



Science for the Carpathians



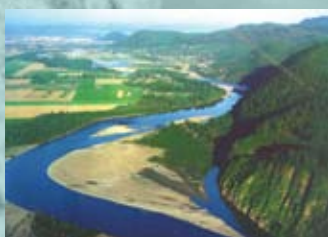
CONFERENCE ABSTRACTS

# FORUM CARPATICUM 2014

Local Responses  
to Global Challenges

September 16 – 18, 2014  
Lviv, Ukraine

[www.forumcarpaticum.org](http://www.forumcarpaticum.org)



Lviv, 2014



Forum Carpaticum 2014 is supported by:



The Forum Carpaticum is a bi-annual open meeting of the Science for the Carpathians (S4C) initiative, which goes back to the initiation of the Carpathian Convention in 2001. The S4C network was formally established in 2008 to foster dialogue between research, policy and practice in the realm of sustainable development of the Carpathian region. It also established strategic partnership with the Interim Secretariat of the Carpathian Convention (UNEP Vienna) to ensure durable basis for collaboration and knowledge transfer. Today, S4C connects more than 400 scientists from Central Europe and other countries. Numerous members actively participate in the Carpathian Convention working groups and meetings of the Conference of the Parties to the Carpathian Convention.

The 1<sup>st</sup> Forum Carpaticum (Forum Carpaticum 2010) in Kraków, Poland identified the need for better data generation, availability, and accessibility to information in the Carpathian Mountain ecological region. The 2<sup>nd</sup> Forum Carpaticum (Forum Carpaticum 2012) in Stará Lesná, Slovakia addressed this need by covering the whole Data-Knowledge-Action cycle, i.e. focusing on how data are generated and transformed into useful knowledge, how the knowledge is transferred to policy and practice, and how it can feed back to research planning.

The 3<sup>rd</sup> Forum Carpaticum – **Forum Carpaticum 2014: Local Responses to Global Challenges** aims to explore ways to address global challenges in the local and regional context. The main themes of the Forum Carpaticum 2014 conference in Lviv, Ukraine are related, but not limited, to the policy priorities of the Europe 2020 Strategy and the Horizon 2020 Programme, focusing on major challenges affecting the Carpathian ecoregion:

1. **Ecosystem services and land use change.** This theme concentrates on the problems of sustainable forest management (SFM), agriculture, agro-ecology, eco-tourism, as well as of control of infrastructure development, urban sprawl, rational utilization of mountain resources, communities and their roles in regulating the access to various ecosystem services.
2. **Climate change, water and extreme events/hazards.** The theme looks into the complex relations between climate change and water resources in the Carpathian area. The focus will be on integrated impact analysis, the resilience of mountain ecosystems as well as their management, conservation and restoration while paying attention to problems of flood protection, water availability and use.
3. **Natural and cultural heritage.** This theme deals with preservation of and threats to various types of natural and cultural heritage of the Carpathians. A critical issue will be assessment, monitoring and forecasting changes in complex Carpathian landscapes both in socio-economic and as well as ecological terms for sustaining biodiversity, traditional economy and human well-being.
4. **Smart mountains.** This theme considers the chances offered to mountain areas by a knowledge-based economy, technology development and green growth including environmental-friendly tourism development, mobility, interrelations between rural mountain areas and urban centres in and outside the Carpathians.

*Science for the Carpathians (S4C)  
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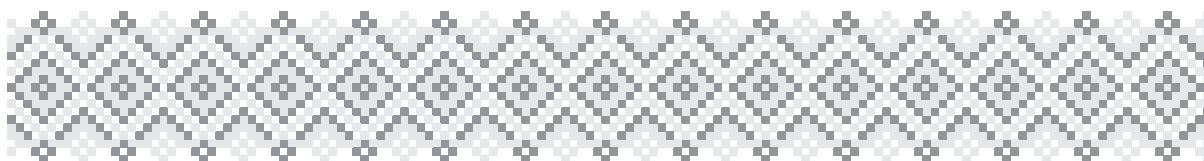
# **FORUM CARPATICUM 2014**

## **Local Responses to Global Challenges**

September 16 – 18, 2014 Lviv, Ukraine

[www.forumcarpaticum.org](http://www.forumcarpaticum.org)

## **CONFERENCE ABSTRACTS**



LVIV 2014

Suggested citation:

S4C (Science for the Carpathians). 2014. Forum Carpaticum 2014: Local Responses to Global Challenges. Conference Abstracts. September 16-18, 2014, Lviv.

Available on-line at: [www.forumcarpaticum.org](http://www.forumcarpaticum.org)

Compiled by: *Ivan Kruhlov and Bohdan Prots*

The abstracts included in this volume were evaluated and selected by the Forum Carpaticum 2014 Scientific Board. Most of the abstracts were not additionally edited and are published as submitted by the authors.

