranges. It seems that more complicated combined effect of precipitation and temperature anomalies that varied in particular years and amongst the mountain ranges limits the production of the alpine grasslands. These results imply that better data on vegetation type distribution are needed in order to explain ecosystem and phenological response of alpine grasslands to regional climate variability.

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NDVI-based analysis of the effect of precipitation on forests in Aggtelek Karst, Hungary

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Introduction. Forests are especially vulnerable to climate change, due to the longevity of trees. Through its impact on forest growth, it will affect both long-term wood supply and carbon sequestration in trees, forest soils and wood products (Kramer and Mohren 2001). Hungary being situated on the climatic boundary between forests and forest steppe vegetation there are concerns that many of our current forest areas would in the future be unable to fulfil their functions with the present species composition (e.g. Mátyás 2008, Czúcz et al. 2011). However, as the mentioned authors also emphasize, this is a complex issue.

Karstic habitats are in many cases quite extreme due to erosion from previous management, increasing their vulnerability. Aggtelek Karst is one of the southern foothill regions of the Carpathians. It is a highly diverse transitional area where continental, alpine and Mediterranean species occur together within short distances, which makes it especially sensitive to change. Ellenberg's Climate Quotient clearly shows this transitional nature (between oak- and beech-dominated forests), slightly favouring oak. After severe droughts and a lack of humid periods in the 1980’s and 1990’s, the 2000’s showed the presence of both extremities, sometimes shortly following each other. Despite the climate conditions apparently favouring oak, a small increase in the dominance of beech and the retreat of sessile oak was shown by historical records (and recently the evidence of deadwood) from the 1980’s (Tanács 2011).

The aim of the present research was to complement earlier results based on archive data, indirect evidence and field experience with some objective measure of the effect of precipitation amounts on the area's vegetation. Vegetation indices calculated from satellite imagery have been widely used for such purposes, recently especially data from NOAA AVHRR and MODIS (for further reference see the review of Pettorelli et al 2005). In this case however the high spatial diversity of the karstic surface and as a consequence the vegetation did not allow the use of spatially coarse-scale data. Since the length of the available time series was also important Landsat (TM) data were chosen for the analysis and NDVI was calculated for different types of forest stands.

Data and methods. 10 summer scenes with the least possible cloud cover were selected from the years 1985, 1987, 1993, 1994, 2006, 2007, 2009 and 2010, most of them from late July or early August. After the atmospheric and topographic correction and edge matching NDVI was calculated for all scenes. For all 10 periods, we acquired precipitation data for the specific month and the previous month, and calculated Standard Precipitation Index values based on the period 1958-2010. The examined periods were then classified as normal, dry or humid periods, based on a.) the amount of precipitation b.) the SPI categories. Point samples from 25 forest stands were chosen based on forest inventory data and field experience, classified as 'coniferous', 'beech-dominated', 'mesophilic oak-hornbeam', and 'dry oak-dominated' forests. We then examined the relationship between the amount of precipitation in the actual and previous month as well as the SPI and NDVI values of the samples. We also investigated the differences of the mean NDVI between humid, normal and dry periods in the different forest types.

Results and discussion. First, Spearman's rho correlations between NDVI and SPI as well as NDVI and precipitation were calculated for both the sample points and the stand averages. When all stands were included the results showed a significant but weak negative relationship between the NDVI and precipitation, and the same for the NDVI and the 2-month SPI values. When examining the same relationships separately in the different forest types, they proved to be rather varied. In general the 2-month SPI seems to have the strongest effect on the NDVI values as well as the previous month's precipitation amount. Beech and oak-hornbeam forests have moderately strong negative correlations with the 2-month SPI but are also affected by the 5-6 month SPI values. In the case of dry oak forests, the correlations are very weak and only significant for the 2-month SPI. Coniferous forests have weak positive correlations with the 2-month SPI.

In the Aggtelek area the studied period (1985-2010) can be considered rather dry compared to previous decades. According to the monthly precipitation amount or 2-month SPI only 2010 can be considered a humid year (with extreme high amounts), whereas 1985, 2006 and 2009 are 'normal' and 1987, 1993, 1994 and 2007 dry. The results of the Mann-Whitney U-test show that the stands' mean NDVI values for the dry and normal years do not differ but the values for 2010 are lower (except for the conifer stands, where they are higher). When carrying out the same test for the separate sampling points, the mean of dry years is significantly higher than the mean of the normal years and both higher than 2010 (except the coniferous stands which show an opposite trend and the dry oak forests where dry years do not differ from normal years). Using a different classification (based on the previous month's precipitation) results in a higher number of humid periods but the results are similar.

Coniferous forests in the area are not native and the samples mostly consist of Picea abies-dominated stands, and this species requires higher precipitation than usual in the area. Therefore it thrives in humid years and suffers from drought. Mesophilic beech and oak-hornbeam forests can be found on the best sites and to some extent are able to retain water therefore their state corresponds to the weather conditions of longer periods and not just the previous month. They behave similarly in most cases since their species composition is similar. As for the lower NDVI values in the humid periods, our field experiences show that while drought has little apparent effect on the stands, humid years see an increased mortality in the mesophilic stands due to the temporarily saturated shallow soils being unable to support the weight of trees. Too much moisture may also lead to foliage diseases. Dry oak forests have adapted to extreme conditions and seem less affected by fluctuations in precipitation. However there are too few years in the database and one with extreme weather, so the results should be handled with care. Further analysis is planned including scenes from other years (possibly using Landsat MSS and ETM data), more background factors (e.g. stand age) and forest damage records.

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POSTER PRESENTATIONS

Airborne hyperspectral remote sensing – potential, data processing and quality indicators

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Airborne imaging spectroscopy techniques (also often called airborne hyperspectral remote sensing) are providing unique operational tools for local-to-regional spatial and temporal monitoring of landscape status and change. Compared to traditional multispectral data, it offers a continuous coverage of electromagnetic spectra within their spectral range, where the so-called “spectral signatures” of the surface are acquired rather than discrete values within broad spectral bands. The typical range of a hyperspectral sensor are the visible and near-infrared (VNIR) ranges, i.e. 400 – 1000 nm towards short-wave infrared (SWIR) within the 1000 – 2500 nm regions. This allows a

development of new methods for Earth surface object detection including a high accuracy target detection and/or quantitative retrieval of surface properties. The application of hyperspectral remote sensing data in the scientific and even the commercial community is quite broad - from agriculture (yield prediction and precise farming), forestry (forest health status, biomass estimation, species composition mapping) through geology (e.g. mapping of minerals, land degradation assessment), up to limnology (e.g. water quality evaluation), and other domains (e.g. military).
Raw hyperspectral data from the hyperspectral system needs basic pre-processing in order to be useable by the end-users. Several software tools and packages have been developed for radiometric, geometric and atmospheric corrections of airborne remote sensing data. A typical pre-processing of airborne hyperspectral data will be demonstrated in pre-processing chain which has been established at Global Change Research Centre – CzechGlobe (CVGZ, Academy of Sciences of the Czech Republic).
There exists a number of hyperspectral data providers in Europe nowadays. However, each of them uses its specific processing chain but harmonized quality indicators and quality layers accompanying hyperspectral data are missing very often. This was also the main reason for a formation of the Joint Research Activity JRA2 "HYQUAPRO" within the FP7 EUFAR project (http://www.eufar.net). The JRA2 had been focused on developing of standardized quality layers for hyperspectral data. Finally 13 quality layers were agreed to be a common base, that each hyperspectral data provider, the CVGZ including, incorporated into his own processing chain.
The poster presentation will be focused on description of quality layers developement and its integration into the processing chain. The state-of-art hyperspectral data pre-processing chain will be presented. Finally several examples of imaging spectroscopy application in ecological studies will be demonstrated.
Since 2004, the Global Change Research Centre – CzechGlobe (CVGZ, Academy of Sciences of the Czech Republic) has been operating the VNIR airborne hyperspectral sensor AISA Eagle. The AISA Eagle system is being produced by Spectral Imaging (Specim Ltd, Finland) company.
Currently, the AISA Eagle system at CVGZ is used for scientific purposes. The imaging spectroscopy data are used to monitor the vegetation response to environmental conditions and map the current status of montane forest stands and grassland ecosystems. The permanent research site of the CVGZ called Bilý Kříž (located in the Moravian-Silesian Beskydy Mts.) became the first test site where AISA Eagle images have been acquqired at ground-based as well as airborne platform. In the following years, a new permanent site of a beech forest nearby the village of Štítná nad Vláří (White Carpathian Mountains) has been established to acquire a temporal series of hyperspectral data. The AISA Eagle system is being recently involved in many research projects, e.g. 1/ identification of the xanthophyll cycle and chlorophyll fluorescence of montane grassland ecosystems using ground-based AISA image acquisitions; 2/ development of physically-based algorithms to estimate the health status of montane Norway spruce (Picea abies (L.) Karst) forest stands from airborne high spatial resolution hyperspectal images; 3/ forest response to the bark beetle outbreak in the Šumava Mountains. Moreover, airborne hyperspectral data were used in theoretical studies of the so-called spectral invariants theory.
Study for this article was supported by the CzechGlobe Centre developed within the OP RDI and co-financed with EU funds as well as the State Budget of the Czech Republic (Project: CzechGlobe – Centre for Global Climate Change Impacts Studies, Reg. No. CZ.1.05/1.1.00/02.0073), CzeCOS infrastructure LM2010007, Czech Ministry of Education (COST OC09001) and FP7 project EUFAR 227159.

Analysis of the vegetation cover in the eastern Căpățânii Mountains (Southern Carpathians, Romania) between 1973 – 2005 using remote sensing and GIS data

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The alpine pasturelands of the Romanian Carpathians have long been exploited and increasing in size, especially where the natural environment allowed sheepherding as a traditional economic activity. Spruce forest and dwarf pines were the most affected species. It is known that they form some of the most fragile ecosystems within the high mountain areas. Therefore, this study is focused on the changes that affected the timberline in the eastern Căpățânii Mountains between 1973 and 2005.
They are part of a wide-spread orographic cluster in the Southern Carpathians (The Parâng Group). Their central area resembles most of the ideal characteristics of alpine pasturelands: low slope, medium to high elevation (1750 – 2100 m), southern exposure mainly, moderate to high humidity. At present, the eastern area of the Căpățânii Mountains is less affected by deforestation, overgrazing and construction comparing to the western area.
We used remote sensing and field observation for a more accurate analysis. Available data cover a 32-years interval: MSS (1973), MSS (1977), TM (1986, 1992), ETM+ (2000) satellite imagery, topographic map of 1980, and high resolution orthophotoplans (2005). Change detection method is very useful in land cover change research (Mas, 1999; Mihai et al., 2007) and it reflects accurate changes in different vegetation types (in this case, spruce forest and alpine meadows).
Results show that the spruce forest has recently recovered. The trees first cover the less exposed surfaces (valleys, ravines, southern slopes). One of the main reasons for spruce recovery is the decrease of sheepherding and grazing. Many sheepfolds were abandoned and shepherds have decreased in size. Some sheepfolds were reconditioned as temporary shelters for tourists. It is an original measure and a step forward to regenerate the damaged environment by protective use in the alpine pasturelands.

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ORAL PRESENTATIONS

A metaanalysis of drivers and patterns of land use change in the Carpathians and the Carpathian Basin

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The Carpathian region had a rich and diverse history during the last 200 years, with patterns and drivers of land change for the region as a whole remaining still largely unexplored. We aim to investigate land use and land cover change (LULCC) and its drivers across the study area. We created an inventory of existing LULCC case studies, and carried out a meta-analysis of the patterns and drivers of land change in the Carpathian Basin.

The case studies are focused on analysis of a broad range of spatial data: cadaster, topographic maps, aerial photographs and satellite data and go back as far as the mid-18th century. Information was summarized for several key time periods (Austro-Hungarian Empire, interwar, socialist period, post 1989). Data on LULCC classes, processes and driving forces was collected and compiled in a structured way and georeferenced where possible. During the study period, land use change substantially in response to socioeconomic and political transformations. Major trends were the homogenization of land-use practices due to the expansion of the Austro-Hungarian monarchy in the late 18th century; agricultural decline in the late 19th century resulting from ongoing industrial development; industrialization and intensification of agriculture on collectivized land after World War II; and widespread abandonment of cropland and pastures after the breakdown of socialism in 1989. In recent years, land abandonment, reforestation, and urban sprawl were the main land use trends, potentially related to EU subsidies but their effects remain unclear.

Our meta-analysis of case studies provides important information on broad-scale land use change in the Carpathian Basin over the past 200 years. It provides a valuable quantitative summary of available data, and underlines the most important variables driving change over time, leading to identification of regional patterns of change in the Carpathian basin.

Land use and land cover change in the Polish Carpathians – analysis of the ground-based repeat photography

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Land use and land cover changes (LUCC) are perceived as major factors affecting global environmental change (Mayer, Turner, 1994). To study dynamics of LUCC different kinds of data are analysed e.g maps, aerial and satellite imagery, statistical data. When satellite or aerial imagery are useful in shorter periods, historical maps, statistical data and ground-based repeat photography offer the possibility to go further back in time. What makes ground-based photography especially valuable is the possibility to compare thematically consistent and fully comparable data even over periods longer than 100 years (Hendrick, Copenheaver, 2009; Roush et al., 2007). Information obtained by repeat photography is also different, because it gives a possibility to understand the impact of LUCC on the mountain landscape to non-specialists (Moseley, 2006).

In this article ground-based repeat photography is used to study LUCC in the Polish Carpathians. From more than 7000 historical photos and postcards, acquired from regional museums, archives, private collections and historical albums and newspapers, 102 photo-pairs were finally retaken and analysed. The historical photos used in the study were taken between 1875 and 1975 and repeated by the author between 2008 and 2011. Detailed locations of the study areas were depending on the availability of historical photos and are situated in four different regions in the Polish Carpathians.

The analysis were divided into qualitative and quantitative part. In the first phase, changes in the land use, based on the interpretation of the agriculture, forests, settlements and technical infrastructure were analysed on each of the photo-pairs in qualitative manner. Results were summarised by using correspondence analysis (CA). In the second phase qualitative analysis of the land cover on the selected photo-pairs was conducted. Using a regular grid overlaid on old and contemporary images, each cell was assigned a value indicating no-, partial- or total-forest cover. Relationship between land cover change and topographical position (altitude, form of relief) was statistically tested by using Cramer's V. Additionally changes of visual landscape by comparing selected landscape metrics (e.g. number of patches, relative mean patch size) for both historical and repeated photo in selected pairs were analysed.

The results show significant increase in forest cover, combined with abandonment of agricultural lands as well as increase of settlements over whole study area. The analysis highlighted also the process of landscape homogenisation with dominant role of forests.

Increasing role of the relief in differentiation of land cover on contrary to altitude over time was also observed.

Results of the study correspond to the results of other works focused on long-term land use and cover change in the Polish Carpathians, however by its form, they give the new insight into possibilities of communication science to the non-professionals, what is very important in terms of participatory planning process as well as increasing the awareness of impact of human decisions on the environment.

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Land cover change in low mountain landscapes of Lviv Oblast (Ukrainian Carpathians) during last three decades

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The goal of the study was to detect and analyze land cover changes (LCC) with respect to the environmental and socio-economic feature in the five model municipalities. Key areas are rural and situated in: 1) foothill – Nahuevychi (2,513 ha), Stara Sil (3,179 ha); 2) low mountain – Yamelnytsya (2,061 ha), Boberka (6,797 ha) and Yasenytsya (4,314 ha) of Ukrainian Carpathians. As the main data was used old 1:50,000 soviet topographic maps 1976-1989, 3-arc second SRTM data and recent satellite images dated from 2005-2008.

At first, a mosaic of natural geoecosystems (GES) are delineated using landforms as the primary component (feature), and which reflect distribution of other hydroclimatic and biotic components, including the potential natural vegetation (PNV). Natural GES include only natural components (also potential) of landscapes. The landforms were manually delineated from topographic maps and characterized by average slope, aspect, and mean elevation (representing altitudinal bioclimatic belts) using statistical overlays with SRTM 3-arc-second data. Then, the PNV and soil were established as a function of morphometry/surface drainage and elevation within the landforms.

The actual land cover pattern and pattern of 1970-1980s were delineated using topographic maps and high resolution images from the Google Earth respectively. Then, the land cover change data were overlaid with the natural GES data for further analysis. Transportation accessibility was included into the analysis as additional economic parameter. It was calculated as a cost-distance surface from the settlements and roads using terrain slope value as a cost surface. The same calculation was made to model marginality of location which is established as cost-distance from the settlements and paved roads. Also we used cadastral map to investigate the relation between land use/owner structure and recent LCC.

The important intermediate result of the study is a geo-dataset of natural GES embracing 41 types with attributes on topographic location, average altitude, mean slope, type of bioclimatic altitudinal belt, soil and dominant PNV. Overall, 11 types of PNV were distinguished. In Nahuevychi and Stara Sil, Carpineto-Querceta and Fageto-Querceta PNV types dominate. However, in Yamelnytsya and Yasenytsya Abieto-Fageta PNV type cover more than 60% of the area. In Boberka, the shares of Abieto-Fageta and Fageto-Abieta PNV types are almost equal. The only municipality with is presence of spruce in PNV types is Yasenytsya.

Six types of land cover changes were distinguished. Three of them can be aggregated in a group with secondary succession changes. In these areas, which were formerly extensively used by agriculture, land cover was replaced by coppice, shrubs, and forest. Another three types of LCC are the result of the forest logging.

The total area with LCC estimates for Nahuevychi and Stara Sil 58.8 ha (2.3 %) and 135 ha (4.2 %) respectively. In other key areas LCC reaches for: Yamelnytsya – 582.7 ha (28.3 %), Boberka – 733.5 ha (10.8%) and Yasenytsya – 622.9 ha(14.4 %). In Stara Sil and Boberka replacement of grassland with forest dominates. In Yamelnytsya and Yasenytsya the occurrence of forest on the place of shrubland estimates in more than 30% of overall LCC.

The LCC more often occurs on moderate and moderate-to-steep slopes, but only in Yamelnytsya – also on steep slopes. The most uncommonly LCC observed within GES of hydric and ultra hydric drainage condition. Our results showed that the LCC occurs with more or less the same intensity in all PNV and natural GES types. The only significant exception is the absence of LCC in the GES with Carpineto-Querceta in Stara Sil.

Areas with land cover changes are mainly situated on forest edges or within the forest. They are not remote far from roads and settlements. But in Boberka and Yasenytsya about 40% of LCC occurs on area with high marginality of location (>4500 conditional meters). In Nahuevychi and Stara Sil LCC more often took place in state forest. However, in the rest three municipalities it was observed more often on agricultural and reserve areas, in addition – within communal forest in Boberka and Yasenytsya.

A common tendency for four of five model municipalities is the increase of the area with forest or dense shrub cover owing to degradation of former agricultural lands.

Our results about structure of natural GES and recent LCC are the essential precondition of efficient management of natural resources. Also this data could be used for development of municipality's master plan.

The models of the upper Wisłoka catchment area landscape changes in the 20th and at the beginning of the 21st century

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Changes in landscape are vastly determined by land-use transformations and may be directed by a number of factors and processes. However, climatic changes and human activity are believed to be dominant when transformations in land-use over time and space are taken into account (Koomen, Stillwell, 2007). When properly modeled the directions of these changes reveal several possibilities to predict, control and put selected processes on the right and desired tracks.

The changes of landscape present in Central and Eastern Europe are believed to be parallel to the socio-economic changes regardless whether they occur on a state or local level. This is especially true for the whole 20th and the beginning 21st centuries. These changes have been caused by a number of man-made processes, inter alia: wars, political and economic transformation or migrations. From this point of view, landscape is intensively explored by the researchers from all of the Carpathian countries (e.g. Maciejowski, 2001a, Halada et al., 2002, Kozak et al., 2007, Sitko, Troll 2008, Balteanu et al., 2010).

The main aim of this study is to show the changes present in the landscape of the upper Wisłoka catchment area since the beginning of the 20th century and to demonstrate their causes along with natural and socio-economic determinants. Moreover, the author attempts to construct a synthetic

model of changes this landscape gone through during last 100 years. Possible scenarios concerning further changes are presented on this example. Notably, a part of the area under investigation operates under special legal regulations as a part of the Magurski National Park.
It is possible to obtain cartographic materials for the last 100 years only by processing them into the scale of 1:50 000, therefore this scale has been applied as the largest one utilized in this study. The maps include, inter alia: WIG topographic maps (1:100 000 for the period of 1933-1938), Surveyor General of Poland maps (1:10 000 and 1: 25 000 for the 1977-1980 period) and aerial photos from 2009. Furthermore, a large part of the study setting has been examined previously by the author and this dates back to the early 1980s (Maciejowski, 2001a).
The upper Wisłoka catchment area is located in the central part of Beskid Niski and covers almost 300 km^2. This area is typical for low mountains and has experienced substantial changes in the landscape during the whole 20th and at the beginning of 21st century.
Agricultural lands prevailed in the upper Wisłoka catchment area in the early 20th century. At that time, arable lands covered low and middle parts of the slopes, in some cases even reaching these sloped at an angle of 15-20^{o} (but terraced in many places). Similarly, leveled fragments of ridges were utilized for the benefit of arable farming. Meadows and pastures concentrated in high parts of the slopes and valley bottoms whereas forested areas were dispersed randomly and formed patch-shaped distribution. These forests comprised stands of beech trees growing within steep slopes (at an angle of above 30^{o}). The maximum range of cultivated lands exceeded 600 meters above mean sea level (Maciejowski, 2001b). These lands were parts of quite densely populated villages at the time (e.g. Krempna, Polany, Grab, Ożenna, Radocyna) where in 1938 resided over 5.5 thousands inhabitants.
The landscape of the upper Wisłoka catchment area was subjected to very dynamic changes after 1947 as a consequence of sudden depopulation. The World War II and Battle of the Dukla Pass in 1944 took a great death and material toll leaving this area partially ruined. Those who remained were later uprooted as the several waves of planned and forced resettlements were put into effect (e.g. Operation Vistula). Although some of the displaced people returned home after the war, the total decrease in population reached up to about 80%. Several villages remained uninhabited until the present day (e.g. Wilsznia, Ciechania, Nieznajowa, Rozstajne). The once agriculturally-slated areas shrunk considerably being replaced by natural forest succession. Terraced slopes were rapidly taken up by birch (*Betula*) and grey alder (*Alnus incana*) trees. In the beginning of these changes concerning land-use structure grasslands prevailed in the landscape, but were soon replaced by successively expanding forests. In the 1960s the upper Wisłoka catchment area was subjected to planned forestations with spruce (*Picea abies*) and larch (*Larix europaea*) trees and this occurred predominantly within the hills sloped at an angle of above 10^{o}. All of the aforementioned processes contributed to a significant increase of the sylvan areas. Furthermore, their total area almost tripled with a concurrent relocation of cultivated land boundary down to 490-500 meters above mean sea level. Consequently, denudation slowed down as pastures and forests were gradually replacing arable lands, surface runoff decreased in favor of subsurface runoff. The latter process was responsible for a slowdown of water circulation in the whole upper Wisłoka drainage basin.
In the mid-1980s this area hosted another stage of intensified human activity as extensive exploitation of forests was ushered in (aimed mainly at beech and alder wood). In addition, between 1984 and 1992 a large area of meadows and pastures was utilized for cattle and sheep grazing - an activity managed by prosperous State Agricultural Farms (PGR) of which the largest were located in Mszana and Ożenna.
The first few years of the 1990s are very important for the whole region. In 1995 almost a half of the entire area under investigation became a part of a newly-founded Magurski National Park, which followed the foundation of Jaśliski Landscape Park in 1992. The latter covers only a small and western part of the examined area. The new legal regulations adopted then go into effect today and clearly differentiates the management and human activity in the protected zones and outside them. In the areas located beyond both parks the economic collapse of large state farms in the early 1990s

is followed by numerous purchases of remained vacant land by individuals. Presently, this results in rapid development of new housing and steady expansion of road network.
Thorough exploration and understanding of both present and prospective changes in contemporary landscape on the example of upper Wisłoka catchment area would allow for broader conclusions to be formed including an international level (the whole Carpathians). This knowledge when put into practice can produce standards for policy actions. Presently, numerous areas in the Carpathian Mountains remain at two concurrent trajectories of development. In spite of increasing human interference, the landscape is subjected to advanced forms of conservation and/or renaturalization as many protected areas are have been established, including national parks.

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POSTER PRESENTATIONS

Riparian zone of water streams in Slovakia – global and local aspects of land cover changes and the future trends

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River landscape as a corridor entity is often interpreted as the space on the bottom of a valley or the bottom of any depression with a stream which is a “product” of fluvial processes and where the substrate-morphological base consists of fluvial sediments in form of a floodplain, a channel with a bottom and banks along with the facial soil habitat structure with plant and animal associations and eventually the land cover structure where the specific social and economic activities and processes take place. Riparian zone is a 3D product of interaction between the aquatic and terrestrial natural systems and it forms a corridor with a specific spatial and ecological gradient stretching along banks and across the floodplains. Its limits are defined by the scope of the flooded parts of the floodplain on the one side and on the other side its boundaries are in the part of bank or bars connected with the bank that are situated above the bank-full stage. The aim of the study was to analyse land cover changes in the riparian zone of not forested landscape based on comparison of its status in two different economic and/or political time horizons (1987 and 2003) and to interpret the trend of development on three hierarchic level: the national level, the level of a segment of the selected water stream and the level of river reaches. Three hierarchic levels make it possible to reveal the global trend and to identify and interpret its regional and local variability as the result of effects exerted by the social, economic and natural drivers. The basic information source about landscape structure was orthophotographs (2003) of Slovakia in the S-JTSK system and aerial black-and-white photographs (1987) spatially adjusted to the same coordinate system. Via the GIS, on the level of Slovakia:

a) Riparian zones of water streams in not forested landscape were classified based on the criterion of the presence and connectivity of its vegetal formations in 1987. The following types were established:

1. Void of vegetation or distinctly discontinuous vegetation (with isolated trees of shrubs or their groups),
2. Discontinuous vegetation (disrupted line structure of riparian vegetation, denuded banks of water streams),
3. Continuous vegetation,
4. Strip corridor vegetation.

b) By overlaying the two layers, types of the riparian zone according to the potential development of their vegetal associations were established:

1. A type with the development of riparian vegetation at a standstill,
2. A type with a progressive development of riparian vegetation,
3. A type with a distinctly progressive development of riparian vegetation,
4. At type of the strip corridor with progressive development of riparian vegetation.

c) Based on the land cover map of Slovakia (2006), the layer of four types of the environment in the riparian zone as spaces that potentially control the development of its vegetal formations was produced. The following environments were established:

1. Very limiting environment (land cover categories 111, 112, 121, 122, 123, 124, 131, 132, 133, 141, 142),
2. Limiting environment (211, 221, 222),
3. Stimulating environment (231),
4. Highly stimulating environment (242, 243).

d) Geo-statistical analysis in order to quantitatively assess the variability of riparian zone types pursuing the geo-ecological landscape types in Slovakia was carried out.

e) Map of the developmental trends in riparian zones was compiled.

Change of land cover and the developmental trend of the riparian zone on two lower hierarchic levels, it means at the level of the water stream segment and its four parts – river reaches – was analysed on the type of the riparian zone with continuous vegetation and the limiting farmland environment. The model area was an approx. 35 km long riparian zone of untrained channel of the Torysa River (50 m both from the right and left banks) between the villages of Haniska and Vajkovce in the Košická Basin (eastern Slovakia). Information source was the same as for the national level, but land cover was classified into 13 types (1. main channel with water, 2. abandoned floodplain channels with water, 3. bars void of vegetation, 4. bars and banks with short herb pioneer formations, 5. floodplain swamps, 6. permanent grassland, 7. permanent grassland and scattered groups of trees or shrubs, 8. continuous shrubs, 9. floodplain forest, 10. arable land 11. gardens and garden colonies, 12. built-up areas and 13. construction areas whereas types 6 to 9 represent vegetation land cover types). Overlay of land cover type layers from the quoted periods and

compilation of contingency tables for the whole segment as well as each river reach made it possible to estimate the global developmental trend for the whole segment either as a converging one heading to the formation of a new structure or a diverging trend proceeding to the differentiation of LC structure including the local trends in river reaches.
The possible conclusion of accomplished analyses on the three hierarchic levels is that the scenario of changes that took place in the riparian zone is positive and convergent. In general, the contact zone of water and bank is changing – proportion of shrubs and forest increases at the cost of grassland, pioneer vegetation and the types uninhabited by vegetation. While the human impact on the farmland in the distal part of the riparian zone increases, extensive management of the proximal part decreases. The type of interrupted riparian vegetation but also the distinctly progressive trend of development accompanied by the increasing width and bulkiness of the riparian zone with continuous vegetation prove it. Grassland existing on local level is not maintained in its original scope and quality and its area and those of orchards and gardens are diminishing. In the vicinity of cities and large rural settlements areas of arable land and built-up LC types increase. On the other side and especially in lowland landscape the type of riparian zone void of vegetation and that with distinctly interrupted vegetation linked to the system of artificial canals stagnates. Many line elements along the Rivers Váh and Hron that might become the types with vegetation of strip corridor seem to be problematic. Although the trend is obvious, an active approach to their management is desirable. Characterization of the type of the riparian vegetation or the one with distinctly disrupted vegetation in mountain and basin landscapes is similar.

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Regionalisation of landscape archetypes

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The several contemporary works of landscape ecologists deal with the problem of landscape type determination with the emphasis on the synergy of multidimensional landscape perception, i.e. the authors mention material part of the landscape and its physiognomy as well as perception of cultural-spiritual entity (Oťaheľ, Hrnčiarová, Kozová, 2008, Hofierka, 2008). The authors also mention efficiency of landscape typology, i.e. its use in the problem solving dealing with the environment by different implementation phases within the landscape planning documents, etc. Concept of landscape archetypes arises from the idea of complex spatial structures allocation in the hierarchical and logical sequence, from the higher level to the lowest one (Hreško, Kanásová, Petrovič, 2009). The landscape units being allocated on the basis of horizontal references of the secondary landscape structure are considered to be the output of landscape archetypes regionalisation. Their genesis and development also reflect vertical references among components of the primary landscape structure. Relation between the primary and the secondary structure reflects the landscape physiognomy, geometrical arrangement of landscape elements, as well as dynamics of processes leading to the landscape transformation and limiting possibilities of landscape utilization. Physiognomic criteria as are geometrical shapes, diversity, and arrangement of landscape elements, are the basic criteria of archetype allocation. Determination and evaluation of the landscape diversity and biodiversity represent significant process studying transformations of the landscape, its individual elements and components. The literature mentions the Shannon Index (SID) as generally accepted method supporting the acquisition of the basic information about time and spatial landscape transformations. The landscape heterogeneity and homogeneity as well as the level of fragmentation are closely connected with the landscape diversity. Arrangement of landscape elements arising from other scientific disciplines (as are for example physics, chemistry, and mineralogy) represents significant criteria of landscape type allocation. Arrangement criteria can be sometimes considered to be the indicator of system stability. The higher level of landscape arrangement, the better stability of its structure, and vice versa. The typical example is the alpine environment being influenced by pasturage resulting in fragmentation of the vegetation structure and disruption of natural ecotone continuum. Forms of landscape structure with the certain level of arrangement have been created as the result of the environmental conditions compliance and the factors determining the way of landscape utilization. Determination of the specific landscape structures with different level of surface and linear elements within the relatively stable borders of operation units (as are for example sub-basins or micro-basins) stands for the aim of the landscape archetype regionalisation.

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Traditional Agricultural Landscapes in the Slovak Part of the Carpathians – an Example of Land Use Research on Local Level

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Landscapes are also dynamic features which structures are developing almost continuously. As the landscape is composed of different components all having their own dynamics, many changes will occur simultaneously and continuously, all at their own speed and magnitude. Studying changes of one single, well defined component is rather simple (Forman, 1995). Landscape structure means the pattern of a landscape, which is determined by its type of use, but also by its structure, i.e. the size, shape, arrangement and distribution of individual landscape elements.

Changes in landscape structure, reflecting the development of human society and its activities, are differentiated depending on the physical-geographical and socio-economic factors. Historical agricultural landscape structures (HSAL) create mosaic of small-scale arable fields and permanent agricultural cultivations due to the specific regional agrarian culture.
Negative impact on the structure of agricultural country in Slovakia and the threat to its heterogeneity and biodiversity had collectivization and socialization processes of agricultural production, which took place after the 2nd World War in the 50s to 70s of the last century. However some HSAL are still preserved. They generate specific landscape image in individual regions.
Our contribution is aimed at detailed land-use research of traditional agricultural landscape. We selected 3 case studies (cadastral areas), located in the Western Carpathians, where there are different forms of anthropogenic relief with preserved diversified landscape structure. Cadastral areas of the Svätý Jur town, the Liptovská Teplička village and the Hriňová town are well-preserved sites from landscape-ecological, but also from cultural historical point of view. Research on current and historical state of land use was elaborated in three hierarchical levels.
Cadastral level: Contemporary land use structure was mapped according the metodology of Corine Land Cover project (Feranec, Oťaheľ, 2009), for purposes of the project the group of heterogeneous agricultural elements was clasified into more detailed level. The areas of HSAL were identified according the defined indicators of mapping key (Dobrovodská et. al. 2010), and landuse changes were studied based on the comparison with historical maps from the three time horizons (1938, 1949, 2010). The aim was to identify HSAL sites and their distribution in the cadastre model areas.
The HSAL localities level: We analysed the land-use type of plots, forms of anthropogenic relief (FAR) and its habitats. Six types of FAR were mapped that originated as a result of improving soil and relief quality of cultivated land. Additional information were recorded as well, e.g. shape of plots, relief plot curve, threats to maintaining the HSAL, general character of non forest vegetation, type of habitats on the FAR, elements of small architecture and significant tree species.
Micro-sites level : Micro-sites were established to present the basic types HSAL type in the pilot area. They were founded on the chosen FAR and also on agriculturaly utilised parts of plots for the purposes of observation of chosen groups zoological epigeic fauna, detailed soil and fytocenological research. On this level detailed characteristics were recorded as GPS coordinates, height, width, length, proportion of the rocky material in the substrat and conectedness of FAR, orientation, altitude, conectedness and cover of non-forest vegetation on FAR.
Research focused on land use structure of HSAL was the basis for further landscape-ecological evaluation of pilot areas to determine the biodiversity, cultural, historical and cultural significance of HSAL as well as setting strategy of their further management and protection. The research results were provided to local governments as a basis for decision making and planning for the future development of municipalities.

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The changes of land-use in Dukla municipality after 1945 against natural and socio-economic determinants

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The land-use structure is believed to be one of the most thorough measures that reflect the influence of human activity upon the natural environment. Land-use forms, including their variety, pace of changes and spatial ranges observed in an area, undergo constant modifications in accordance with the dominant types of human activity. These are shaped by historical factors and stages of socio-economic development. Simultaneously, the scope of changes farmlands and woodlands get to (both in scale and extent) considerably alter local carbon balance, water circulation, matter cycle as well as modify biodiversity (Verburg et al., 2009).