Front page design: *Elżbieta Laszczak, Dominik Kaim, Katarzyna Ostapowicz, Ihor Dykyy*  
Photos: *Natalia Kolecka, Bohdan Prots*

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# FORUM CARPATICUM 2014

**Tuesday, September 16**

|   |  |  |  |
|---|--|--|--|
| <b>Registration</b><br>7:30-9:30<br>Franko University   |  |  |  |
| <b>Opening Session</b><br>9:30-11:00<br>Assembly Hall, Franko University  |  |  |  |
| <b>Coffee Break</b><br>11:00-11:45  |  | <b>Side event</b><br><b>Tastes of the UA Carpathians</b>   |  |
| Thematic Session 1<br><br><b>Forest Ecology I</b><br><br>11:45-13:30<br><br>Room 1, House of Scientists                                       | Workshop 1<br><br><b>WWF: Ecological Connectivity</b><br><br>11:45-13:30<br><br>Assembly Hall, Franko University       | Thematic Session 2<br><br><b>Climate-Water-Landforms-Soil</b><br><br>11:45-13:30<br><br>Room 2, House of Scientists                          | <b>Side event</b><br><b>Meeting of the Group on the Caucasus Region</b><br><br>Room 3, House of Scientists |
| <b>Lunch</b><br>13:30-14:45   |  |  |  |
| Plenary Session 1<br><br><b>Ecosystem Services and Land Use Change</b><br><br>14:45-16:00<br><br>Assembly Hall, Franko University             |  |  |  |
| <b>Coffee and Posters</b><br>16:00-16:45  |  |  |  |
| Thematic Session 3<br><br><b>Ecosystem Services &amp; Sustainable Forest Management</b><br><br>16:45-18:30<br><br>Room 1, House of Scientists | Thematic Session 4<br><br><b>Land Use/Land Cover Change</b><br><br>16:45-18:30<br><br>Assembly Hall, Franko University | Workshop 2<br><br><b>CARPIVIA/ Carpathian Convention: Adaptation to Climate Change</b><br><br>16:45-18:30<br><br>Room 2, House of Scientists |  |
| <b>Conference dinner</b><br>19:30-22:30   |  |  |  |

**Wednesday, September 17**

|   |   |   |   |
|---|---|---|---|
| <div>Plenary Session 2</div> <div>Climate Change and Extreme Events</div> <div>9:00-10:30</div> <div>Assembly Hall, Franko University</div> |   |   | <div>Side event</div> <div>Meeting of the Group<br/>on the Caucasus<br/>Region</div> <div>Room 3, House of<br/>Scientists</div> |
| <div>Coffee and Posters</div> <div>10:30-11:15</div>  |   |   |   |
| <div>Thematic Session 5</div> <div>Forest Ecology II</div> <div>11:15-13:00</div> <div>Room 1, House of<br/>Scientists</div>                | <div>Thematic Session 6</div> <div>Biodiversity I</div> <div>11:15-13:00</div> <div>Assembly Hall, Franko<br/>University</div>  | <div>Thematic Session 7</div> <div>Smart Mountains I</div> <div>11:15-13:00</div> <div>Room 2, House of<br/>Scientists</div>  |   |
| <div>Lunch</div> <div>13:00-14:15</div>   |   |   |   |
| <div>Plenary Session 3</div> <div>Natural and Cultural Heritage</div> <div>14:15-15:45</div> <div>Assembly Hall, Franko University</div>    |   |   |   |
| <div>Coffee and Posters</div> <div>15:45-16:30</div>  |   |   |   |
| <div>Workshop 3</div> <div>WWF: Old Growth<br/>Forests</div> <div>16:30-18:00</div> <div>Room 1, House of<br/>Scientists</div>              | <div>Thematic Session 8</div> <div>Biodiversity II</div> <div>16:30-18:00</div> <div>Assembly Hall, Franko<br/>University</div> | <div>Thematic Session 9</div> <div>Smart Mountains II</div> <div>16:30-18:00</div> <div>Room 2, House of<br/>Scientists</div> |   |
| <div>Lviv Down-Town Bus Tour (Starts/ends on Rynok Square)</div> <div>19:00-20:00</div>   |   |   |   |

**Thursday, September 18**

|   |
|---|
| Plenary Session 4<br><b>Smart Mountains</b><br>9:00-10:30<br>Assembly Hall, Franko University |
| <b>Coffee Break</b><br>10:30-11:00  |
| <b>Closing Session</b><br>11:00-12:30<br>Assembly Hall, Franko University                     |



# PLENARY SESSIONS

### Scientific collectives in region-building processes

Bernard DEBARBIEUX<sup>1,2</sup>, Jörg BALSIGER<sup>1,2</sup>, Dusan DJORDJEVIC<sup>1</sup>, Simon GABERELL<sup>1</sup>,  
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Policy-making today routinely integrates science as a reference, if not as a guide, especially in domains related to natural resources and environmental management (Miller and Edwards, 2001; Takacs, 1996). Accordingly, an ever-growing number of scientific experts have become influential in public agencies and international organizations, or have entered close relationships with them, and have become involved in all phases of the policy-making process, albeit in different forms (Jasanoff, 1990; Keller, 2009). Some observers have identified increasing interaction between scientists, political authorities, and global environmental organizations as the first “emergent aspects of transnational politics in environmental initiatives” (Jasanoff and Martello, 2004: 4).

At the same time, the global drive to fortify science-policy interaction has been accompanied by the striking growth of environmental analysis and regulation at the regional level (Balsiger and VanDeveer, 2010). Between 1945 and 2005, 60 percent of all new international environmental agreements were of a regional character (Balsiger and Prys, forthcoming), a trend that has been reinforced by the promotion of sustainable development and by the integration of environmental issues in development policies.

This paper investigates the parallel unfolding of these two trends-towards science-based policies and towards regionalization. First, it raises the specific question whether and how the regional framing of environmental initiatives and the regionalization of science influence each other, and whether this encounter has inspired new forms of interaction between scientists and policy makers. Second, it offers insights for the specific case of mountain regions in Europe and Central Asia, where many regional institutions have been created or conceived for dealing with specific environmental and sustainable development issues since the late 1980s (Debarbieux et al., 2013). The analysis builds on a series of inter- and transdisciplinary research projects and mobilizes data from primary and secondary written sources, as well as interviews, focus group discussions, high-level panels, and participant observation at several regional meetings between 2008-2013.