Rapid changes in land-use structure are now observed in the whole Central and Eastern Europe. Mountainous areas, including Carpathians, remain among the most susceptible to these changes. In some cases, especially on a local scale, the directions of changes in land-use may not be congruent with EU Common Agricultural Policy. For this reason, the results of this kind of research come in handy when supporting European Environment Agency (EU agency) attempts on verification and constant updates of the land cover data collected as part of CORINE Land Cover Program (Ciołkosz i in., 2011).

Presently, the whole Carpathians experience rapid changes of land-use structure. This, by and large, results from frequent abandonments of agricultural lands and subsequent succession of sylvan areas (Kozak, 2003, 2010, Ostafin, 2009). The latter causes the forest-agricultural boundary - one of the most important and discernible boundaries observed in the landscape - to relocate. This process is accompanied by a plethora of other phenomena connected with the changes regarding socio-economic development of this region.

The main goal of this study is to demonstrate changes of the natural environment in the mountainous areas on the example of Dukla municipality (Beskid Niski Mts) with a special regard to transformations in land-use forms as an observable evidence and anthropopression responsible for a number for factors underlying these changes. All of these socio-cultural and economic determinants shaping contemporary land development have been methodically identified and classified by significance for the land-use changes. Additionally, authors attempt to concoct a few scenarios of prospective changes in the natural environment in light of expanding civilization. The latter issues may also be considered as extra goals of this study. All of the work done has been supported by a range of available information on land-use in the past and scrupulous documentation of land-use changes in other areas of Beskid Niski (e.g. Lach, 1975, Warcholik, Dygoń, 2007). Another premise of this study is a deficiency of actual research concerning the study setting.

The study setting encompasses Dukla - an urban-rural municipality located in the eastern part of Beskid Niski. This municipality covers 235 km^2 inhabited by 15 thousands residents of which 15% live in the municipality seat – the town of Dukla. The area of Dukla municipality includes typical for the Western Carpathians ecosystems therefore may be regarded as representative for low mountains as a whole. Moreover, this region holds the remnants of numerous anthropogenic processes affecting land-use structure in the whole Beskid Niski during the 20th century.

In the first few decades of the 20th century Dukla municipality housed well-developed agricultural production and sparsely distributed crude oil wells. Military actions of the 1939-1945 left most of the area destroyed and following forced resettlements of 1944-1947 resulted in a serious decrease of population density. These actions greatly limited human activity in Beskid Niski and adjoining region of Bieszczady. In the southern part of Dukla municipality most villages quickly became desolated. Agricultural lands abandoned by the displaced population were subjected to natural succession of vegetation intensified later by planned forestations all responsible for relocation of arable land boundary (up to 100 m lower than before the World War II) and great expansion of sylvan areas (Maciejowski, 2001a). Since the early 1980s this expansion slowed down as a consequence of increased woodcuttings (mostly beech trees that were only partially reforested after the war) and intensified cattle and sheep breeding (prosperous local State Agricultural Farms commonly known as PGR). After socio-economic transformation at the end of the 1980s, the beginning of the 1990s a new process of human interference in municipality’s natural environment was observed and evidenced by gradual expansion of new housing (Maciejowski, 2001b), often erected as so-called seasonal second homes.

Present land-use structure in Dukla municipality is a main effect of the recent changes of total population (considered from a long-term, historical perspective) and contemporary socio-economic processes. Vast population loss connected with military actions that took place during the World War II (“Battle of the Dukla Pass”), post-war forced resettlements and large, selective population outflow significantly deformed demographic structures. The amount and quality of demographic potential (as measured by demographic reproduction, level of education, social and occupational structure) determines the demand for different kinds of land and diversifies their purposes in local economy. This greatly influences both the scale and range of particular land-use forms – forests, arable lands, grasslands and built-up areas. In the first decade of the 21st century as many as three factors associated with political and administrative changes can be distinguished. These include: 1) reconstitution of independent, self-governed local administration along with rising social propensity to self-determine and mobilize local government to take actions when necessary; 2) revival of market economy; 3) stimulation of socio-economic development by making use of borderland location with regards to (relatively new) legal solutions adopted by the European Union.

The possible scenarios of land-use changes on a local scale as compared to the whole Carpathian Mountain range are supposed to embrace such major elements shaping changes of socio-economic determinants as: 1) disparities in demographic structures 2) prevailing social attitudes towards migrations 3) human capital abundance 4) arrangement of settlement system 5) stability of economic situation 6) transformations in state policies and changes in territorial administration; and finally 7) influence of external factors and its intensity.

Thorough detection and deep understanding of these elements along with socio-economic circumstances distinct for a country under investigation would provide valuable guidelines for environmental policy. As a result, there is a chance for some processes to be properly monitored. This prompts the authorities 1) to shape appropriate directions of land-use changes 2) to pursue a local policy in accordance with both state development plans and EU directives 3) to consider a new environmental policy framework suitable for all countries and regions located in the Carpathians.

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The dynamics of land use in the middle sector of the Moldova river drainage basin (Eastern Carpathians, Romania)

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The evolution of land use reflects the anthropic influence over natural environment, illustrating the main features of the social, demographic and economic dynamics. This general statement has significant differentiations as a function of the diverse spatial, natural and administrative instances. Differentiations are obvious in areas situated marginal to the mountain area, being tightly connected with the different rhythms of population growth or increase from lowlands and highlands, with the resources complementarity and with the specificity of some social and economic factors.
Valuable information on land cover dynamic can be extracted from cartographic sources dating from different historic periods. Jointly analysis with actual remote sensing images (consecutive series with large spatial cover), in Geographic Information Systems (GIS), allow the creation of temporal assemblages for several scales.
The present study focuses on the restoration of the evolution of land use in the last two centuries in the middle sector of the drainage basin of Moldova river, which lies in the North-East of the Eastern Carpathians (Romania) and spreads in the mountainous, sub-Carpathian and plateau unities. The local characteristics of land use were analyzed from data obtained by digitizing the old map (1778) and cadastre plan (1856) of Bucovina, created in the Austro-Hungarian Empire period, topographic

maps (1894, 1940, 1984), satellite images taken during the last 30 years and the ortho-images of the year 2006. The diachronic integration and analysis of the data was made using ARC GIS 9.3 and TNT Mips 7.3 programs. The relations between different land uses and the main geomorphometric parameters were also subject to analysis, a useful instrument being the Digital Elevation Model (DEM) with its main derivatives (altitude, declivity, aspect) obtained on the basis of the topographic map at 1:25,000 scale.
Study results show that important differentiations in the dynamic of the land cover appear between the northern and southern part of the studied area. These differentiations are imposed by the evolution of the historic, social and economic environment of these areas. The northern part, especially for the XIX century is characterized by the expansion or the apparition of new locality, agricultural and pasture expansion, complemented by the significant reduction of forested surfaces, while in the southern part, for the entire period, the tendency of land use preservation, especially for forests, is characteristic, mainly because of a particular judicial regime.

Forest ecology 1

ORAL PRESENTATIONS

Identification and protection of old growth forests in Slovakia

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Research of the old growth forests in Slovakia has a relatively long and rich history. Nevertheless, complex information concerning of old growth forests has been more or less based just on a qualified estimate (mainly Korpeľ 1989). The absence of accurate data and the great threats to the natural forests in Slovakia were the main reasons to conduct the nationwide selective mapping of old growth forests in Slovakia.

Identification and mapping of old growth forests in Slovakia took place between years 2009 and 2010. Further mapping and a data rectification concerning some of the localities took place in 2011. Procedure of the mapping and identification was monitored and supervised by the Scientific Board of the project consisting of experts from various scientific disciplines - ecology, zoology, phytocenology and forestry.

From a methodology point of view, the mere identification and mapping of old growth forests was conducted in several individual steps. Initially, for the purposes of the identification definition of the term - "Old growth forest" was clarified. Subsequently, preliminary selection of the localities designated for mapping was conducted whilst several data sources were used. The pre - selection included localities which were in the past described as the old growth forests particularly by Korpeľ (Korpeľ 1989), but also by Vyskot (Vyskot 1981), localities based on information and pointed out by local experts or localities selected from the database of protected areas where subject of the protection was classified as a natural forest or old growth forest. The largest number of localities was selected from the database administered by the National Forestry Centre in Zvolen.

Selection criteria were based on the approximation of data regarding of the natural tree species composition, age and size of forest complexes. Following of the initial pre - selection, boundaries of the localities were adjusted in line with ortophotomaps. In total, for mapping were selected 325 localities with an area of approximately 60 000 ha. Concurrently, with the localities preliminary selection, methodology for the identification and mapping of old growth forests was developed. Criteria and indicators concerning especially ecology and structure of old growth forests were set and established. However, development of the methodology also had to take into account time, financial and technical restrictions of the project. Therefore, it was not quite possible to carry out detailed mapping of selected areas. In addition to the aforementioned, information regarding anthropogenic interventions and influence, and information regarding of the transport and tourist accessibility was also gathered. In order to minimise any subjective assessments of the localities evaluation matrix was developed which had to meet already established definitions and criteria.

In field, mapping was done by 25 selected surveyors, who have undergone two weeks training. Core members of the project team mapped almost half of the selected localities and some of the disputable results of the mapping were further verified by the core team in 2011. Found data were recorded into a database and information from the maps was processed in the GIS system into vector layers. Data can be further evaluated by statistical and geostatistical methods. Collected data have disclosed some alarming facts regarding of the status of old growth forests in Slovakia which came surprising also to the project team. There are considerably less of old growth forests than it was originally anticipated. Identified were 125 localities of old growth forests on an approximate area of 10 100 ha (Jasík, Polák 2011) which is only 0,54% of the total Slovak forest area. In addition, 170 remains of 1 520 ha were recorded; their mapping however has not yet been completed.

Original estimates of the project team varied somewhere between 20 000 to 25 000 ha of old growth forests. To briefly sum up, almost all identified old growth forest carry visible signs of human activities of minor scale from a long-time past. Old growth forests were mostly preserved in hard to access or remote areas. Ironically, localities which were difficult to access in the past - for example debris or remote areas at the far side of some valleys can be now days easily accessed by modern technologies. On contrary, areas which are now days hard to access by using modern technology - for example areas in steep rocky sites, were in the past preferred using gravitation of a wood. Scope of some influences from the distant past, such as grazing in forests or presence of large herbivores (bison, moose, bos, and wild horse - tarpan) was not possible to assess within implementation of this project. On the other hand, current influence of abundance of ungulates, quite often introduced (ovis, chamois) entail a serious problem in some old growth forest areas. Unfortunately, this problem is quite often overlooked by foresters. Evaluation of the gathered data has demonstrated some interesting results concerning of the mapped biotopes, their age, thick woods, deadwood etc.

Substantial researched information was also information regarding of the protection of old growth forests. Some old growth forests are protected only partly or are protected insufficiently. Almost one third of the identified old growth forest areas are not protected adequately.

Projects for protection of several of these localities were elaborated using information from the mapping. Attempts for wood harvesting in some identified localities, even in the ones with strictest protection were noted during implementation of the project. Some of the localities have been seriously damaged by wood harvesting. However, on the most of the localities we have managed to prevent intended harvesting. For these reasons advocacy work of the project had drawn considerably more resources than it was originally anticipated.

Conservation of several localities was aided by gathered data, but also by an enormous support of scientists. Some of the project activities were also focused on increasing of public awareness about significance of old growth forests. The most important are development and updating of the web site about Slovak old growth forests (www.pralesy.sk) and elaboration of an electronic study, where almost all gathered information can be found. In support of feasible utilization of the old growth forests which are included within world heritage sites “Carpathian beech forests” a study analysing existing possibilities with recommendations and measures was elaborated.

We wish to thank to all our surveyors, to the Scientific Board and other colleagues for their tributes to this project. We thank to our donors, who took part in co - financing of this project. Project was funded by EEA and Norway grants and State budget of the Slovak republic. Project was also co-funded by WWF.

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Tracking *Abies alba* and *Fagus sylvatica* over 30 years in Western Carpathians

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In studying the developmental dynamics of Carpathian fir–beech forests, many authors have noted the decreasing share of silver fir (*Abies alba*) in research plots and the replacement of fir by European beech (*Fagus sylvatica)*(e.g. Vrška et al. 2009). The general topic of our study is the comparison of tree spatial patterns of fir and beech, searching for the differences between them and investigating their tree spatial patterns in time.

Our research questions were: (i) how stable is tree spatial pattern within a single tree species over 30 years? (ii) Are there any statistically significant differences between the tree spatial patterns of fir and beech? (iii) What kind of spatial interactions can we find between beech and fir trees? And (iv) what is spatial dependence of both species on windthrow mounds?

Our study was performed in the Outer Western Carpathians in the Czech Republic, at the border with Slovakia. Detailed surveys were conducted in the Salajka (N49°24', E18°25'), Razula (N49°21', E18°23') and Mionší (N49°32', E18° 39') national nature reserves. The elevation above sea level ranges from 660–890 m. The terrain is characterised by slopes of various inclinations (up to 20°) and exposures. Thanks to strict protection since the 1930s we have had the opportunity to follow all these communities during their spontaneous development.

Seven 3-ha rectangular plots were analysed. The univariate pair correlation function g(r) was used to describe tree density variability of living trees with DBH ≥ 10 cm (e.g. Stoyan & Stoyan 1994). To investigate the spatial relation between species, we used the bivariate pair correlation function $g_{ij}(r)$. Edge effects were corrected using Ripley's isotropic correction (Ripley 1988). The analyses were carried out for datasets from the 1970s, 1990s and 2000s. A bootstrap method (Efron & Tibshirani 1993) was used to test for significant differences between the mean values of fir g(r) and beech g(r) and for estimating confidence intervals.

Bootstrap significance tests revealed significant differences between tree spatial patterns of beech from 1970s and 2000s. Tree spatial pattern of beech showed statistically significant lower clustering at the distances above 30 m in the 2000s. Vice versa tree spatial pattern of fir revealed commonly higher clustering of trees over 30 years.

In the 1970s significance test didn't reveal differences between the mean values of g(r) for beech and fir. In the 2000s tree spatial pattern of fir showed statistically significant higher clustering in the interval 14–24 m in comparison with tree spatial pattern of beech.

The spatial distribution between beech recruits and all fir trees revealed a positive association which is a marked difference against the independent or negative association between beech recruits and other beech trees.

Both tree species were strongly associated with windthrow mounds. However fir trees reveal markedly higher positive dependence on mounds than beech trees.

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Structure and functions dynamics in the Carpathian forests of Bucovina, during the last century

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The province of Bucovina is located in the northern part of Romania, mainly in the north eastern Carpathians and can be superposed to the actual Suceava County. In the 1775-1918 period, this region was annexed by the Habsburg empire and a lot of changes occurred in the organization and management of area, changes visible even today in comparison with other areas of the Carpathians. Because of the low density of population in the region (5.25 inahbitans/km^2 in 1775) and low accessibility, until the 19th century, more than 90% of the forested area preserved the structure and aspect of primeval forests. The replacement of natural balanced forests by monocultures has had a bad influence on forests, causing a great instability in the stands. Maintaining spruce stands stable is a challenge that must be solved by both forest management plans and sylvotechnincs tools. In the future the natural regeneration techniques will contribute to develop a "close to nature" silviculture with more productive and more stable stands.
Research methods. Based on old maps, descriptions and inventories made in the forest management plans (1870-2010) and the field studies made in the forest reserves we have established and mapped the "structures type" connected with the intensity of human activity (Barbu, I., 1994, 1996). Other methods for the study of the structure of stands are based on the measurement of the position of trees in space and evaluation of structural parameters based on the frequency of tree species according to the number of trees (N/ha), basal area (Gm^2/ha) and volume (V*m^3/ha) and the stages of development.
Frequency three types of forest structures were analyzed for the last century:
1. Primeval forests with old ages and dimensions of trees without human interventions by cuts
2. Secondary forest, natural regenerated forests on the place of ancient primeval forests
3. Artificial stands, artificial and natural regenerated after the cut of secondary forests. Most planted species were Norway spruce and fir.
Some forest reserves have been established after the First World War in all the vegetation belts in which large areas of primeval forests preserved for scientific purposes Slatioara, Giumalau, Calimani, Dragomirna and Zamostea are the best known.
Key results. In the Carpathians the low density of population and the lack of industry in the middle age and modern period have conserved most part of the forests. Only the lower part and the upper part of the forest massifs were affected by grazing and wood harvesting.
At the end of 19 century more than 90% of forests were virgin forests. The construction of railroads and forest roads made accessible the wood from Carpathians for the markets of Europe. Before, only few forests located in basins in which wood rafting (Bistrița) permit the wood transport were used. Our studies on some forest districts form the old Orthodox Church Forest Fund of Bucovina show

that the amount of spruce in the composition of stands has increased, whilst the fir and broadleaves proportion has decreased.

Lack of access in mountainous slopes forced the overexploitation in the accessible zones. Permanent administration of the forest appear at the end of 19 century after the first modern forest code. The practice of intensive silviculture start at the beginning of 20 century when the effects of the overexploiting of the plain forests are visible and new solutions for the artificial regeneration in sensitive areas are proposed. Intensification of the management in the state forests and church forests and the establishment of plantations after clear cuttings, of then compositing non local species become large and larges. Natural regeneration is also used on large areas of broadleaves forests treated in coppice system.

Disturbances must be incorporated in the decisional process of management of the forest, knowing the natural, disturbances regime and the risk induced by human transformation of the stands in the last decades centuries, through plantation and structure simplification (Ichim,R., 1988; Barbu, I., Cenusa, R., 1987).Disturbances include generally stochastic processes that disrupt the structure and functionality of forest ecosystems and may include abiotic (snow, wind, avalanches, fire) and biotic (insects, pests, game) factors. The *intensity*, expressed in % of damaged trees, and the *extent* of disturbances, expressed in % area affected in one event and the *frequency* of such events in the life cycle of the forest represent the most important element for the evaluation of the risk of region or site unit. Both abiotic and biotic disturbances operate at the regional scale (such as tempests in the Carpathians in 1948, 1962, 1966, 1972, 1982, 1996, 2002 or gypsy moth (*Lymantria monacha)* in 1956 – 1959 in the Eastern Carpathians) and at the fine scale such as local damages caused by snow or excessive herbivore – mainly *Cervus elaphus* and *Capreolus capreolus* (Ichim, R., 1988, 1997).Regional scale phenomena are responsible for the successional processes that can take decades to centuries, white the fine scale phenomena are responsible for the maintenance of the regeneration process and the stand structure dynamic in shorter periods.

Predictability of disturbances is quite difficult, but the risk evaluation (Barbu, I., 1985, 1987, 1996, 2005) can give information at different scales concerning the regime (frequency, intensity and extent) of damages for a specific forest. Forest restoration efforts needs to recognize that fine scale heterogeneity is very important in determining the species composition of the following trees generation, maintaining the population size and the stability and resilience of the stand.

The integration of this factors in the disturbance regime, which create the conditions for the changes in the structure of stand through the gaps and deadwood, generating local niches and concentrations of damaging factors (insects, game etc.) give an other perspective of the role of disturbing factors in the history of a stand. In the simplified structures of age – classes regime, the frequency and the damages caused by disturbing factors are more important and more difficult to manage. In the natural forest with uneven aged structure, the replacement of dead trees by new cohorts is very easy and quite "natural", but in large areas of even aged stands damages are economically important and the impacts more complicated.

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Accessibility modeling and forest management in Iezer Mountains, Southern Carpathians, Romania

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Introduction. This paper analyzes the accessibility of a mountain area in the Southern Carpathians (Romania) from the point of view of forest management. The main *objectives* of the paper are the following:

- The multitemporal mapping of the human impact on the study area, as well as of the forest stand features (including a GIS buffer analysis).
- The mapping of the forest stand features and the mountain areas according to their accessibility (very accessible to very isolated areas) using two GIS analyses (deterministic and probabilistic approach).
- The mapping of past and present wood harvesting areas together with the windthrow occurrence areas, forest stands and the mountain accessibility features.
- The qualitative and quantitative analysis of these results, focusing on the explanation of the relationship between anthropogenic influence, mountain accessibility features and forest management issues.

Study area. The Iezer Mountains belong to the Fagaras Mountain Range, which in its turn represent a subdivision of the Southern Carpathians. This massif is made especially of crystalline rocks, which develop from 500 m altitude to more than 2400 m.

The region is famous both for the sheep grazing activities, which explain the presence of many traditional sheepfolds near the timberline (1400 to 1800 m), and for its extensive forests (accounting for 77.5% of the total area). There are four vegetation zones: the deciduous forests zone (lower than 1300-1400 m), the coniferous forests zone (1400-1800 m), the subalpine zone of dwarf pines (1800-2250 m) and the alpine pasture zone (2250-2462 m).

The forests in the Iezer Mountains still reflect an important anthropogenic influence, although they are in a process of natural recovery (Mihai et al., 2007). Since 1900, the most accessible areas in the Central and Eastern sections of this massif have been the first to experience wood harvesting activities. According to the forestry cadastre maps, the periods of peak activities were 1920-1926 and 1948-1956. The timber was harvested through the clearance of the mountain slopes. Before World War II, such an activity was supported by the narrow gauge forestry railway that followed the Raul Targului Valley as far as the confluence with the Rausor. From 1932 until 1945 wood harvesting slackened and was followed by a forest recovery period. Starting with 1974, two national reforestation programs were initiated in order to restore the forest stands. After the year 2005, several extreme stormy episodes were responsible for the intensification of windthrow phenomena.

Materials and methods.

The data for these analyses were collected from digitized topographic maps (present-day and historical), orthophotos, satellite imagery (Landsat TM and ETM+ multitemporal data), and forestry cadastre maps in paper format provided by the forestry districts. We also employed documentary historical evidence and information gathered from the local forest experts regarding especially the harvesting and windthrow areas. All these data were validated by GPS field surveying.

The GIS approach integrated vector and raster data within a spatial analysis project. Forest stands related data like typology, structure, age, degree of coverage and class of productivity were integrated together with other data like the anthropogenic features, the accessibility models

(deterministic and probabilistic) and forest management spatial data (windthrow areas and timber harvesting areas).
Results. The main outcome of our paper consists in several digital maps showing the relationship between the anthropogenic features of the Iezer Mountains area (in a multitemporal perspective), the distance buffers around some of these features (in correlation with the mountain relief characteristics), and the accessibility areas derived from GIS models development (Mihai, Sandric, 2004, Sandric et al., 2011). All these maps were integrated with the forest stands in selected areas corresponding to the sections with intensive anthropogenic impact on the forest stands.
These can be identified as areas with younger stands of spruce fir and beech, windthrow occurrence areas or windthrow susceptible areas. All the maps were interpreted and compared, by using not only qualitative methods but also geostatistical approaches (ex. geospatial regressions between accessibility areas, forest stand ages and degrees of coverage together with windthrow susceptible areas derived from a separate analysis, Savulescu, Mihai, 2011).
Discussion. The interpretation of the above mentioned data offer an important tool for forestry planners. It is useful to observe first what are the forest stands which were not situated within the anthropogenic influence area (the buffer analysis is helpful).
Then the accessibility areas can be easily correlated with the highest density of anthropogenic features like forest roads, paths, the former forestry narrow gauge railway, the Rausor dam, the chalets and shepherd huts, but also with the former forestry harvesting areas and windthrow occurrence areas. The main issue is that the forest recovery process after each reforestation stage did not produce forest stands with similar features like the primary ones. Wind affected them because they were not stable enough.
Another fact is that historical timber harvesting areas overlap the most accessible areas and the youngest forest stands, which now create the main forest management problems. The future development projects in the Iezer Mountains focus on the opening of a ski track at Portareasa (under construction), taking advantage of the accessibility offered by the Raul Targului Valley. Consequently, some forest stands will need to be removed, which will create favorable conditions for the occurrence of further windthrow phenomena.
Conclusion. The analysis of anthropogenic impact, together with the accessibility and forest management features may help forest planners to identify on the maps both the most stable forest stands and the less stable ones, which require a special management strategy. Their relationship with the anthropogenic elements can easily be noticed. Future projects, like ski track development and the opening (or re-opening) of new timber harvesting areas might start from a scientific basis. This approach integrates a lot of forestry data, which might be integrated in different GIS analyses in order to produce new data for a sustainable management. The results will need to be further correlated with the spatial data on forest ownership.

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Change of species composition – possible solution to the current decline of spruce monocultures in the Moravsko-slezske Beskydy Mts.

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Introduction. Norway spruce (*Picea abies* (L.) Karst.) monocultures show symptoms of decline in health condition in the Moravsko-slezske Beskydy Mts. (Western Carpathians, Czech Republic). These monocultures were planted in the 4th (beech) and 5th (beech with fir) forest vegetation zones with prevailing beech and fir. In the natural species composition in these zones, Norway spruce was only admixed species. Main factors of spruce decline are nutrient disturbances (low values of base saturation), change of climatic conditions (higher temperature and lower precipitation during the vegetation period) and massive occurrence of fungi and bark beetle.

There are several measures towards correction of current status. The change of species composition is the most important of them. Techniques of stand conversion and thinning (for increasing stability before conversion) have been recommended (Slodičák et al., 2012). Recently recommended species compositions are oriented on soil-improving function.

This study is focused on experiments with comparison of different tree species and spruce on the localities of the 4th and 5th forest vegetation zones. The aim was to analyse possible differences in soil characteristics (Ca, Mg, base saturation) under stands of tested species.

Methods. In total, three localities were included in the study (Tab. 1). Analysed stands were planted on former agricultural land which ensures homogeneous conditions and eliminates the effects (litter and humus) of previous stands.

Tab. 1: Basic characteristics of experimental localities.

Locality	Tested species	Age of stands (years)	Year of samples	Elevation (m)	Forest type group (according to Viewegh et al., 2003)
Vítkov	lime/spruce	46	2009	600	*Abieto - Fagetum humidum (fraxinosum)*
Machov	larch/spruce	45	2010	700	*Abieto - Fagetum illimerosum acidophilum*
Bystré	beech/spruce	12	2009	517	*Fagetum acidophilum*

Forest-floor (L, F, H) and top-mineral-soil (A) were sampled using a square iron frame (625 cm^2) under stands of tested species (3–6 samples per plot) in 2009 and 2010 (Tab. 1). All samples were analysed in a laboratory. In the presented study we used the results from analysis of plant available nutrient element concentrations (Ca, Mg) by the Mehlich III method and base saturation V (by Kappen method). Data were analysed by simple descriptive statistics because variants are not replicated.

Results. Practically in all cases, we observed lower content of plant-available Ca and Mg and lower base saturation under spruce stands compared to stands of other investigated species (Tab. 2). In experiment Vítkov, horizons H and A were mixed because it was impossible to separate individual horizons. Under spruce stands these horizons were investigated individually. In spite of this fact, determined values under lime stand were higher for all investigated variables.

Tab. 2: Content of plant-available Ca and Mg [$mg.kg^{-1}$] and base saturation V [%] under stands of different tree species in horizons of forest-floor (L, F, H) and top-mineral-soil (A).

Locality	Tree Species	Horizon	Ca ($mg.kg^{-1}$)	Mg ($mg.kg^{-1}$)	V (%)
Vítkov	Spruce	H	2393	165	44
		A	1228	95	44
	Lime	H+A	2831	259	81
Machov	Spruce	H	1557	168	20
		A	398	60	8
	Larch	H	2089	282	20
		A	354	56	15
Bystré	Spruce	L+F+H	2626	380	53
		A	285	73	31
	Beech	L+F+H	4959	691	71
		A	666	104	42

In horizon H+A under lime stand, content of plant-available Ca was 18% and 131% higher compared to horizons H and A under spruce stand. Similarly, content of plant-available Mg under lime (horizon H+A) was 57% and 173% higher compared to horizons H and A (spruce), respectively. Base saturation was higher under lime stand about 84% compared to spruce stand in both investigated horizons.

In experiment Machov, results showed higher amount of plant available Ca (about 34%) and Mg (about 68%) and the same base saturation (difference 0%) in horizon H under larch stand compared to spruce stand. On the other hand, content of plant-available Ca and Mg was lower (about 11% and 7%) in horizon A under larch stand compared to spruce one. However, base saturation was higher about 88% under larch stand in this horizon.

In experiment Bystré, we found higher amount of plant-available Ca (about 89% and 134%) and Mg (about 82% and 42%) under beech stand compared to spruce stand in mixed humus horizon (L+F+H) and upper soil horizon (A), respectively. Consequently, base saturation was also higher (about 34–35%) under beech stand in both investigated horizons.

Discussion and conclusion. We found higher base saturation under canopy of lime compared to spruce on former agricultural land. Lime showed soil slightly higher in magnesium and calcium compared to spruce. These results are in accordance with Hagen-Thorn et al. (2004).

Some authors found larch to have worse (Podrázský, Štěpáník, 2002) or the same (Menšík et al., 2009) effect on soil compared to spruce. Our results, however, show a different situation. We found larch forest-floor humus higher in calcium and magnesium while concentrations in topsoil did not differ practically between larch and spruce. The use of larch in the process of conversion is, however, supported by its important stabilizing function. Mixtures of spruce and larch showed significantly lower wind damage compared to spruce monocultures (Vicena, 1998).

European beech is able to get more calcium from deeper soil layers (Bagherzadeh et al., 2008). Similarly Berger (2001) confirmed better soil conditions under beech (including mixtures with spruce) in flysch-derived soils. Our results show higher concentrations of base nutrients in both forest floor and soil under beech canopy compared to adjacent spruce.

In conclusion, our results support the theory about the soil-improving function of lime, larch and beech on the localities of the 4th (beech) and 5th (beech with fir) forest vegetation zones. These tree species contribute to higher content of Ca and Mg and consequently higher base saturation in forest-floor and topsoil.

Recommendations for forest practice should be supported by exact results. This is not always fulfilled. Some ameliorative tree species are supported in the process of forest subsidies to planting on forest sites where their function is disputable. For example, soil-improving function of beech on the highest mountain sites and on waterlogged sites. On the other hand, positive effect of birch on soil conditions is disregarded in the frame of forest subsidies.

Our results contribute to the better understanding of this issue. Conversion of spruce monocultures into mixtures with lime, larch and beech on appropriate sites can improve forest soil condition. Forest soil condition is essential for future long-term productivity and forest health in the Moravsko-slezske Beskydy Mts. in the frame of Western Carpathians.

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Multicriteria optimization of forestation policy with a focus to Ukrainian Carpathians

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Under the Anthropocene era conditions (Rockström, 2009) finiteness of natural resources becomes obvious. Lack of vital forest resources goes far beyond a forest cluster (KPMG, 2012). Change of the Earth's climate model adds a high uncertainty and urgency to the problem of forest resource use and renewing. A necessity to eliminate the discrepancy between demand and supply of forest ecosystems services (Millennium Ecosystem Assessment, 2005), including timber, induces the search for new approaches to forestation problem investigation.

Modern practice of forestry in Ukraine is predetermined by a number of factors: low percentage of forest area, an insignificant fraction of mature forest stands, inefficient use of forest land capacity (Debrynyuk, 2010). Transition to sustainable forest management as a complex management of forest ecosystems, taking into account economic, environmental and social aspects, is the most important forestry problem today. The transformation process is impeded by a weak and inefficient forest policy at different levels. While policy legislation rests on the principle of sustainable forest management, weak institutions, highly regimented forest management and underdeveloped mechanism of public involvement in forest planning and governance challenge sustainable forest management implementation on national level and violate forest managers' ability (). General economic environment of transition to a market economy, unfavorable investment climate, high share of state property and low state investments, low income of local population inhibit sustainable forest resource use and renewing.

In this context, the study of effective forestation methods appears especially important and difficult. Rapidly changing climatic conditions make inadequate decisions, adopted several decades ago. Some natural and man-made forest ecosystems that have evolved over centuries and were efficiently functioning, today collapse and die, not withstanding changes in temperature and hydrological regime, the onset of diseases and pests (Debrynyuk, 2011).

In such context the question of effective forestation policy design requires consideration of positions of foresters, environmentalists, economists and a local community. Till XX century forest plantation establishment in Ukraine has isolated and episodic character. Intensive forest use in 50-s induced intensive artificial afforestation which was common till 90-s and only synergy of market transformation and rapid worsening of economic situation strongly decreased afforestation activity (Soloviy and Keeton, 2009).

Traditional forest planning is based on optimization solutions, which are usually evaluated by one criterion (profit maximization), while sustainable forest management requires consideration several criteria simultaneously. The situation is complicated by the fact that optimization of forest management by one criterion, for example, carbon sequestering or maintaining biodiversity is contradicted by such criterion as maximization revenue from forest enterprises' operations. Therefore sustainable management of forest ecosystems requires complex management that is multicriteria optimization. Goal programming, heuristic methods and Analytic Hierarchy Process (AHP) are the most famous methods for multicriteria optimization of silviculture (Kangas et al., 2007, Nijnik et al., 2012).

We examined three forestation methods usually applied in conditions of non-protected areas of Ukrainian Carpathians: natural reforestation, artificial forestation and fast-growing plantations from silvicultural, environmental, economic and social points of view applying AHP approach (Saaty, 2005) and Expert Choice software to understand which methods should be used under specific silviculture / environment / economic / social conditions (Zahvoyska and Shvediuk, 2011). We analyzed all forestation alternatives, their pros and cons, advantages and disadvantages and cautions for use, resulting from the forest site, forest type, particular species, targets of forest operations, forest policy etc.

Results of forestation alternatives ranking and sensitivity analysis of the results will be presented and discussed in the paper. They can be used for development of well-grounded scenario of silviculture activities, including Multiple Path approach (Gadow at al., 2007) to design attractive forested landscapes and productive forests. These findings can bring additional light on the problem of (af)forestation for provision multiple ecosystem services as well as for didactic and policy purposes to reveal in a quantitative manner a sensitivity of forestation methods ranking to significance of policy-making criteria.