Our research makes two distinct contributions. Empirically, it traces the evolution of diverse forms and modalities of science-policy interaction in a domain previously neglected in the relevant mainstream literature. Such cooperation can be observed from the Pyrenees to Central Asia, albeit with a degree of variation that largely remains unexplored in scientific research. Sometimes scientific cooperation served to lay the groundwork of a mountain policy initiative, other times it appeared in its wake; some examples appear as loose networks of individual scientists, others are set up as formalized monitoring and observation centers; finally, some scientific joint efforts are formally linked to, or incorporated in a mountain policy initiative, while others are largely independent.

Conceptually, it helps to refine the concept of science-policy interaction by situating it in a regional context and proposing a typology that can be applied to other domains. On the one hand, this involves greater attention to four different types of regionality:

1. Realist regionality: the regionality of the environmental reality which refers to bio-physical regions presupposed by scientists, when they adhere to some kind of realist epistemology;
2. Representational regionality: the regionality of knowledge which refers to regions of

representation (i.e. the set of statements, images, data that scientists produce for arguing about the very nature of environmental regions);

3. Institutional regionality: The regionality of political institutions which refers to institutional regions as defined for example by international treaties or formal conventions; and
4. Social regionality: The regionality of the social world, regions being here categories of social practices (e.g. referents of social discourse) that scientists, policy-makers, activists, entrepreneurs, etc. adopt for activating or promoting a regional public.

On the other hand, we propose a typology of regional scientific collectives, comprising four different types:

Type 1: specialized scientists independent of regional governance initiative (e.g. University of Central Asia, UCA);

Type 2: Scientific collective established as counterpart of regional governance initiative (e.g. International Scientific Committee on Research in the Alps, ISCAR);

Type 3: Scientific collective established to be counterpart of planned or abandoned regional governance initiative (e.g. Science for the Carpathians Initiative, S4C); and

Type 4: Techno-scientific network established to meet data specific information demands of regional governance initiatives (e.g. Observation System for the Alps, SOIA).

The research for this paper benefited from financing under a series of projects, including “Globalization and re-territorialization of environmental initiatives in Central Europe: stakeholders, narratives, images (GLO-RETE)” (financed by the Swiss National Science Foundation), “European Regional Mountain Initiatives: From Pyrenees to Caucasus (ERMI)” (financed by the Swiss National Science Foundation), and “Mountlennium: Reaching Millennium Development Goals through Regional Mountain Governance” (financed by the Swiss Network for International Studies). The authors are grateful for the support from the respective institutions.

Our analysis of regional scientific collectives and science-policy interaction in mountain areas of Europe and Central Asia shows that the notion of regional scientific collective encompasses very different forms of cooperation between scientists. Furthermore, it reveals that while regional political institutions are nearly unanimous in their call for regional scientific expertise, it appears that they often start from a very vague idea of how this expertise should be organized on a regional basis. In practice, however, this vision of a partnership between scientists and policy makers is never fulfilled because scientific collectives tend to develop their own agendas and/or because regional political institutions end up working with altogether different scientific partners.

#### References:

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### Exploring challenges to sustainability in provision of ecosystems services by upland forests in Scotland and Ukraine

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This paper seeks to provide both conceptual and practical guidance towards solving the problem of implementing the sustainable provision of forest ecosystem services into stakeholder considerations and policy-making decisions. Based on the work with relevant stakeholders in both Scottish uplands and the Ukraine's Carpathians an attempt is made to identify, demonstrate, and communicate innovative ways of improving the key ecosystem services of mountain forests, and enhancing their sustainable provision for the benefit of local communities and society at large. Contemporary societies expect a range of services to be delivered from mountain forest ecosystems. Their growing societal importance is clearly reflected in policies. The conceptual framework for the Millennium Ecosystem Assessment (2005) states that people are integral parts of ecosystems and that a dynamic interaction exists between them and other parts of ecosystems. This approach encompasses social, economic and environmental interactions, and the dynamics and cross scale issues that have multiple outcomes. However, multi-functionality is a challenge since the combination of multiple ecosystem services may be very different and dependent on a high number of factors. Stakeholder priorities with respect to individual ecosystem services may be variable, as may be a range of stakeholders. Reflexive, participatory and multilevel governance, in a continuous process of its adjustment needs therefore to be developed to enable decision-makers to consider existing opinions and behavioural patterns of the diverse stakeholders who drive the mountain forestry change and respond to it. In such a retrospective, numerous questions have arisen, among which the integration of carbon sequestration into multifunctional forestry development is among priorities. Carbon forestry enables society to buy time for development of low carbon and decarbonisation technologies; while its integration into multifunctional land use offers innovation, employment and new markets, with locally and regionally oriented value chains. This particularly concerns mountain areas where forestry could foster socio-economic development and combine it with the enhancement of nature and rural landscape. However, the question: how to multiply synergies and balance trade-offs merits attention. Fostering resilience of sensitive mountain forest ecosystems to climate change necessitates the establishment of an appropriate framework, because, although multipurpose forestry may result in lower rates of carbon sequestration, it is expected to be more attractive to people as it will provide additional benefits and will promote sustainable mountain development.

#### References:

Millennium Ecosystem Assessment, 2005. [www.millenniumassessment.org/en/index.aspx](http://www.millenniumassessment.org/en/index.aspx)

## Forest biomass distribution and its loss between 1985 and 2010 in the Western Carpathians

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The ability to monitor and quantify forest change is a prerequisite for better understanding human-induced environmental changes and their impact on forest ecosystems. Moreover, the questions relating to the spatial and temporal dimensions, and its magnitude remain fundamental to forest services' concerns. Here, we assessed changes in forest aboveground biomass associated with forest disturbances and recovery between 1985 and 2010 in the Western Carpathians. First, yearly maps of aboveground biomass based on Landsat time series and field data were created. Second, we applied a trajectory-based change detection to reconstruct forest disturbances and recovery. Then, we distinguished and investigated abrupt disturbances and long-term changes processes in respect to topographic factors and dominant stand age. Finally, we quantified biomass losses and gains associated with abrupt and gradual disturbances, and forest recovery.

Overall, 55% (~30,700 ha) of the total coniferous forest experienced a loss of biomass over the observation period, while ~30% showed severe or complete removal of forest biomass. At the same time, 11.2% of the area was reforested or regenerated on previously damaged forest stands. The total coniferous biomass dropped by 15% between 1985 and 2010.

Comparing abrupt and gradual changes, long-term biomass losses dominated across all altitudes and slope classes. While abrupt disturbances affected less forested area, the fraction of severe biomass losses was significantly higher. Both, abrupt disturbances and long-term changes occurred predominantly on S, SW, and SE facing slopes. Severe biomass loss from gradual changes lasted up to ten years, and increased with altitude. Finally, abrupt disturbances were predominant within older coniferous stands (between 90 and 120 years).

The unsustainable forest management in the past, catalyzed by high levels of pollution loads during communist times, caused a significant damage to the coniferous forests in the Western Carpathians. Since the early 1990s, spruce-dominated stands have shown low resistance against biotic and abiotic threats. They have thus been susceptible to fungal diseases and insects outbreaks on the one hand, and adverse climate condition with subsequent extreme weather events on the other. Between 2005 and 2010 widespread and severe biomass loss reached a climax.

Monitoring and quantifying forest changes are of prime scientific and economic interest. Our study provided an example of spatially and temporally explicit quantification of forest biomass. Such knowledge is prerequisite for sustainable forest management and the provision of ecosystem services.

## **The BioREGIO Carpathians project: methodology and results from the “Connectivity and Continuum” analysis**

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BioREGIO Carpathians is a transnational cooperation project, co-financed under the second call of the EU South East Europe Transnational Cooperation Programme, priority area “Protection and Improvement of the Environment”. It involves 16 partners from nine different South European, Central and Eastern European countries. The seven Carpathian Ministries of Environment are observers to the project. BioREGIO Carpathians run for three years (2011 – 2013) and is a flag ship project for the Carpathian Convention and its Biodiversity Protocol and herein it seeks for a close relationship to the Biodiversity Working Group in the CC. One basic strategy the project is built on is the maintenance and conservation of structures to foster ecological connectivity and following the hypothesis to sustain endangered species and to enable large herbivores and carnivores to live in coexistence with our modern society. The maintenance of an ecological continuum is essential for the provision of the ecosystem services and for the valorization of the biodiversity, which may open Positive socio-economic effects for the local populations (avoiding road kills, tourism, recreation, high-quality environment).

However, the Carpathian countries are experiencing a massive modernization of their road infrastructures since the end of Communism and 1700 km of new motorways are expected to be constructed within the next few years in Czech Republic, Hungary, Romania and Slovakia (Jaeger and Madriñán, 2011). This run-to-development, if not conducted considering the ecological network, may fragment natural areas, limiting dispersal and genetic exchange of some wildlife species. Large carnivores and herbivores, due to their habitat requirements and low densities of occurrence, react sensitively to landscape fragmentation. Thus, they are appropriate for designing a GIS habitat suitability model that covers their ecological preferences, which are assumed as representative for other Carpathian species, too. Picking up that thematic issue, following the JECAMI (Joint Ecological Continuum Analyzing and Mapping Initiative) approach from the Alpine Space Project ECONNECT (<http://www.econnectproject.eu/cms/>), based on the evaluation of the general permeability of the landscape considering several impact factors, BioREGIO aims to explore the distribution of potential suitable habitats and of least-cost paths adopting a species-approach.

The approach combines two ArcGIS 10.0 free-downloadable tools in a GIS suitability model. The three-step Habitat Suitability Model developed is considering the ecological characteristics of seven umbrella species for the Carpathians. First, the habitat suitability model is created with the CorridorDesign (Majka et al., 2007). It identifies patches of suitable habitats by assigning different suitability values to ecological factors for each species. The model returns the suitability value (0-100%) indicating the appropriateness of a particular land cover patch for the dispersal of a species. The second step consists on reclassifying the suitability values by considering the presence of species-specific ecological factors, which enables to identify core areas for each species. The third step seeks to identify ecological corridors by using LinkageMapper (<https://code.google.com/p/linkage-mapper/>); it allows detecting the most probable corridors by applying a minimum-cost analysis and calculating the least cost paths for passing through the land cover matrix. This comprehensive GIS approach has been applied following a Carpathians-wide and a pilot region approach, to identify both the general regional ecological network and to highlight the main barriers at local level. The main advantages of this method are the possibility to consider the habitat factors' preferences in different classes, to combine habitat suitability evaluation for several species and to weight different factors in different ways, integrating expert knowledge and empirical data. Where



available, wildlife observation and presence data, have been integrated to validate the model and the derived dispersal paths for each umbrella species.