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POSTER PRESENTATIONS

Can we define historical range of variability in temperate mountain spruce forests of Central Europe

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Climate change could significantly alter disturbance regimes in forest ecosystems. In mountain regions of Central and East Europe, scenarios with increased frequency of severe windstorms and droughts, which could trigger large-scale bark beetle outbreaks, are predicted. During the past decade, this region has experienced severe blowdowns and bark beetle outbreaks. Thus, an important question is whether these events are part of the historical range of variability, or whether they are related to climate change and past management practices. In this talk, we review historical evidence regarding the occurrence of severe windstorms and bark beetle outbreaks in the Bohemia Forest (Czech Republic) and the Tatra Mts. (Slovakia), where recently about 20 000 ha of forest was disturbed by windstorms and bark beetle. In addition, we review the few existing studies on the disturbance history and dynamics of spruce forests in the region. Based on historical evidence and published studies, severe stand replacing disturbances, including both windstorms and bark beetle outbreaks, have occurred in the region during the past several centuries and are likely to be part of the historical range of variability in these forests. However, the lack of representative studies makes quantification of the historical disturbance regime difficult.
In the second part of the presentation, we also present results of dendroecological study reconstructing disturbance histories from spruce primary forests in Czech Republic and Romania. These studies focused on: what historical natural disturbances have shaped the structure and

development of an old-growth, subalpine *Picea abies* forest? Are large-scale, high-severity disturbances (similar to the recent windthrow and bark beetle outbreaks in the region) within the historical range of variability for this forest ecosystem? We reconstructed the site's disturbance history using dendroecological methods in our study plots, established to span an elevation gradient. It total we have established about 150 plot regularly distributed inventory plots in three different study areas. Growth patterns of about 4000 increment cores were screened for increment cores were screened for (1) abrupt increases in radial growth indicating mortality of a former canopy tree and (2) rapid early growth rates indicating establishment in a former canopy gap. Spatial and temporal patterns of canopy accession varied markedly over the study areas, resulting in disturbance pulses that corresponded to an elevation gradient. The majority of the trees reached the canopy during two pulses. Historically documented windstorms roughly coincide with peaks in our disturbance reconstruction. Our study provides strong evidence that these forests were historically shaped by a infrequent, moderate- to high-severity natural disturbances. Our methods, however, could not definitively identify the agent(s) of these disturbances. These findings challenge the traditional view, which holds that small-scale endogenous tree mortality events (gap dynamics) drive the dynamics of these forests. Our results, however, should be viewed with sufficient caution when making generalizations about the disturbance regime of *P. abies* forests throughout Central Europe. In reality, it is likely that characteristics of the disturbance regime vary in space and time along a continuum from small-scale gap dynamics to infrequent, stand replacing events. The few studies examining disturbance processes in old-growth *P. abies* forests in this region highlight such variability.
Nevertheless, the recent mid-1990s windstorm and the ensuing spruce bark beetle outbreak may provide an analogue for past disturbance, as the duration and severity of these events could easily explain past patterns of growth response and recruitment in our results. Thus, it seems reasonable to assume the interaction of wind storms and bark beetles seen in the contemporary landscape has occurred historically. Our methods, however, could not definitively identify the agent(s) of these disturbances. Nevertheless, the recent mid-1990s windstorm and the ensuing spruce bark beetle outbreak in Czech Republic may provide an analogue for past disturbance, as the duration and severity of these events could easily explain past patterns of growth response and recruitment in our results. Thus, it seems reasonable to assume the interaction of wind storms and bark beetles seen in the contemporary landscape has occurred historically. Additional studies in old growth remnants across the region will facilitate a more thorough understanding of the historical range of variability in mountain *P. abies* forest dynamics.

The vegetation dynamics after windstorm in the High Tatra Mts.

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The wind as a disturbance factor is important in vegetation dynamics in the larch-spruce ecosystem in the High Tatras Mts. The large scale windstorm damaged 12.600 ha of forest ecosystems on November, 2004, followed by fire that damaged 230 ha on July, 2005. The most widespread affected forest communities are *Lariceto-Piceetum*. As for the classification by the Zurrich-Montpellier School, the communities were classified in the *Vaccinio-Piceion* alliance as the *Vaccinio myrtilli-Piceetum* association. All the permanent plots are located on glacial moraine sediment with the gravel, podzolic cambi soil, 6th forest vegetation rank and 900-1300 m a.s.l.

Results from four permanent plots on the calamity area are presented. The plots for study vegetation dynamics were established in 2005 immediately after windstorm and fire. Also a plot is established as reference site (REF), the forest stand wasn't damaged by windstorm and presents the development of larch-spruce forest in the High Tatras Mts. Another three plots were established at the stands affected by the windstorm under different management. The forest stand processed in the traditional way, where the wood had been removed, and the area had been reforested again (EXT) and forest stand affected by the fire with processed wood and reforestated (FIR). The last plot presents forest stand damaged by the wind disaster without intervention, natural processes after the windstorm (NEX) can be observed.
Each site was sampled every year, starting in 2005. Sampling was conducted with the modified Braun-Blanquet abundance scale. The size of every permanent research plot is $400m^2$. Three 1m x 1m permanent quadrants for detail analyses inside each permanent plot are taken. Biomass was determined indirectly by destructive methods for permanent quadrant (g/m^2). The results from statistical analyses were processed in CANOCO for Windows, CCA was applied to the data.
For ecological interpretation of major gradients, weighted Ellenberg´s indicator values of plants were plotted on a RDA ordination diagram as environmental variables (light, temperature, continentality, moisture, acidity, nitrogen).
The research of vegetation dynamics showed that herbal composition of calamity plots correspondents to larch-spruce undergrowth in 2005. During the years 2006 – 2009 different developments of vegetation on permanent research plots were observed. In 2011 the herbal composition of the NEX site approached the EXT and FIR plots.

Application of Sustainable forest management system in the mountain forests in the Ukrainian Carpathians Mts.

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The Czech Republic within the foreign development cooperation (investigate organisation from the Czech Republic is Forest Management Institute in Brandýs nad Labem) realized in the period 2005-2010 two projects in the Ukrainian Carpathians Mts., which dealt with forest planning and design of optimal forest management - The Project No. 134/05-07/MZE/ „The Regional and management forestry planning tools for the Ukraine" and the Project No. 33/MZE/B/08-10 „The System of differentiate management in forest ecosystems of the Ukrainian Carpathians Mts."
The development objective was to bring the Czech regional and management forestry planning tools into the background of the forestry management in the Ukraine and to support an establishment of Ukrainian forest information system using latest IT products, monitoring and computer technologies as well as to provide training to the management.
The pilot areas, each with an approximate area of 10,000 ha, were situated in the Eastern Carpathians (geological area of Carpathian flysh) in Nadvirnyansky gosleschoz in Ivano-Frankivska region. They occupies Buchtivetska and Chripilivska forest administration and the Mountain forest administration of the Ukrainian scientific research institution for mountain forest management of P.S. Pasternak in case of the first project, and Maksimecka and Bystricka forest administration in case of the second project.

The basis of both projects was detail recognition of ecological conditions of ecosystems i.e. forest geobiocenoses. For this purpose is used geobiocenological system (Zlatník 1959) in the modified form i.e. with system of vegetation tiers according to Plíva (1971) and with addition of geomorphologic types (level of stones, degrees of slope).
The first project was dealt with the issue of complex management units, including suggestions categories of forest protection and the concept of complex road network with construction priorities. All data are worked up in "layers" in GIS, which is new element in the Ukrainian forestry.
The main objective of both projects was to introduce the Ukrainian partners to the forest management method using the tool employed in planning in the Czech Republic, i.e. the Regional forest development plan.
This way designed system of management, which is based on detail knowledge of ecological conditions including GIS elaboration is an ideal tool of Sustainable forest management system not only of forets, however also of landscape. Application of this management system fills the 4th, 5th and 7th paragraphs of Carpathian convention (Framework Convention on the Protection and Sustainable Development of the Carpathians).

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Changes of forest cover in the Silesian Beskidy Mountains over the last 230 years

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The Silesian Beskidy Mtns constitute one of mountain areas in Poland most transformed by intensive changes in land use through deforestation for fuel, building materials and agriculture from the Middle to modern times. Initially, colonization for agricultural use involved deforestation the more easterly terrains, especially river valleys in different parts of the the moumtains. Climax associations of beech and fire-beech survived with their natural character up to the XV century when the colonization of the area by the Vlach people started. From that time on, changes in the structure of forest stand accelerated. The greatest transformation of the forest structure started in the first half of the XIX century with the introduction of clear-cutting forest management.
The logged area was 90% reforested by *Picea bies* which created, in the lower subalpine forest, an artificial monoculture in place of the fire-beech (*Abieti-Piceetum*) and beech (*Luzulo luzuloidis-Fagetum*, *Dentario glandulosae-Fagetum*) forest. The latter associations presently occur in small patches in different parts of the analyzed area. The monoculture was build initially by different ecotypes of spruce originating from other regions. These showed a greater vulnerability to various biotic- and abiotic factors and were prone to die of spruces specimens.

The main goal of the present research is the estimation of landscape elements in the period from 1779 to the present, particularly in terms of forest- and non-forest cover.

The analysis of the changes in the forest cover that occurred during that period of 230 years, is based on investigations conducted in the Polish part of Silesian Beskidy Mtns. In addressing the question, all available cartographic materials covering the period were examined. These pertained to the following years: 1779/1783 (*Theil des Wieliczker Kreis*; 1:28 800), 1840/1862 (*Herzogthum Schlesien, Teschner Kreis;* 1:28 800), 1876/1906 (*Spezialkarte der Österreichisch-ungarischen Monarchie*; 1:75 000), 1966 (Topomap 1:50 000; sheets 541.3/P *Cieszyn*, 541.4 *Żywiec*, 551.2 *Rajcza*), 1994 (Topomap 1:50 000; sheets M-34-74-C, M-34-74-D, M-34-75-C, M-34-86-B, M-34-87-A) and 2009 (colour photographs on a scale of 1:25 000).

The results of the analysis were compared with forest impact statements from the 1930s as a means of corroborating the results obtained for other periods. The identification of particular landscape elements (if at all possible) was very much subject to the quality (black and white, colour) and degree of generalization of the maps. GIS methods were used in the analysis and interpretation of all cartographic materials.

To allow comparison of the species composition of the beech forest typical of the area with that of the artificial spruce monocultures, key plots were made. The forest cover decreased significantly over the 230 year period investigated. On the 1840/1862 map, forest occupied more than 480 sq km, 471,7 sq km in 1876/1903, 353,1 sq k in in the 1960sm though, in the 1990s, the forest cover had increased to 375,8 sq km. The forest impact statements show that this recent minor increase reflected the fact that trees planted in the 1960s had reached maturity.

In the Silesian Beskidy Mtns, long-term changes in land use have had a significance influence on the extent and species composition of the forest cover. Analyses of maps and photographic imagery show that, in the last 230 years, human economic activities led to marked changes in the cover. The last transformations in the structure of the forest ecosystems in the second half of the last century, namely, the dying away of the spruce forests, can be attributed to biotic and abiotic factors and, indirectly, to global climatic changes.

Forest ecology 2

ORAL PRESENTATIONS

Inter- and intra-annual variability of forest vigour response to climate in the West Carpathians: Experimental use of MODIS satellite imagery

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There is an increasing need for more profound understanding of relations between climate and ecosystems, and thus for improving human's capabilities for the identification of vulnerable species, communities and regions; optimization of management options; and mitigating negative effects of climate. A great deal of attention has been paid to forest ecosystems in the Carpathians, which have been recently suffering from the elevated occurrence of extreme climate events, such as drought periods and heat waves (e.g. Ciais et al., 2005), windstorms (Gardiner & Quine, 2000) or excessive snow loads (Hlásny et al., 2011a). Projections of future climate development suggest increased incidence of such events (Walther et al., 2002; Schär et al. 2004), hence improving the knowledge on climate-forest-management relationships is a timely task.

This study addresses the intra- and inter-annual variability of forest vigour in the West Carpathians during the period 2000-2010 in relation to the incidence of excessive heat and drought events. European beech (*Fagus sylvatica* L.) and several oak species (*Quercus* sp.) are addressed. Beech is one of the most widespread Carpathian tree species; beech was however found to be climate sensitive close to this species lower range limit, and drought induced decline and mortality has already been observed in some regions (Geßler et al., 2007; Mátyás et al., 2010). Oaks have been addressed as drought tolerant species, which could substitute beech in some of drought-exposed sites in the future (e.g. Hlásny et al., 2011b).

The investigation has been based on the satellite imagery acquired using the MODIS instrument (Moderate Resolution Imaging Spectroradiometer) that is installed on the TERRA spacecraft (http://modis.gsfc.nasa.gov). The instrument is viewing the entire Earth's surface every 1 to 2 days, acquiring data in 36 spectral bands (0.4 µm to 14.4 µm). Two bands are imaged at a resolution of 250 m at nadir, with five bands at 500 m, and the remaining 29 bands at 1 km resolution. The main asset of using MODIS products is the global coverage obtained every one to two days; hence such data can be used to describe the intra-seasonal variation in various ecosystems.

Normalized Differentiated Vegetation Index (NDVI) (Goward et al., 1991; Tucker et al., 1991) with spatial resolution of 250 meters was used to describe the variation in vigour of beech and oak stands. NDVI represents the ratio of absorbed photosyntetically active radiation (PAR) and reflected radiation in the near infrared spectrum. Healthy vegetation is expected to absorb PAR intensively, while plant's spongy mesophyll leaf structure creates considerable reflectance in the near infrared spectral region. Hence, healthy vegetation has low red-light reflectance (PAR) and high near-infrared reflectance, what gives high NDVI values. Using this rationale, we expect that NDVI variation reflects changes in trees photosynthetic activity, and this can be related to stress (climate or other) acting upon the trees.

We collected the NDVI MODIS images for the period 2000-2010 covering the whole of the West Carpathians. Using forest management plans and other environmental databases we identified the clusters of MODIS pixels with monospecific beech or oak composition so as each group contains 5 to 12 pixels. We extracted 10-year time series of NDVI for each pixel, hence having available 40 to 60 NDVI values for each pixel during each vegetation period; these time series were subject to further analyses. Climate stations in the surrounding of each cluster of MODIS pixels were used to transfer the data on the intensity and duration of heat waves and drought periods to the centre of each cluster. Finally, thorough investigation of intra- and inter-annual variations of NDVI values during the entire 10-year period has been performed and all variations were interpreted in relation to the incidence of climate extremes.

We found that heat periods did not induce the observable changes of investigated stands spectral reflectance, provided these periods were not accompanied by lack of precipitation. In contrast, precipitation-free periods longer that 5-10 days initiated observable decline in NDVI values, what suggests the occurrence of drought induced stress to trees. All observed changes in NDVI were clearer in case of beech as compared with oaks. Magnitude of change was ranging between 3-20%. No irreversible changes were observed during the investigated period, and all stands recovered after the first precipitation event; this suggests that even the most extreme events did not cause heat and drought induced tree mortality or damage. The fact that experimental design did not embrace extremely dry sites, in which such processes could occur, does not allow us inferring that such mortality does not occur in the Carpathians. The obtained results contribute to better understanding of forest trees response to climate, and identify critical intensity and duration of the addressed climate extremes which cause an observable stress of beech and oaks in the West Carpathians. In addition, the proposed approach allows us for taking advantage of short ground track repeat cycle of MODIS instrument not being burden by low spatial resolution of this imagery.

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The study of NDVI index for Silesian and Zywiec Beskids forest health

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The aim of the work was to find a method that allows an indication of apparent differences in stands in which health changes are not visible from ground level and are not measurable by traditional methods. Spruce stands in Polish Beskids have shown symptoms of decreased vitality and resistance for over a dozen years, resulting in large-scale forest decline. One of the reason for poor vitality of Beskids spruce stands was introduction of foreign spruce genotypes, namely spruce monocultures, not adapted to the local sites and soil, instead of mixed stands with beech and fir in a major share. Impaired trees are especially vulnerable to fungal infections, but most of all to bark beetles attacks, which are usually the last agent in the mountain spruce stands dieback process. Therefore trees exposed to these organisms are currently under special treatment, to slow down stand decline process and to sustain their existence in order to provide successful regeneration.
Material and Methods. One way to determine the health of forest stands is the analysis of multispectral imagery using factors based on the study of vegetation. One such indicator is the NDVI (Normalized Difference Vegetation Index), which shows the condition of vegetation. The plant is in good condition and is not exposed to stress, if the NDVI index is above 0.6. On average NDVI values for vegetation ranging from 0.4 to 0.8 for the spring and summer growing season when vegetation is most abundant in chlorophyll.
Research area include Forest Inspectorates is situated in the Silesian and Zywiec Beskids in the Carpathian Mountain such as Bielsko, Ustroń, Wisła, Węgierska Górka, Ujsoły and Jeleśnia. The study was conducted using multispectral imaging satellite Rapid Eye 20/08/2009 characterized by high contrast, the absence of the test area of clouds and the relatively low noise due to atmospheric conditions. The bases for all research were geomatics materials, mainly as digital layers together with database, integrated with digital map and IT Forest State Systems SILP. Software used in the

analytical process includes ArcGIS and ERDAS IMAGINE. The calculated indices NDVI and area (ha) assigning pixels for the range -1.0 - 0.4 (open water courses, roads, uncovered soil, fresh harvesting surfaces) were rejected to avoid errors resulting from the lack of trees. Were studied groups of forest sub compartments, where the share of spruce is 100%, and age > 60 years. The results are combined with digital map with forest sub compartments to give a set of areas in which the observed NDVI values between 0.4 - 0.8. The NDVI results in 2009 were compared with the results of NDVI in 2010 but only in Ujsoły Forest Inspectorate.

Results and discussion. The lowest values of NDVI in Silesian and Zywiec Beskids include the area under peak in the highest massif (1000 - 1257 m a.s.l.). For a solid spruce stands in this inspectorate, whose the average percentage is 100% and spruce age > 60 years lower NDVI values where stands are vulnerable to decay (0.4-0.6) cover an area 2188 ha (69.0%), while stands with higher NDVI (> 0.6) with better health condition cover an area 973 ha (31.0%).

The NDVI results in 2009 were compared with the results of 2010 but only in FI Ujsoły.

In 2009 the lowest values of NDVI index Ujsoły Forest Inspectorate are located in the central part and in parts of the top country border of the massif of Rycerzowa (1226 m a.s.l.) and Wielka Racza (1236 m a.s.l.). For a solid spruce stands in this inspectorate, whose the average percentage is 100% and spruce age > 60 years lower NDVI values where stands are vulnerable to decay cover an area 1332.76 ha (76.21%), while stands with higher NDVI with better health condition cover an area 416.07 ha (23.79%). In 2010 the research has shown changes in lower NDVI values – 1273.33 ha (82.8%) and in the NDVI with better health condition – 264.27 ha (17.2%). Reducing area of the lower NDVI may be due to the harvesting infested forest stands. Also sanitary cutting analysis does not allow conclusions. Infested trees in 2009, in forest compartment were inventoried in the amount of 25692.18 m^3 in these stands. In 2010 - 22339.12 m^3. Decreases in the size of sanitary cutting in 2010, which are generated by the infested trees can be caused by cutting in the year 2009 and has already started the process of reducing the bark beetles gradation in the area.