The results of the investigation on ecological connectivity carried on during the three years of the project are visualized through a Web-GIS application. The overlapping of core areas and least-cost paths with the Google Open Street Map highlights the possible physical barriers that may hinder the free movement of the considered species. Additional threats to the detected ecological connectivity may come from the foreseen motorways and from the expansion of settlements. Since the Carpathians have a high diversity through all their range, from an environmental, legal and social point of view, we have organized specific site visits in the locations identified as most endangered. The general Carpathians-wide ecological connectivity can be maintained only with actions developed at local level. Site visits were organized in Slovakia, Romania, Ukraine, Serbia and Hungary. Local investigation have taken in consideration not only the physical barriers (roads, settlements - current and foreseen) but also the legal aspects of wildlife conservation and the socio-economic framework of each location. The multi-disciplinary approach followed in BioREGIO, allowed the identification of the main problems regarding connectivity and ecological networks particularly concerning the umbrella species considered. Main identified barriers for connectivity range from illegal urban sprawl to the absence of road-kills prevention systems, from the construction of new motorways regardless of ecological connectivity to the law awareness of local people concerning ecological connectivity beyond protected areas.

The investigation on the ground together with local experts and stakeholders enabled the adaptation of the GIS results (core areas, least-cost paths) and the development of feasible solutions to overcome the detected barriers from a physical, legal and social point of view. The project results will be transferred into an outlook about future actions to be implemented in the Carpathians to maintain connectivity and to sustain large carnivores, herbivores and biodiversity.

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- ECONNECT project: <http://www.econnectproject.eu/cms>
- Linkage Mapper: <https://code.google.com/p/linkage-mapper/>
- CorridorDesign: <http://corridordesign.org/>



### **Carpathian integrated assessment of vulnerability to climate change and adaptation measures**

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The CARPIVIA, CarpathCC and CARPATCLIM projects assessed the vulnerability of the Carpathian region to climate change in combination with other anthropogenic pressures. This paper will summarise the conclusions of the research.

The paper will discuss vulnerability and adaptation options for:

- Key climate change pressures (temperature and precipitation)
- Water resources
- Forests and Forestry
- Wetlands
- Grasslands
- Agriculture
- Tourism

The paper will close with the main elements of a strategic agenda on adaptation that will be discussed at the Fourth Meeting of the Conference of the Parties (COP4) to the Carpathian Convention. This agenda underlines that at regional level, linking different policies of nature conservation, river basin management and sustainable farming, could significantly strengthen the Carpathian region and its resilience to climate change impacts. Regional cooperation platforms, like the Carpathian Convention and S4C, could be a critical vehicle to mainstream this in different countries. Countries in the Carpathian region can increase their resilience and tap into European resources by mapping out a path towards a climate-proof future, which draws upon, and conserves, the unique natural and cultural values of the Carpathian region. The added value of increased transnational cooperation and joint activities is especially strong when planning for climate change adaptation, as much of the predicted impacts of climate change relate to seasonal and geographical shifts. This is true for species and communities (forests, tree-lines, northern limits) as well as for socio-economic aspects (tourist arrivals, tourism seasons). Financial resources are limited. A key action is to create flexible and equitable financial instruments that facilitate benefit - and burden-sharing, and that support a diverse set of potentially better-adapted new activities rather than compensate for climate impacts on existing activities. To succeed, new partnerships between government, civil society, the research and education institutions, the private sector and international organisations will be key. Essential components of such partnerships will be capacity building and information sharing, climate-proofing of infrastructure and investments, climate-cross compliance, and design of eco-system based adaptation measures to make biodiversity management more dynamic.

More information: [www.carpivia.eu](http://www.carpivia.eu)

## Understanding distribution of air pollution and atmospheric deposition in complex mountain terrain

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Air pollutants are an integral part of the recently occurring climate change. From a perspective of increasing temperatures the most important are carbon dioxide (CO<sub>2</sub>), halocarbons, methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), ozone (O<sub>3</sub>), and aerosols. Ozone in addition to being a powerful greenhouse gas is also responsible for extensive negative effects on human and ecosystems. Other pollutants with high potential for ecosystem effects are various nitrogenous (N) compounds and sulfur dioxide (SO<sub>2</sub>). Among these compounds, nitric oxide (NO), nitrogen dioxide (NO<sub>2</sub>), ammonia (NH<sub>3</sub>) and nitric acid vapor (HNO<sub>3</sub>) can directly affect health of humans and plants and also significantly contribute to atmospheric N deposition. Increased N deposition causes serious ecological effects such as changes in species diversity or water contamination. Information on concentrations and distribution of compounds which are the air quality criteria pollutants (O<sub>3</sub>, NO<sub>2</sub> and SO<sub>2</sub>) is often available for urban areas. However, there is little information on most of the ecologically-important air pollutants in remote areas, including forests.

Mountains create special problems in regard to feasibility of establishing and maintaining air pollution monitoring networks, due to their complex topography, difficult access and lack of electric power to run electronic equipment. Passive samplers have greatly helped in this regard allowing for monitoring ambient concentrations of O<sub>3</sub>, NO<sub>2</sub>, NH<sub>3</sub>, HNO<sub>3</sub>, and sulfur dioxide (SO<sub>2</sub>) in remote areas. The USDA Forest Service team in collaboration with various partners has conducted numerous monitoring campaigns in the European and North American mountains aimed at better understanding of distribution of these pollutants in remote mountain ranges. Results of these studies, aided by geostatistical methodologies and inferential modeling, have resulted in development of maps of air pollution concentrations and atmospheric deposition. Such maps are very useful for understanding risks to human health, ecosystems health and sustainability, as well as provision of ecosystem services. Methodological advances and results from studies conducted in the Carpathian Mountains (including the Tatra, Retezat, and Bucegi ranges) and the Sierra Nevada Mountains (including Sequoia & Kings Canyon and Yosemite National Parks or the Lake Tahoe Basin), the San Bernardino Mountains, and the White Mountains in California will be discussed. A new inferential model for estimates of N deposition in complex mountain terrain will also be presented.

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## **Changes to channel morphology and physical habitats for river biota, and infrastructure damage caused by a major flood on the Biała River, Polish Carpathians**

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Restoration of degraded, maintained river sections often encounters opposition reflecting fears of flood-related risk of damage to the infrastructure located in the valley floors. Indeed, in mountain areas flood events of large magnitude are usually associated with extensive material loss resulting from destruction of infrastructure and changes in channel morphology (erosion and especially widening). The proposed restoration scheme for the gravel-bed Biała River, Polish Carpathians, involves establishing of an erodible river corridor in two reaches located in the mountain and the foothill course of the Biała. In these reaches, longer, unmanaged channel sections alternate with short, channelized sections and that pattern of channel types is associated with a general tendency towards increasing channel narrowing and incision in the downstream direction. In June 2010 a flood with a recurrence interval of at least several tens of years, the largest on record so far, occurred on the Biała River inducing significant morphological changes and substantial material loss. This study aims at determining the effects of the major flood event of 2010 on the physical habitat conditions for river biota, channel morphology as well as valley-floor infrastructure.

Surveys of 10 pairs of unmanaged and channelized cross-sections located close to each other, performed in 2009 and in the late summer 2010, were used to assess the flood-induced changes to physical habitat conditions. A comparison of the channel planform prior and following the flood event provided information on the degree of channel widening, as well as changes in the width of particular elements of the active zone of the river in 8 sections of the Biała. The impact of the flood on the valley-floor infrastructure was next confronted with the degree of river widening in the unmanaged and channelized river sections. Before the flood, the unmanaged cross-sections were typified by significantly greater number of low-flow channels, finer bed material and greater lateral variability in depth-averaged and near-bed flow velocity than channelized cross-sections. The flood tended to equalize habitat conditions in both types of river cross-sections, obliterating differences in particular physical habitat parameters between channelized and unmanaged channel sections.

A comparison of channel planform from 2009 and 2012 indicated that the flood increased the width of low-flow channels and of gravel bars. Lower degree of river widening by the flood, observed in more downstream sections, must have reflected greater channel incision typical of this part of the river. Degree of active channel widening differed between channel sections of differing morphology: in the surveyed unmanaged cross-sections bankfull channel width increased by half and by a third in the channelized ones. However, damage to the valley-floor infrastructure was practically limited to the channelized river sections. This indicates that unreasonable management of riparian areas, constricting river space, rather than the degree of river widening has been a principal reason for the extensive economic loss related to infrastructure damage during the recent flood of this magnitude.

## Local level resilience as a prerequisite for climate change adaptation

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In the period 2011-2013 the EU funded SEARCH project implemented activities to increase social and ecological resilience in watershed ecosystems of the Mediterranean Region in the face of climate change. The lead implementing organization was IUCN, while the Centre for Development Innovation (CDI-WageningenUR) contributed to the implementation with knowledge on learning, stakeholder involvement and watershed management. The lessons learned and experiences obtained have been brought together in a toolkit. This paper will summarize how the toolkit can be applied and can be of use for the Carpathian region.

**The challenge.** Climate change is affecting livelihoods of people all over the world but these are the economically and socially least developed groups of the society that are most vulnerable to climate change impacts. Therefore, strengthening the resilience of these most vulnerable groups should be at the heart of climate change policies. However, in order to realize this, a transparent and accountable governance and institutional set up is needed that enables a more targeted decision making process. A key element is the representation of all relevant stakeholders, at horizontal and vertical levels, throughout the whole process of setting up and implementing adaptation strategies. This will empower and strengthen the resilience of stakeholders to improve both their social and ecosystem abilities to cope with change under various climate change scenarios. There is a gap between these ambitious ideas and realities on the ground. On one hand, there are national climate change adaptation policies, generally described in a theoretical way; there are also other sectoral policies for e.g. water, agriculture, forestry, fisheries. On the other hand, there is the ground level where farmers and other rural people try to adapt to climate change and other changes that put stress on their livelihood. Like in many other parts of the world, the pressures on the livelihoods of local people in the Carpathians are numerous and climate change is not their first and most important concern. Their dominant worries relate to a daily struggle to survive caused by a bad economic and social situation. This counts especially for the small farmers in mountainous areas where climate change impacts are at the same time the most severe. Increasing their resilience is therefore not only relevant to increase their adaptation capacity but, most importantly, also to improve their livelihoods and perspectives for the future.

**The Resilience Framework.** The approach used in the toolkit is based on the 'Resilience Framework'. The following definition of resilience has been adopted: *"A watershed system's capacity to absorb, manage, and adapt to social & health, agricultural, and ecological changes (or stressors) while still maintaining its essential structure, feedbacks, and functionality."*

The logic for choosing the *watershed* as the geographic unit for developing resilience adaptation plans is that it is important to limit clearly the zone of intervention. River (sub)basins are very suitable for that, because water is essential for ecology and economy.

The developed framework includes four main components, namely:

- **Diversity** of the economy, livelihoods and nature. Diverse markets, industry or farming systems, for example, give people the alternatives they need to be adaptive. Bio-diversity ensures the availability of ecosystem services needed to buffer climate impacts – such as storage of water in upper-watershed forests – and sustain life and productivity.
- **Sustainable infrastructure and technology.** These refer to engineered and 'natural infrastructure', as well as adaptable and sustainable technologies for the reduction of vulnerability. 'Infrastructure' also includes natural infrastructure such as wetlands, floodplains and peatlands that store water, lower flood peaks or protect coastal communities.

- **Self-organization and Adaptive Governance.** Self-organization is developed in practice through participatory governance and empowerment of people. Stakeholder involvement is crucial.
- **Learning.** Ensuring that individuals and institutions can use new skills and technologies needed to adapt and make effective use of better climate information and adaptation strategies as they become available.