Normalized vegetation index NDVI is an indicator that can be used to study the health condition of the stands. In order to increase efficiency should be used in a series of imaging at monthly intervals. Given the very rapid changes in stands in the Silesian and Zywiecki Beskid single picture shows the situation at the moment and need to apply a series of images for faster capture changes in the stands. In the spruce forests carries the task of forest protection and silviculture efforts to protect and rebuild the stands. These works make it difficult to properly assess NDVI index due to the rapid dynamics of change.

Estimation of coniferous forest biomass change using a Landsat trajectory-based approach

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Forest biomass is a major store of carbon and thus plays an important role in the regional and the global carbon cycle (Kimball *et al.*, 2000; Schroeder *et al.*, 2008). Accurate forest carbon stock assessment requires both estimation of forest biomass as well as reconstruction and interpretation of biomass dynamics (Kurz *et al.*, 2008). Yet, forest dynamic is characterized by disturbances and recovery, key-processes affecting site productivity and forest carbon cycle. Thus, spatially and temporally explicit knowledge of these processes and their drivers are critical for understanding regional carbon cycles.

Here, we present an alternative and efficient method of using satellite data to assess aboveground coniferous forest biomass changes in the Western Carpathian Mountains between 1985 and 2010. This study area was affected by long-term anthropogenic pressure followed by recent coniferous forest decline. Additionally, the integrated effects of biotic and abiotic disturbance regimes on biomass change are investigated. We used a Random Forests (RF) modelling approach (Breiman, 2001) and a near-annual time series of satellite images to estimate yearly aboveground biomass. Further, using a trajectory-based change detection approach (Kennedy *et al.*, 2010), the history of disturbances and recovery was reconstructed.

We found a dramatic decrease in forest biomass over time that intensified after 2005, exceeding spatially and temporally previous forecasts (Hlásny *et al.*, 2010). Overall, biomass loss affected almost 60% of total coniferous forest, while moderate to strong disturbances causing either strong degradation or complete removal of forest biomass occurred on about 30% of the area, which equals to almost 17,000 ha of the area's total coniferous cover. At the same time, 11.2% of the area (~6,300 ha) was reforested or regenerated on previously damaged forest stands, whereas only 4.1% of the total forest was undisturbed over the entire period. The predisposing factors of forest decline were: 1) unfavorable forest composition (spruce plantations) introduced during the Austro-Hungarian Empire and in the following of the XX century, and 2) long-term air pollution during communist times leading to loss of tree vigor and retarding its growth. Both factors led to lower spruce resistance against fungal pathogens and extreme weather events. The latter has been intensifying during the last decade fostering elevated activity of bark beetle. Moreover, numerous mild winters and dry growing seasons facilitated the insect survival and reproduction, and boosted its outbreaks. Disturbance hotspots indicate these high insect pest levels in many areas and reveal strong interactions between biomass and climate conditions.

Summarizing, we showed the effectiveness of a near-annual satellite time series and a trajectory-based approach to track biomass changes in the Western Carpathians. Furthermore, biomass loss and accumulation were qualitatively and quantitatively assessed. Our study demonstrates how spatial and temporal estimates of biomass help to understand regional forest dynamics and derive degradation trends in regard to regional climate change.

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Computer tomography in threat assessment of Silver fir (*Abies alba* Mill.) by wood rot on protected areas in Polish mountains

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Occurrence of fir stands in the Polish mountains is determined by forest management in the past, especially is connected with excessive planting of spruce from 19 century. Also in the years 1970 - 1990 was observed large-fir stands regression in Europe, mainly caused by air pollution. For these reasons, fir has been almost entirely supplanted by the spruce in Sudeten and in the western part of the Polish Carpathians.

After a period of fir stands area reduction in Polish mountains, and replacing them with spruce and beech, recently from about twenty years, this species come into prominence again in revitalization process, especially when spruce stands are dying on all area of Europe.

Research carried out in the Carpathians seed stands of fir showed significant damage of fir trunks (Niemtur et al. 2011) therefore we decided to carry out similar studies in three national parks and two reserves, where there is a high probability of occurrence of natural provenances of fir.

Our investigations were carried out in five fir stands, representing different parts of firs range in the Polish mountains. It were: Chojnik reserve in Karkonosze National Park (Sudeten Mnts), the National Park of Table Mountains (Sudeten Mnts), Holy Cross National Park (Holy Cross Mountains), reserves Oszast and Śrubita (Western Carpathians). In total we tested 150 silver firs trees in the lowest part of the trunk, on five experimental plots, using the Picus Sonic tomograph (tab. 1).

Tab.1. Geographical coordinates of experimental plots

	Location	Establish year	No of trees	N	E
1	National Park of Table Mnts	1993	30	$50^0 29' 32''$	$16^0 19' 28''$
2	Reserve Chojnik, Karkonoski NP	1959	30	$50^0 50' 16''$	$15^0 38' 50''$
3	Holy Cross National Park	1924	30	$50^0 53' 39''$	$20^0 54' 37''$
4	Reserve Oszast	1971	30	$49^0 25' 54''$	$19^0 11' 16''$
5	Reserve Śrubita	1958	30	$49^0 24' 22''$	$19^0 0' 42''$

Picus Sonic tomograph is a non-invasive tool for wood diagnosis in the trunks of live trees. It is the only method that enables estimation of wood damages without cutting or boring the selected trees. This is important in growing seed stands and first of all in national parks and reserves (Niemtur, Chomicz 2008). Measurement level was determined at 10 cm from the surface of soil from the side of the slope and we used 8 to 12 measuring points for each tree, depending on the size of the circuit, according to the manufacturer's instructions (Goecke, Rust, 2007). Sensor number 1 was always placed on the north side

Tab. 2. Classes of damages by wood rot specified by Picus Sonic tomograph.

Classes of damages	cross-section area damaged by wood rot [%]
I	0
II	<25
III	26-50
IV	>50

We found that computer tomography method confirm also on protected areas in Polish mountains large participation of fir trees with high percentage of the wood structure completely destroyed by fungi pathogens at the bottom of trunk, tab. 3.
The largest percentage of rotten trunks of fir characterised Śrubita reserves (93%) and Oszast (90%). Firs in the Table Mountains National Park had the smallest percentage of trees with wood rot damages (33%)

Tab.3. The percentage and number of fir trees (N.t.) in different classes of damages by wood rot.

Location		Classes of damages			
		I	II	III	IV
National Park of Table Mnts	N.t.	20	9	1	0
	%	*67*	*30*	*3*	*0*
Reserve Chojnik	N.t.	12	10	8	0
	%	*40*	*33*	*27*	*0*
Holy Cross National Park	N.t.	18	4	4	4
	%	*58*	*13*	*13*	*16*
Reserve Śrubita	N.t.	2	20	4	4
	%	*7*	*67*	*13*	*13*
Reserve Oszast	N.t.	3	14	9	4
	%	*10*	*47*	*30*	*13*

We confirm also differences of damages of wood among firs on each experimental plot and occurrence of fir trees without any damages, despite their old age. Healthy firs among inspected trees, could be used in the restitution of fir in the Sudeten and also in the selection in other mountainous areas.

The above information from protected areas are particularly important because of spatial restrictions to the use of fir seeds stands in Polish mountains.

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Assessment of forest spatial pattern and its changes using integrated landscape model: the Carpathians case study

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The Carpathians are an important European biodiversity hot spot, holding valuable semi-natural or primeval areas, a wealth of forest resources, and a great variety of plants and animals with the richest community of large carnivores in Europe, including all of the large European predators. Forests have always been a major resource of this region. Currently they cover approximately 50% of the whole Carpathian region (including Transylvania) and up to 80-90% between 1000-1500 m a.s.l. (Kozak et al., 2008). Political transformation initiated in the late 1980s led to profound shift in the post-communist societies and economy (Turnock 2002) causing e.g. changes in forest spatial pattern, fragmentation and connectivity. Those changes have essential consequences for species' habitats and populations, often resulting in a loss of forest biodiversity (e.g. Riitters et al., 2002).
The appropriate assessment of changes in landscape spatial pattern (fragmentation and connectivity) is crucial for understanding the underlying ecological processes and their dynamic (Forman 1995). The categorical models of landscape structure, especially the patch-based model, in which landscapes are conceptualized and analyzed as mosaics of discrete elements, have been the most common for last two decades (e.g., McGarigal et al., 2009), and many well-developed and widely understood quantitative techniques supported by advanced tools and applications quantifying landscape structure have been developed based on those models (e.g. McGarigal and Marks 1995). One of more advanced methods based of categorical landscape models is morphological spatial pattern analysis (MSPA; Vogt et al., 2007) - the pixel-based approach that holds the binary e.g. habitat/non-habitat description of landscape but instead of defining patches, determines different landscape elements (core, edges, perforation, branch, connector and islet).
Although categorical models have led to major advances in understanding pattern-process relationships, those models do not accurately represent continuous spatial heterogeneity of a landscape. While a conceptual shift has been proposed to supplement the categorical models by gradient (continuous) models for situations where spatial heterogeneity is continuous rather than discrete, few studies actually use those models as a context (e.g. Hoechstetter et al., 2011). For example recently, McGarigal et al. (2009) proposed to use metrics from the field of surface metrology (area of three-dimensional surface analysis) to quantify landscape structure. They demonstrated that some of surface metrics do not have obvious analogs in landscape metrics and

therefore they could give unique insights into description of landscape structure. Other methods already known in landscape ecology have been also re-designed allowing for examination of ecological gradients, at least to some extent, e.g. moving windows, fuzzy techniques, texture analysis, spectral and wavelet analysis or lacunarity analysis (see Hoechstetter et al., 2011). Though methods described above are promising to examine ecological gradients, yet a unified framework and methodology for the analysis of landscape structure using integrated gradient and categorical models are still missing.

We have three objectives in our paper:

(1) introduction of an integrated methodology which links categorical (i.e., MSPA) and gradient approach (i.e., moving window, surface metrics and texture analysis) allowing to evaluate landscape (in our case forest) spatial pattern and its changes;

(2) assessment of trajectories of forest fragmentation and connectivity changes in the northern part of the Carpathian Mountains;

(3) comparison of the results with past studies from the study region which were mainly performed for two or three points of time (e.g. Ostapowicz et al., 2006, Kuemmerle et al., 2007).

The study area is located in a range of the Landsat scene: 187/26 (path/row) and cover partly Poland and partly Slovakia. The forest cover data were obtained from the analysis of time series of Landsat TM and ETM+ for years 1987-2011. In particular, we focused on four points of time: 1987 (before political transformation), 2000 (after political transformation), 2006 (after accession to the European Union), 2011 (current status), for which images for summer season with cloudiness below 10% were available. To identify forest cover on sattelite images we applied the supervised, hierarchical approach combining image segmentation, knowledge-based rules to extract a training set and support vector machine (SVM) classification. For each of the forest/non-forest map, the morphological spatial pattern (MSP) classes map was generated. In the next step, we applied the moving window approach to the MSP classes maps. In this method the window of defined size moves over the landscape one cell at a time, calculating the selected metric (e.g. proportion of cores or edges) within the window and returning that value to the center cell. The result is a continuous surface which could reflect e.g. how an organism perceives the structure of the landscape as measured by that metric. We calculated maps of proportion of MSP classes in moving windows with different sizes (7x7 pixels, 21x21 pixels, 35x35 pixels). Those maps allowed us to assess fragmentation and connectivity for given points of time and then, using map algebra functions, to create the trajectories of its changes.

The initial results showed that our approach allowed to assess the forest spatial pattern and its changes (in particular trajectories of changes) in more detailed manner. In general, both processes - increasing and decreasing of fragmentation and connectivity – could be observed with variant intensification in different parts of the study area.

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Creating Guidelines for Implementing Reduced Impact Logging and Advance Sustainable Forest Management in the Ukrainian Carpathians

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Inappropriate timber harvesting and road building techniques continue to be one of the greatest obstacles to sustainable forest management (SFM) in the mountain forests of western Ukraine. Cutting streamside buffer zones, skidding across rivers and riverbeds, point-source pollution, and utilizing inappropriate or obsolete technology are among the poor logging practices that plague current forestry operations (Bihun, 2004, Bihun *et al* 2009). Decreased site productivity, soil compaction, sheet and gully erosion, sedimentation, decrease in water quality and fisheries habitat are just the surface manifestations of these poor logging practices. Disruptions to wildlife corridors, migration patterns, forest health, the increase in threatened and endangered species, and resultant decline of biodiversity are part of the larger challenge of protection of the mountain forests of the Carpathian ecological zone (Bybljuk & Styranivsky, 2000). The rapid increase of forest dieback and uncontrolled development is compounding the impact of forest harvesting.

The use of cable harvesting systems, the most environmental sound harvesting method for the rugged mountain terrain, has declined sharply (now < 5% of harvests) and, currently, more than 80% of all harvests utilize tractors (Adamovsky *et al*, 2000). For the development of sustainable forestry in the Carpathian region, it will be necessary for a gradual and planned transition from even-aged forest management relying on clearcutting. Another necessity is substantial, long-term investments in forest technology, such as re-introduction of mobile cable harvesting systems and well-engineered and environmentally sensitive road building (Korzhov, 2004). Lack of infrastructure in roads has hampered sustainable forest management and overharvesting on the more accessible sites has contributed to the unbalanced diameter-class distribution characteristic of today's mountain forests (Kudra & Grydzchuk 2004). In 2007-2008, the Ministry of Environment made its first investment in the creation of a road network by constructing over 80 km of state-of-the-art forest roads in the Carpathians. Concurrently, there has been a gradual reduction and replacement of caterpillar tractors with wheeled skidders. In addition to an expanded road network and appropriate technology, implementing best management practices (BMPs) and reduced impact logging (RIL) are important components of transitioning to SFM. Notwithstanding the need for roads and modernization, a comprehensive analysis of the economic, social, and ecological impact of road building and monitoring of legal and illegal harvests should an integral part of a landscape-level planning in the Carpathians (Shkirja, 2005).

The current World Bank Forest Law Enforcement and Governance (FLEG) program has begun to address the problem of widespread failure of forest governance and the associated illegal logging in Ukraine and countries of the former Soviet Union. It has not, however, addressed ameliorating the affect of abusive timber harvesting practices in both sanctioned and illegal logging operations. This paper address the possibility of creating a set of BMPs for timber harvesting operations and finding the best strategy for training and implementing these practices in the forest sector in Ukraine. The adoption of environmentally sound timber harvesting practices better known as Low Impact Logging (LIL) or RIL are a challenge in Ukraine and other Carpathian countries (Bihun *et al* 2009). Harvesting schedules should be designed to accommodate work with natural landforms and incorporate measures for the protection of biodiversity. Accreditation and acknowledgement of timber harvesters that completed the training can be tied to third-party forest certification of loggers or other incentives. The pilot project in Ukraine has the potential to expand into all the countries of Carpathian ecological region.

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Identifying functional green infrastructures in the Carpathian Mountains: assessments of forest loss, alteration, continuity and connectivity

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To communicate the need for improved biodiversity conservation and provisioning of ecosystem services toward ecological sustainability, the concept green infrastructure has emerged (e.g., EU 2010). Functional green infrastructures are crucial for the health, adaptive capacity and resilience of ecosystems by providing space and structures to maintain or restore all their functions and to support adaptation to climate change effects. However, the policy vision of green infrastructure is in stark contrast to the present poor connectivity and quality of habitat networks, and limited collaboration among actors and sectors needed for management and governance of green infrastructures in forest, rural and urban landscapes.

Identified as a biodiversity hotspot, the Carpathian Mountain ecoregion is currently faced with the challenge of maintaining functional green infrastructures of forest habitats. This paper focuses on the need for integration of protection, management and restoration of natural forests and cultural woodlands at multiple spatial scales to maintain composition, structure and function of high conservation value forests. This requires several types of data and analyses. We first estimated the regional variation of historic loss of beech (*Fagus sylvatica*) forest cover and its transformation to conifer plantations using remote sensing data. We then used a suite of historical maps to illustrate the need for assessing also forest continuity. Finally, we made spatial analyses of habitat connectivity to assess the degree to which forest patches are perceived by focal species as functional habitat networks.

The estimated loss of beech forest cover, irrespective of composition, structure and function, varied between 46% and 95% at the scale of different Carpathian ecoregion countries. Losses were higher in the economic centre of the region compared with its periphery and at lower altitudes rather than at higher altitudes. Analyses of historical maps covering more than two centuries indicate that even if forest cover remains, the loss of patches of forests having been continuously present in an area is underestimated. Finally, analyses of connectivity indicate that the area of old forest with continuity forming functional green infrastructures is also overestimated.

Mapping of high conservation forest habitat networks for the maintenance of functional green infrastructures for biodiversity conservation and provisioning of ecosystem services thus need to include use of multiple data sources such as remote sensing data, forest management plans and historical maps, temporal and spatial analyses of forest cover, as well as assessment in the field of composition, structure and function of forest ecosystems (Angelstam et al. 2011, Elbakidze et al. 2011). In addition wooded grasslands in traditional cultural landscapes outside forests may host forest species specialising on dead wood and old trees.

Additionally, there are different levels of ambition for biodiversity conservation to be achieved (Angelstam et al. 2004); e.g., (1) presence of species with small area requirements and generalists,

(2) viable populations of species dependent on natural forest structures or having large area requirements, (3) ecological integrity with communities of all naturally occurring species and natural processes, and (4) social and ecological resilience.
To develop functional green infrastructures as an outcome of adaptive landscape governance and management it is thus urgently needed to

(1) develop evidence-based knowledge (e.g., Svancara et al. 2005) and approaches for integrated spatial green infrastructure planning at scales from local to trans-national (Edman et al. 2011), and
(2) increase collaboration among human and natural sciences, and academic and non-academic actors to facilitate learning and sharing of knowledge and experience (Tress et al. 2006, ESF/COST 2010). Place and area-based production of new knowledge, and collaborative learning processes are two important tools to achieve integrative research.