**Toolkit structure. Step 1: Developing a vision.** The visioning phase of the extended PCC starts by asking stakeholders to develop a precise and shared initial vision statement of how a society sees itself to be at some point in the future in a context of climate change. The visioning phase is important because it takes the various actors out of their day-to-day problem solving realities into medium-term and long-term thinking of the effects of their day-to-day actions .

**Step 2: Vulnerability assessment.** To better understand the targeted system (the area of intervention), users need to conduct a thorough situation analysis. The situation analyses relate to subjects like the system delineation, description of the main features of the area (basin area, topography, geomorphology, geology, climate, water sources, land cover, land use and population) The description can be used as a baseline of the socio economic and ecological conditions. The baseline includes an identification of major problems and issues related to resources and people that may influence resource availability and people's adaptive capacity.

**Step 3: Adaptation Strategy Development.** The main outcome from the strategizing phase is a local adaptation strategy document for the area of interest, consisting of a vision, key data from assessments, scenarios and an agreed strategy.

**Step 4: Planning.** The main outcomes envisioned for the planning phase are: (a) Detailed work and financial plans for specific activities within the resilience strategy; (b) Agreement on the roles and responsibilities of stakeholders and other actors; (c) Agreement on institutional arrangements for managing and maintaining new infrastructure. Tools for this step include: planning workshop, prioritization and ranking, and action plans development.

**Step 5: Implementation.** The main outcomes from the implementation phase are likely to include pilot and demonstration projects carried out within budget to a high quality and in accordance with agreed plans.

**Step 6: Reflection.** Reflection is essential for benchmarking climate change adaptation measures that are successful, and eliminating those that are not. In particular, reflection should be conducted with a view towards strengthening policy and legal frameworks at the national and regional levels.

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### **The design of agri-environment schemes in protecting heritage (natural and cultural) and encouraging green growth: does the English experience have relevance for the Carpathians?**

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Within the European Network for Rural Development, agri-environment schemes represent a key tool in achieving “green growth” combined with the conservation of natural and cultural heritage. Such schemes have been encouraged in EU members and accession states, though their efficacy and value-for-money has been occasionally questioned (Kleijn and Sutherland). If agri-environment schemes are to have a role in the agricultural economy of the Carpathians, their design and implementation must be based on evidence gathered from the widest relevant experience.

Within the EU, England (the largest component country of the UK) has used such schemes widely and increasingly developed rigorous monitoring programmes both to test the success of the schemes and to inform revision and enhancement of their design. Thus in 2003, a detailed review recommended that the best elements of the schemes introduced in the late 1980s be combined into a single revised scheme, Environmental Stewardship, of which one component is Higher Level Stewardship (HLS). HLS is targeted on areas and holdings that have potential to deliver the greatest environmental benefit. *Natural England* (the English conservation agency) and the NERC Centre for Ecology and Hydrology collaborated in a major programme to develop methods whereby the success of HLS in meeting its goals could be assessed (Mountford *et al.* 2013). *Natural England* administers the HLS scheme and makes HLS agreements in negotiation with individual landowners and managers. The project sought to achieve a standard assessment of agreements in their first year from which future progress could be assessed. The project used detailed field survey and mapping of features, including habitats, vegetation and species. In addition the design and building of the individual agreements, together with an appraisal of the relevant survey results, was made by a panel of experts.

The project also assessed a sample of agreements that had been under way for 2-4 years, as an early indication of scheme success. This portion of the project included a detailed assessment of how appropriate the agreements were in the context of local landscape character. The differing roles and interests of individual agreement holders, conservation NGOs and public sector agencies were assessed through a series of regional stakeholder workshops. The HLS scheme has a strong focus on public access and these workshops included an appraisal of how amenity usage and tourism can be integrated within management to protect heritage. This 4-year programme not only included one full year devoted to upland habitats comparable to those represented at medium altitudes in the Carpathians but also focussed on such habitats in one of the regional workshops.

The conclusions emerging from this programme gave a largely positive assessment of Higher Level Stewardship, its potential to deliver desired outcomes and likely contribution to the Rural Development Programme. However, the research indicated issues that would need to be rectified or improved, particularly if HLS were to be employed as a model elsewhere: a) Management approaches must be targeted on appropriate features, where the goals are achievable, rather than implemented indiscriminately; b) Management objectives for an agreement should be clear, so that those allocating public funds can assess which agreements are likely to succeed; c) “Indicators of Success” used in measuring progress should be fully measurable and quantifiable; d) Decisions

made in designing and revising the agreement should be fully documented; and e) Management approaches should be based on the best available science and clearly described.

The nations of the Carpathian mountains differ both within themselves and in comparison to England in terms of history, habitats and environmental legislation. However, the English experience with agri-environment schemes may have relevance at a number of levels, both as a guide on what to do and also on what not to do. HLS has brought the expertise of ecologists to bear in designing management approaches for habitats from coastal saltmarshes to high altitude grasslands, and includes a suite of prescriptions that focus on, among others, montane heaths, siliceous grasslands, alpine grasslands, alluvial meadows, hay meadows and a wide variety of mires. This paper makes some direct comparisons between agri-environment schemes as they are implemented in England and in Romania.

The habitat and floristic differences between England and the Carpathians clearly mean such prescriptions are not directly transferable. However, the clear meticulous design structure of HLS agreements may have relevance. Carpathian agri-environment schemes and their agreements need thorough monitoring using a representative baseline from which to judge future progress. There needs to be a consistent process for evaluating the agreement design and, with increasing pressure on resources, the contribution of such agri-environment schemes to ecosystem goods and services in the Carpathians needs to be demonstrated.