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Rich, richer the richest?: Biomass and tree species diversity in Western Carpathians natural forest versus Białowieża natural lowland forest

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The relation between above-ground biomass and tree diversity is the most important question studied by a lot of scientists due to problem of a carbon accumulation in forests, and next because of global climate changes (Szwagrzyk, Gazda 2007). In our study we decided to compare a diversity and above-ground biomass of the natural forests of Western Carpathians with a very famous lowland natural forest of Białowieża. The aim of our study was to answer the following questions: Is the above-ground biomass in natural forests correlated with tree species diversity besides the kind (montane or lowland) of forest? Is this positive or negative relation? Studies were conducted during the 2000 year. Within Białowieża Primeval Forest (58 000 ha) there were established 160 permanent sample plots. They formed a grid with an average size of 267 × 1067 meters, with its shorter side oriented roughly to an 86° azimuth. In Gorce National Park (7 019 ha) there were established 398 permanent plots in a grid of 400 m. Within all plots there were measured diameter at breast height of all trees with diameter equal to or larger than 12 cm within 200 m^2 circle plot and height of these trees. We calculate the number of tree species and Simpson's index of tree species diversity to the above-ground biomass for every plot within these natural forest stands. Analyzed plots ranged from only one tree species stands (mainly spruce) to mixed deciduous lowland forests with six tree species per plot. The above-ground biomass accumulation ranged from 6 to 1155 (average 251±13) tons of dry mass per hectare within the Białowieża forest and from 2 to 849 (average 242±8) tons of dry mass per hectare within the Gorce forest. But this difference is insignificant. Instead there is positive relation between above-ground biomass and tree species diversity both in the Białowieża forest and in the Gorce forest. Although in the Gorce forests this relation started from a lower value and it increased quicker than for the Białowieża forest. To conclude this study we may state that there is a positive relationship between tree species diversity and above-ground biomass in both the Western Carpathians and lowland natural forests.

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Virgin and old-growth forests of the Ukrainian Carpathians, their structure models and detection criteria

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Remains of the virgin and old-growth forest ecosystems have been preserved in the forest cover of the Ukrainian Carpathians. The ecosystems have a special nature conservation value to the whole Europe. The virgin and old-growth forests are particularly valuable to Ukraine where forest share is only 15.7% and the anthropogenic forests have low biological stability. The virgin and old-growth forests are valuable natural etalons for reconstruction of derivative plantations and optimization of the forest management based on close to nature silviculture.
Methods for the virgin and old-growth forest inventory and maps of locations of the virgin and old-growth forests on the test plots in the of the Gorgan mountains of the Carpathians and central part of the Subapline Carpathians were developed using forest structure models and remote sensing data.

Adequate models of forest structure for detecting the spruce virgin and/or old-growth forests in the Shyrokoluzhansk nature reserve were developed using ground-based study data on the old-growth beach forest stands of the Uholka-Shyrokoluzhansk forest.
The study showed that the shape of the binominal distribution of trees responsible for detecting the virgin and/or old-growth forests. Sites of spruce virgin and/or old-growth forests of the nature reserve “Gorgany” that correspond to the objective criteria were detected and fixed on a map.
Development of the model based on periodic monitoring using GIS technologies allows finding principles of reconstruction of forests owing main self-regulating and protective mechanisms similar to the etalon forests.
The study focuses on formulation of clear criteria for the detection categories of virgin and old-growth forests as well as aspects of conservation and management.

A new concept of data acquisition for forest management in Slovakia

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Forests occupy 41% of the territory of Slovakia, and represent the natural formation providing irreplaceable economic, ecological and social functions for nature, landscape and society. Forest management in Slovakia is based on the regular collection of data on all forests in the ten-year planning cycles. Data are obtained mostly by traditional practices of terrestrial mensuration based on stand yield tables. These methods are costly, generate biased results when compared with results of forest inventories (Šmelko, Šebeň 2011), and their applicability in uneven-aged and structurally varied forests is rather limited.
For these reasons, a new concept of data acquisition on forests has been suggested, which is based on: 1) the use of existing data and update them with the single tree growth simulator (Fabrika, Ďurský 2006); 2) a statistical correction of updated information according to the results of the sample adjustment measurement (Šmelko 2011); and 3) the derivation of the necessary data on trees and forest stands by method of the remote sensing using multispectral images and laser scanning data.
Upgraded system should improve the accuracy of stand data, cheaper their acquisition, and create conditions for the wider use of up-to-date technologies in the future. Assumptions, the expected benefits and possible risks of introducing a new system into practice of forest management are discussed. Research tasks, which are necessary to resolve to support the proposed concept are defined.
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ORAL PRESENTATIONS

Examining synergies and conflicts in social, ecological and economic interactions in the Slovenský Raj National Park

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The countries located in the Carpathians have valuable forests, which previously, were owned and managed almost exclusively by state. Transitional changes, including the emergence of private companies, have overall resulted in a drop in the level of employment in the forestry sector, largely leading to impoverishment of local communities (Soloviy and Cubbage, 2007; Nijnik et al., 2009). Various stakeholders (*e.g.* forest owners, users, farmers) present multiple interests in the region. The sustainable forestry would need to be built on the integration of priorities of these diverse stakeholders, including many new forest owners. Implementation of sustainable development policies requires participation, capacity building and well-established institutions linked to a strong social capital.

However, totalitarian regimes weaken social capital, leading to its dysfunctions (Putnam, 1995; Lin, 2000). In former command-and-control economies, state monopoly and administrative control, resulted in the decline of trust in formal institutions and in the erosion of effective participation in planning and decision-making (Nijnik and Van Kooten, 2000). Often, various 'grey/black' networks were created, as the result (Paldam and Svenson, 2000). These networks and the reliance on personal relationships (Murray, 2005) and/or "politonomy" (Nijnik and Oskam, 2004) rather than on multi-stakeholder and multi-institutional cooperation have slowed down the processes of democratisation, decreasing the effectiveness of sustainable forest management. These countries have undergone significant political transformations. However, the low social capital is deemed to increase general mistrust brought about by the experiences within a command-and-control economy (Paldam and Svendsen, 2000). Closed informal networks (Portes and Landolt, 2000) often exclude from the decision-making all those who are not members of elite political structures, rejecting their potential constructive criticism which might have encouraged the system to change/improve (Gatzweiler and Hagedorn, 2002).

The communities in Slovensky Raj National Park (SRNP) are analysed in this paper, with a special focus on the involvement of Roma minority in sustainable forest management. The paper argues that advancing local institutions and promoting participation to increase social capital would result in a more sustainable management of forests. The major hypothesis tested is that sustainable forestry strategies, in areas with initially low trust and weak social networks, need to create opportunities/space (Lin, 2000) for repeated interactions between individuals who are to become willing to expresses their needs, cooperate, and learn from one another (Brehm and Rahn, 1997).

Social capital, cooperation and community development in SRNAP are discussed and potential scenarios linking sustainable ecosystem management with sustainable livelihoods are investigated. We specifically focus on opportunities for increasing of social capital by improving cooperation through repeated interaction of stakeholders and capacity development. It is anticipated that this effort would improve the circle from learning by doing and knowledge sharing, through to building of social capital/capacity to uncover and manage possible conflicts, multiply outputs from synergies and identify/promote actions for sustainable development.

The paper first outlines some conceptual elements of social capital and participation applied in the context of sustainable forestry. This is followed by the methodological approach and our discussion about major problems in SRNAP. Finally, we present the results and conclude with the findings of empirical work and a brief discussion. The results suggest that a way towards sustainable livelihoods lies in the integration of forest management with community development, and that learning, repeated stakeholder interaction, building up of trust and cooperation between and within local communities are important preconditions for success.

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Toward incorporating human dimensions information into large carnivore management decisions – the case of the Rodna Mountains National Park, Romania

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The growing trend towards greater spatial proximity between people and wildlife and their reliance on the same resources leads to an increase in the frequency and intensity of conflict which has been observed in many parts of the world. In this research human-wildlife conflict is understood as both a clash between people and large carnivores over "space, food and life" (Treves 2009) and a socio-political conflict, the conflict between various social groups with different attitudes and interests with respect to large carnivores and their management (Treves and Karanth 2003; Madden 2004, Treves 2009). Often protected areas are sites where biodiversity conservation values clash with human interests for safeguarding life and livelihoods. Large carnivore conservation is particularly challenging for a plethora of ecological and socio-political reasons and their coexistence with people is essential for their future persistence. This can be achieved by resolving conflicts and finding ways for carnivores and people to share the landscape. Consequently, ecological assessments and socio-political investigations are complementary and equally important in addressing the problem although the latter aspects are relatively new in Romania.

In this study we present a comparison between fundamental life values and attitudes held by local people and sheep farmers toward large carnivores (bears, wolves and lynx) and the beliefs of Rodna Mountains National Park (Romania) staff about these groups. To explore the values of wildlife held by local people a questionnaire survey was conducted on a random sample of 383 adults (≥ 18 years of age) from 24 local communities, for a confidence level of 95 and a confidence interval of ± 5. The same questionnaire was applied to leaders of 80 sheepfolds that are found inside the park. The questionnaire was designed to assess respondents' attitudes and values, knowledge and experience of large carnivores, behaviors toward large carnivores and demographic characteristics, and it was administered as a face-to-face paper and pencil interview. The perceptions of the Rodna Mountains National Park (RMNP) staff were explored through in-depth interviews. These interviews also gathered park staff's views on the importance of using human dimensions information in decision-making regarding large carnivore management.

We assessed the hypothesis that differences in attitudes are related to differences in values held by various groups. Attitudes toward large carnivores were relatively negative among sheep farmers and were positively correlated with values of security and tradition. In general, the interviews showed a fairly good overlap between stakeholder attitudes and values and staff beliefs about them but several discrepancies were also identified. Differences were noted between opinions held by various park staff and also with respect to the respondents' location (urban vs. rural), gender, formal education and employment status. These could be addressed in the future by including systematically collected human dimensions information. The park staff agreed on the importance of human values to large carnivore decision-making and the need to understand local people's and stakeholders' values and opinions. However, the interviews showed that there was a lack of clarity among park staff on how to apply this information. This highlights the need for a closer collaboration between researchers and practitioners.

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Integrating the human dimension of nature protected area management into practice. Reflections from a case study in Romania

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While in the new paradigm of nature conservation, a stronger focus is put on the human dimension (social, economic, cultural) the international and European policies (e.g. the CBD and its Programme of Work on Protected Areas, the Carpathian Convention, the European Spatial Development Charter) call for an integrative approach.
Although protected area management emerged as a new science, with an interdisciplinary approach (Getzner et al., 2005), strongly oriented to practice, integrating the human dimension of protected area management remains problematic both in theory (as a question of approach and methodology) and in practice (as a question of stakeholder involvement procedures and inter-institutional collaboration schemes, for the appropriate data management and transfer into knowledge).
As a consequence of the increasing complexity of the protected areas' management objectives, more diverse data is necessary for an effective planning and implementation. Decisions have to consider local/regional needs by involving stakeholders but reliable, accurate and updated data is also necessary in order to integrate protected areas in their territories. Specific indicators are necessary in order to balance conservation and social-economic development. Social and economic indicators for spatial analysis and territorial planning exist and data is generated and processed by an increasing number of institutional and non-institutional actors, each of these having specific aims, which need to become convergent in the act of protected area management. Little is known among conservationists on the practical approach to the human dimension, on how to analyze the relation between protected areas and their wider territories, on how to transform existing data into useful knowledge, policy and practice. The efforts of scholars in this sense are of little use to practitioners due to the poor integration of their results in the national level policies and guidelines, which need to be supported by a legislative framework.
The Carpathians have the richest biodiversity in Europe, most of the biologically outstanding ecosystems being included in a wide network of nature protected areas, starting from the second half of the XXth century. The accession to the EU and the development of Natura 2000 network in most Carpathian countries was accompanied by a significant, quite explosive increase of the territory put under protection or conservation. In the same time, the new approach to protected area management, in line with the modern paradigm of conservation, as emerging from the EU directives, guidelines and policies, came to challenge the practitioners, not only in the preparation of management plans but also in their implementation. The Carpathian countries, share not only an area of natural and cultural value but also a history and some social-economic and political characteristics, which are directly and indirectly influencing nature conservation efforts. The development of national level policies and institutions in the Carpathian countries faced similar

problems, such as the rapid social and institutional change, the tradition of centralized, top-down approach (Lawrence, 2008), the lack of specific data and knowledge for the management planning and implementation, etc. Strongly influenced by the global context, the social-economic dimension of conservation emerged as a brand new issue and as an increasingly stringent requirement, which is often expressed from a unidirectional or sectoral perspective (e.g. tourism development/management, ecosystem services, social-economic benefits, etc). Little focus is put on the direct and indirect relation between the natural and the human dimensions, on the spatial relations and on a coherent and integrative approach.

Given these conditions, management plans for nationally designated areas and Natura 2000 are not based on a sound and effective social-economic analysis of their local or regional context, such issues being presented in an informative and descriptive manner (Černecký, 2011), while research and monitoring in the social-economic field is insufficient (Švaida, 2009). This aspect is reflected in practice, in the vague and inefficient objectives and actions, causing difficulties in the development and implementation of e.g. regional development programmes and in the overall implementation of management plans.

The paper presents some results and reflection emerging from an analysis of the relationship between the local communities and Calimani National Park, Romania, undertaken in the framework of my PhD thesis. As result of this study, some specific indicators, which are relevant for the analysis of the social-economic context emerged, together with a possible approach to this issue, that can be useful for the protected area practitioners in the Carpathians and for the development of data management policies and collaboration schemes. These indicators are presented and discussed in relation with the protected area management objectives and with the classical social-economic indicators used in spatial analysis and planning. The protected area management fields, which refer particularly to the human dimension, are correlated with the input data needed for the context analysis and with the knowledge which is necessary in the overall and sectoral planning phase. In the same time, some dissfunctionalities in the data flow management, as resulting from the inter-institutional relationships between different actors involved in spatial planning and protected area planning in Romania were identified.

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Robustness, vulnerability and adaptive capacity of long surviving traditional forestry institutions in central Europe.

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This paper concentrates on the analyses of historical forest common property regime in central Europe – called 'Urbars' - that transformed into the present forest governance structure after 40 years interruption during socialism. The political transformation and changes in property rights structure has created the opportunity for forestry owners to re-establish their traditional management practices. However emergence of market and increased market demand for timber may affect the robustness and vulnerability of those historical regimes and the institutional structure of traditional social-ecological systems (SES).
To study these processes, it is essential to understand how SESs become vulnerable as the context in which they operate changes in increasingly globalized world. Systems can become adjusted to some type of disturbances, and in doing so may become vulnerable to regime changes caused by many contemporary social-economical processes (Janssen et al. 2007).
This article aims to highlight the new disturbances that change the structure of traditional SES and analyze the effect that this processes have on the robustness of the system. Moreover, it aims to offer some recommendations to enhance the robustness of the system to be able to cope with new disturbances. To address this, we reviewed academic literature on several traditional SESs threatened by new disturbances in their environment. We also interviewed a number of local forestry communities in east part of Slovakia. To analyze the changes occurring in our study, we used the conceptual framework proposed by Anderies et al. (2004). This framework emphasizes the interrelationship between four main components of SES (resource, resource users, public infrastructure providers and public infrastructures) that are especially important with regard to robustness. Resource users and public infrastructure providers are human-based. Public infrastructure includes physical infrastructures and social capital (i.e., institutional rules). The links between the components may challenge the robustness of the overall SES.
Recently more and more natural resources and local communities continue to be vulnerable to some internal and external disturbances. Structural changes (e.g. intrusion of new resource users, changes in institutional settings) may seriously affect the capacity of the system to adapt to external disturbances. The research of traditional forest regime reveals how the structural and institutional changes seriously affect the quality of a given natural resource and makes a SES profoundly vulnerable. This research shows how globalization and emergence of market affects the robustness of traditional long lasting SES. In an attempt to adapt, some local foresters have intensified the use of this resource. As a result, new vulnerabilities are emerging. This situation can lead toward the inevitable collapse of this traditional SES. However flexibility of rules, local knowledge and experience creates conditions for renewal and increases ability for adaptation to external disturbances.
This situation may lead towards the collapse of this traditional SES and, thus, to the inevitable loss of long lasting historical regime and a unique example of the sustainable use of a natural resource. Despite several problematic issues discussed above this study reveals that self-governance, local knowledge and flexible rules, where identified as perspective attributes of resource regime to cope with unpredictable disturbances and complexity of global changes. Urbars' can be seen as long surviving institutions for sustainable forest management under the market and globalization.
The structure of this paper is as follows: The second session highlights the main factors enhancing the vulnerabilities of SES. The third session presents the case study and analyzes the driving forces that enhance the vulnerabilities of the local SES and its effects on its structure and robustness. The

session number four discusses the possible consequences of changes in disturbance for the traditional SES and offers some recommendations to enhance the robustness of traditional SES. The last session draws some general conclusions.

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Stakeholders' perception of traditional agricultural landscape and its management (3 Slovak case studies)

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Traditionally cultivated agricultural landscape reflects the history and long-time mutual relation between generations of farmers and landscape resulting to occurrence of specific agricultural features. Over decades a man applied its wisdom, knowledge and skills inherited over generations with respect to nature and its resources. Historical agricultural landscapes (HAL) are remarkable not only from ecological and cultural–historical point of view but also represents significant landscape pattern and resource of beauty and knowledge (Huba et al., 1988). On another hand, due to lack of support and interest they are marginalized and slowly disappearing (Špulerová et al., 2011).
Slovakia is country of various natural and cultural conditions and its preserved traditional agricultural landscape is typical by variability as well. It has been significantly changed mainly during era of communism in the 1950s-1980s, and partly in period of political and social transformation in the 1990s and after accession of Slovakia to EU in 2004 (Bezák, 2009). The mentioned historical milestones influenced majority of the agricultural landscape in Slovakia and the livelihood of local inhabitants, who have been carriers of conserved agrarian culture. Therefore there is an urgent need to better understand people's views on HAL, their perceptions of changes and attitudes towards farmland management if land use and conservation policies are aimed to be sustainable.
As part of the individual project "Research and maintaining of biodiversity in historical structures of agricultural landscape of Slovakia" realised in 2009-2011 we developed a sociological survey which was realized in 2010 in the three pilot sites with occurrence of HAL structures:
1. The Liptovská Teplička village – montane landscape of steep slopes with rocky soils around built up area of the village located at the end of long valley. The way of historical agricultural management originated stone walls and terraces on adjacent slopes which have been partially preserved (Štefunková, Dobrovodská, 1997). Geographical location of the village formed local stakeholders to live as separated community for many decades.
2. The Hriňová town - belongs to relatively large area of dispersed settlement in middle part of the Slovakian mountains. Here inhabitants live mostly separately in small settlements, sometimes quite far from the central part of the small town. Farmers used to live and work alone and

surprisingly collectivisation never taken place here, instead local association of individual farmers have been managing the land from the 1970s.

3. The Svätý Jur town - localisation near capital of Slovakia is evidently influenced by suburban effects, like daily migration, individual housing development, etc. Most of traditional vineyards handled by individual farmers were changed to large scale management from the end of 1950s when area was handed over to the state farm (Lieskovský et al., submitted).

Our contribution is dealing with some findings from realised large scale questionnaire survey with local inhabitants (5% of permanent residents). Questionnaire consisted of answers grouped to preselected options/categories in combination with possibility of few free answers for respondents. Statistical evaluation was proceeded by using SPSS (Statistical Package for the Social Sciences) in the form of cross assessment of selected types of answers. We analysed responses of stakeholders within several clusters as to stress key issues achieved from the research:

1. Perception of landscape and HAL
2. Perception of biodiversity of HAL
3. Perception of selected factors for ideal management of HAL by recent farmers
4. Perception of ideal land use by recent farmers and non-farmers.

Overall we evaluated 119 completed questionnaires in the Liptovská Telička village, 382 in the Hriňová town and 230 in the Svätý Jur town.

Results obtained from the questionnaire survey confirmed following issues:

- Similarities regarding the gaps in recent agricultural management in Slovakia (e.g. inappropriate conditions of CAP for local farmers) as perceived by local stakeholders were found in all study regions. These facts must be stressed when developing future national schemes and programmes of agricultural support.
- The historical development and current form of landscape is unique in each study region. Likewise perception of local inhabitants is regionally specific and should be individually considered in the future local management plans.
- Opinions of passive actors in agricultural management (non-farmers) reflect outside public contentment with the recent farming activities taking place in the regions. Results interpreted from their opinions can help to avoid conflict of interests in the agricultural landscape.

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Identification of Ecosystem Services in the Subcarpathians of Buzău County in Romania

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Our activities are diverse, with complex consequences that are sometimes hard to explain. Applying the ecosystem services concept to describe the interactions in the human–environment system, helps us to identify human dependence on ecosystems, and also the role humans play in altering the environment. We depend on ecosystems for their services: benefits we obtain from them; like food, fuel and materials, but also a choice of other not so obvious services, such as formation of soils and water supply (MEA 2005).

Ecosystems may deliver more than one service, so their manipulation to maximise one particular service can lead to unsustainable management and risks reducing other services. It reduces their value for other uses and leads to conflicts between different stakeholders and converting traditional multi-function landscapes into single-function land use types and eroded or polluted wastelands (De Groot 2006).

We hypothesise that ecosystem services management could lead to more successful maintenance of biodiversity levels and coping with hydro-meteorological hazards. Identification of ecosystem services in the Buzău Subcarpathians will lead to improved knowledge about the human-environment system in the area, and is a predisposition for sustainable management.

The Buzău Subcarpathians are a suitable case study area for the application of the ecosystem services concept owing to its complex physiogeographic characteristics and hydro-meteorological hazards occurrence on one side, and recent socio-economic changes on the other. In addition, it is an area of high biodiversity, which together with the rest of the Romanian Carpathians acts as a refuge for important European species, especially large carnivores, e.g. the brown bear (*Ursus arctos*) (van Maanen et al. 2006). Buzău County lies in south-eastern Romania, and extends from the Romanian plain to the Carpathians. Our case study is a rural area near the town Pătârlagele situated in the Subcarpathians. Although the ecosystems in the area are in well preserved state, they are vulnerable to anthropogenic change due to severe natural conditions (altitude, slopes, soils, precipitation, etc.) (Kuemmerle et al. 2008).

We hypothesise that key local ecosystem services are related to natural hazards regulation, as 30-40% of agricultural land is subject to them (Micu and Bălteanu 2011). These services allow the area to be habitable and are vital to the safety of villages in smaller catchments affected by mudflows and flash floods. They maintain access through the main Buzău River valley, as important transport routes like the national road 10 and the railroad to Nehoiu are threatened by landslides and rockfall. These services are regulated by the interplay of abiotic (climate) with biotic factors (vegetation). Ecosystems, especially forests and riverine vegetation, have an important effect on regulating surface flows and buffering of extremes in discharge of rivers (EASAC 2009).

Main environmental change drivers are connected with the collapse of socialism; following Romania's entry into the European Union and the implementation of new agricultural and environmental policies. Bălteanu and Popovici (2010) state, that one of the major changes in the period of transition was the extension of private property over agricultural and forest lands, that followed decollectivisation. It resulted in numerous small holdings (over 4,25 million nationwide) with an average size of 2,15 ha (MARDR 2010). This has lead to land abandonment, forest and agricultural land fragmentation, and large deforested areas (Bălteanu and Popovici 2010; Niculae and Pătroescu 2011). Together with the expected climate changes an increase of hydro-meteorological hazards occurrence in the area is likely (Micu and Bălteanu 2011).

Land abandonment has a negative effect on habitat provision, as it threatens the maintenance of high value grasslands. They are important habitats for European-wide acknowledged bird species, like the corncrake (*Crex crex*) and are already being managed through payments for habitat maintenance (TRINET 2010; MARDR 2010).

A study made by Niculae and Pătroescu (2011) in the near Subcarpathians showed that the area experienced around 10% deforestation between the years 1990 and 2006, and the number of forest patches increased by 11%, with a 14% decrease in their size. Together with the emergence of small plots, the land-use pattern has become more fragmented. This affects hazard regulation and can lead to habitat loss.

Large deforested areas in intensely populated and managed areas as in our case study areas, can lead to slope instability and rapid water runoff (Glade 2003). This has resulted in increased landslide activities, mudflows, and flash floods (Micu 2011). It also affects water cycling and can cause siltation, for example in the nearby Siriu water reservoir.

Identification of ecosystem services and drivers of change at the case study area are the first steps in analysing environmental change regarding ecosystem services provision. The next steps are spatial quantification of ecosystem services, environmental change modeling (with the focus on land-use change) and assessing the new human-environment state.

(The CHANGES project (Changing hydro-meteorological risks as Analysed by a New Generation of European Scientists) is part of the Marie Curie Initial Training Network, funded by the Seventh Framework Programme. The objective of the CHANGES Work Package 2 is to analyse the changes in exposed elements at risk, i.a. ecosystem services.)

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POSTER PRESENTATIONS

Small towns in the Romanian Carpathians – peripheral spaces searching for their urban identity

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The Romanian Carpathians are considered one of the least populated and poorly urbanized regions of the country, a region that is about to become completely isolated, with 20% of the total of towns, of which only 5 have over 50000 inhabitants. The majority of the mountain towns (46) have less than 20000 inhabitants, showing that their importance in the armature of the network of mountainous settlements could be substantially significant if their territorial role and their functional profile would be recognized and supported by adequate development policies.

Our study intends to identify the socio-spatial and environmental features generated by the recent transformations suffered by towns with less than 20000 inhabitants in the Romanian Carpathians and to explain them from the perspective of their peripheral position in the urban system. The trajectory of localities we are interested in is enclosed in the general evolution of Romanian towns of inferior level, being the first to suffer the shock of the transition from a centralized economy to an economy based on free market (Ianoş, 2004, Zamfir et al., 2009).

Many of the small Carpathian towns have lost what meant their basic economical activities, fact that led to the modification of the social structures, a visible phenomenon when there are analyzed the structure on groups of ages, the unemployment rate, the migration, etc. Unconsolidated urban structures, sometimes exclusively developed on the basis and in the purpose of the exploitation of minerals and forests, some of them have lost even their urban identity, being similar to a series of rural localities, some of the latest being even more flourishing.

All these are signs of a long process of isolation, of perpetuation of difficult economical situations and disconnection from the development strategies that operate in central areas (Portnov, 2004). Peripherization is a dynamic process, depending on scale and time, result of political and socio-economical actions and not necessarily on the natural isolation. It transposes in the case of small towns in the Romanian Carpathians in a low density of the population, a weak accessibility towards the important urban centers, a reduced mobility of the population, a decreased number of jobs available and limited possibilities of economical development (Leimgruber W., 1994).

Complementary the paper analyses the complex relation between small towns and their natural environment in terms of sustainable development oriented urban planning, focusing also on small urban localities' capacity of influencing protected natural areas, in conserving biodiversity and promoting sustainable tourism opportunities. The analysis will also take into account environmental degradation indicators (for. example pollution generated by mining activities or habitat destruction by forestry).

The present intercession also intends an interdisciplinary approach of the regional issues, monitoring the deciphering of the way in which the specific of the mountainous local environment has a role in the development of these towns. The small mountainous towns shall be analyzed from the perspective of their specific features that manifest in the territory: the role of demographic barycenter, the productive function (guaranteed by the mountainous natural resources and by the population involved in fields specific to the area), the structured character (small towns regarded as local sustainable development poles able to determine flows depending on the type of services that are offered) (Burdack, Knappe, 2007). All these are aspects that, if adequately valued, would represent a chance for the small towns to become central spaces at a local and micro-regional level.
Nevertheless we also ground our analysis on the fact that in the Romanian Carpathians there is a multitude of urban categories, among which: the *ancient tourist resorts* with urban traditions and a solidly-built identity (Sinaia, Busteni, Vatra Dornei, Baile Herculane), *mining towns* that due their existence to some natural resources intensely valued in the communist period according to the policy of aggressive industrialization (Vulcan, Aninoasa, Borsa) or *recently-declared towns* (after 1990) that through functionality and urban endowments do not succeed to surpass the recently abandoned rural statute (Brosteni, Salisea de Sus, Baia de Aries) (Ronnas, 1984, Pop,2006). The critical situation of some of the small Carpathian towns, often mono-industrial, whose decline has attracted the diminishment of some urban functions and even the return to a functionality of rural type that obliges us to take into account some possibilities of reviving through the re-articulation of the traditional activities that ensure the existence of urban settlements, the exploitation of the brand image of its manufacturing, if it does not exist.
The typological diversity of small towns offers us a way of illustrating in a detailed manner, through case studies, the individual social, economic and environmental features of the subjects comprised in the analysis. Our study is based on processing the existent statistical information, explaining and exemplifying in a cartographic manner the existent situation and highlighting the peripherization processes and local/regional disparities that manifest in the Romanian mountainous urban environment.

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Second homes in the vicinity of national parks in the Polish Carpathians - an inevitable urbanisation?

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The phenomenon of second homes is today one of the most dynamic and impetuous factors of spatial, social and economic transformation in mountainous areas in the Polish Carpathians. It is also one of the most dynamic forms of anthropogenic impact of tourism (Mika, Faracik 2008).
The owners of second homes in the Polish Carpathians are mainly residents of large urban complexes lying at the foot of the Carpathian Mountains, primarily the Upper Silesia region and the agglomeration of Kraków.
The estimated number of second homes in the Polish Carpathians is more than 20 thousand (Mika 2012). This phenomenon is developing in a dynamic and spontaneous way. Second homes tend to be located in strong concentration and spatial isolation from permanent housing in the area. The strong dispersion of second homes is also stimulating the development of permanent settlements, which creates a synergistic effect of urbanization. This leads to a rapid urbanisation of agricultural land and to taking up valuable natural areas and landscapes.
The increase in land prices and the gradual saturation of the space by second homes causes urban dwellers to constantly search for new locations. One of the most important factors in the location of second homes is the proximity of natural and untransformed wildlife, therefore the immediate vicinity of national parks enjoys great interest of investors.
The aim of the presentation is to provide the quantitative and qualitative characteristics of second homes' development in the immediate vicinity of the Gorce National Park as well as to show circumstances of this phenomenon and the current and potential conflict situations that occur as a result of an increasing urbanization of the natural environment.
Research area. As a part of the Western Beskidy Mountains, the Gorce Mts. are a particularly attractive location for second homes, being located in proximity to Krakow (about 80 km; about 1 hours drive) and along the main road leading to Zakopane (the main Polish mountain tourism centre). The mountain range of Gorce, due to national park protection, is not intensely developed for commercial tourism, and the area does not experience mass tourism. Villages in the Gorce Mountains are typically agricultural, so that the owners of second homes can enjoy calm and quiet.
Problems of second homes' development in the Gorce Mountains have not yet been discussed in scientific literature. The beginnings of this phenomenon in the Gorce area date back to the early twentieth century. The rapid development started in the 1970's, when the Gorce area belonged administratively to the Krakow voivodeship. Since the 1990's, this phenomenon has been intensified and it has become the main factor of urbanisation and functional transformation of rural areas.
Research methodology and some results. Now, second homes in Poland do not have to be registered. There is also no legal obligation to designate special recreational areas for second homes. Therefore, buildings that serve recreational purposes arise in areas which are intended for permanent housing. This leads to many difficulties in investigation of the second homes' phenomenon and imposes the need for arduous fieldwork. In the years 2007 to 2010, detailed field studies were carried out in order to identify second homes in selected villages in the Gorce Mountains (Łopuszna, Obidowa, Ochotnica Górna, Poręba Wielka) and to define the locational characteristics of these objects in the landscape. There was also a detailed survey among owners of second homes, local residents and employees of the Gorce National Park about motivations behind the creation of second homes, territorial origin of their owners and conflict situations related to nature conservation function of the Gorce National Park.

During the study, 1361 second homes have been identified, most of which arise outside the permanent housing area and tend to form spatial clusters. Since the 1990's, the spatial development of that settlement type has been regulated merely by market mechanisms in the real estate industry and by the boundaries of the Gorce National Park. Due to the intensity and location forms, the second homes settlement raises a lot of controversy, in particular in relation to nature conservation and uncontrolled urbanization.
The spread of second homes in the mountainous areas of the Polish Carpathians is one of the symptoms of the process of suburbanization. Gradually, second homes cease to function as recreation houses, becoming the first homes. Transformation of second homes into the first mansions is clearly noticeable in the Silesian Beskid and Beskid Wyspowy Mountains. The research in the Gorce Mountains also confirms this trend.
In the future, the development of second homes in the immediate vicinity of the Gorce National Park will continue. The resulting conflict situation will increase. More and more second homes arise directly at the border of the park. Ensuring a balance between the expectations of second homes' owners and the needs of nature conservation is becoming a challenge for both the national park management and local authorities.

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Fragile Adaptive Governance? Carpathian Forest and the Market

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The analyzing of the sustainable management of the natural resources requires a firm understanding of the natural system, institutional context and social dimension and their mutual interaction. Today diversity of interest, multiple decision actors and global environmental changes have dramatically increased probability of unexpected events to which society is exposed.
Common pool resources (CPRs) are natural and human constructed systems that generate finite quantities of resource units so that one person's use does subtract from the quantity of resource units available to others. Exclusion of beneficiaries through physical and institutional means is especially costly (Ostrom, Gardner, and Walker 1994). Examples include fisheries, irrigation systems, groundwater basins, grazing ranges or forests. Individuals jointly using a CPR are assumed to face potential social dilemmas in which individual short-term interests are in conflict with long-term society interest and thus make governance of the commons challenging field of economic research and policy.
There are disputes based on both – theoretical and empirical evidence – over the optimal or robust property regimes which would balance use and protection of the resources. Traditional approaches for natural resource management suggest private or state-centralized management as the only viable solution to prevent resource degradation (Gordon, 1954; Hardin, 1968; Scott, 1955).

Numerous empirical studies provides evidence of capacity of local users to solve social dilemmas of the commons and use the resource efficiently, contrary to the prediction (Berkes, 1985, 1986, Netting, 1972, Ostrom, 2005, Acheson 2003; Poteete et al, 2010 and others). In most of those cases no external authority is needed to solve the resource management problems, self-management and self-governance increases willingness to follow the rules and monitor others than when an authority simply imposes rules (Fleischman et al, 2010, Ostrom and Nagendra, 2006).

Carpathians are rich in forests and characterized by existence of a long forestry tradition and dynamic evolution of the forest ownership originated in 17th century. After more than 40 years of centralised state property regime forests where re-nationalised to original owners to in 1993. Absence of proper institutions prevented re-establishment of effective regimes. Our paper concentrates on the analyses of historical forest common property regime in Carpathian region. Applying multiple methods approach to study collective actions on social dilemmas we argue that these can be seen long lasting institutions for sustainable forest management under the market and democratic regime. Flexibility and local experience creates conditions for renewal and increases ability for adaptation to external shock. Although collective actions of the commons are typically studied on local level our paper and multiple methods in particular provides insight into how to scale up results from empirical studies to larger decision making arenas.

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