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### **Carpathian Natural Heritage contributing to the European biodiversity: endemism and conservation status of species and habitats of European importance**

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The Carpathians are hosting rich biodiversity and on European scale they represent the biodiversity hot-spot. Despite turbulent period connected with the significant changes in society, land use and increasing pressures to the nature since the second half of 20th century, Carpathians are still typical by large areas of relatively low-disturbed nature with dominance of native habitats and species. This paper examines how the Carpathian Nature Heritage is contributing to the European biodiversity. In the paper, we are focusing to endemism and conservation status of the Carpathian species and habitats. In our special focus are species and habitats of the European importance (i.e. those listed in the Annexes of the Habitats Directive), but we address other species as well.

The endemism is the relative term – it needs to be linked with the reference area and thus we could distinguish different hierarchical levels of endemism. In the past, several papers provided information about endemism in Carpathians in individual countries (e.g. Piekoś Mirkowa et al. 2003 for Polish and Hurdu et al. 2012 for Romanian plant species) and it is expected that the project BioRegioCarpathians will produce a new review. This paper provides the basic information about



Carpathian endemism and deals in more detail with those Carpathian endemic species that are listed in the Habitat Directive annexes. Namely, one moss, 13 vascular plants, one beetle and three mammal species belong to this group. The information about their distribution, population size and threat factors are provided and discussed. Probably the most important consequence of endemism is a high responsibility of the administrative bodies on the respective spatial level for protection of the concerned species. This means, there is also the responsibility of the Carpathian science to collect information about these species and provide the scientific background of measures for their conservation.

Based on Article 17 of the Habitats Directive, the Member Countries of the European Union are obliged to report each six years on the favourable conservation status of the species and habitats, listed in annexes of the Habitat Directive. The first reporting was done in 2007 covering years 2001-2006; the second reports for period 2007-2012 submitted the Member Countries in 2013. Despite these reports do not cover whole Carpathians (Ukraine and Serbia are not members of the EU), we consider useful to review situation of the Carpathian species and habitats that are included to them. We will provide summaries for individual taxonomic groups of species and the habitat groups and will discuss the individual parameters. Similar information we will provide also for selected species and habitats. The changes in the favourable conservation status, especially its progress between two reporting periods will be highlighted as well. This review will provide very recent view to the situation of the Carpathian species and habitats that was not available till now because 1) the favourable conservation status was assessed only on the level of individual countries or individual biogeographical regions, but not on the level of the Carpathian mountain system; 2) the 2007-2012 reports were delivered in 2013 and the reports for biogeographical regions are under preparation, the comprehensive report on the EU level similar to report from first (2001-2006) period (EC, 2009) is expected in 2015.

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## **Primeval forests of the Ukrainian Carpathians as a unique natural heritage and their ecological services**

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In Ukraine, the forests cover only 17.6 % of its territory, and this is the least percentage among the European countries. That is why, the forest fund of the Ukrainian Carpathians has and will have in future a big economical and ecological significance for the country. Under the effect of the concept of "coniferization", introduction and domination of the coniferous species took place in the Ukrainian Carpathians, and these new forests, as well as monoculture spruce stands, have appeared in the area of natural beech forests. At present, their area is 184 thousand hectares. It should be stressed that water protection role of secondary spruce forests is two times less than that of beech forests.

At the beginning of 20-th century, forward thinking naturalists of Hungary, Poland and Czechoslovakia have realized fundamental scientific-natural and applied significance of the primeval forest ecosystems and created several forest reserves required for their protection (Szafer, 1913; Földvary, 1933; Zlatnik et al. 1938). After the 2<sup>nd</sup> world war, the Ukrainian scientists and nature protection institutions considerably increased their net and also created new protected objects with bigger area. In order to preserve natural ecosystems and unique mountain landscapes, biological, phytocoenotic and landscape diversity, the Carpathian biosphere reserve, as well as 10 national natural parks and more than 100 forests reserved were created. The area of all objects of nature protection fund equals 15% of the region territory which facilitates preservation of the biological and phytocoenotic diversity and the ecological balance in the mountain region.

In the natural protected fund, the endemic, relict and primary forest phytocoenoses preserved from the pre-glacial and post-glacial periods are the most valuable ones in the natural protection regard. *Primeval forests belong to ecosystems of different age and possess the aboriginic flora and fauna, undisturbed pedosphere, natural coenotical structures in which all stages of their development are presented – from self-regeneration and juvenile to senile and self-desintegration stages.* In primary phytocoenoses, direct and feedback relations between the autotrophic and heterotrophic blocks and pedosphere have been preserved, and thus, they function as homeostasis ecosystems (Stoyko, 2005).

In primary forests, big ecological information about the geographic spreading of primary forests in different Holocene period, as well as about their natural succession and vitality has been accumulated. They are specific natural laboratory for conducting complex ecological investigations of forest formations.

*Logistics value.* Primeval forest ecosystems were formed in different geological, geomorphologic, soil and climatic conditions. Therefore, they are relevant to studying silvogenesis process in various ecological conditions. In the primeval forest ecosystems, interesting scientific information about their coenotic structure, the relationship between phytocenosis, zoocenosis, microbiota, pedosphere has accumulated. That is why they are relevant to the forest science.

*The value for the conservation of biological and phytocoenotic diversity.* In the artificial forests with monoculture domination, biological and phytocoenotic diversity of pauperization that adversely affects their ecological stability is observed. Primeval forest support a diversity of the aborigin flora, fauna, microbiota and natural phytocoenosis pool.

*The value for the study of dynamic trends of forest formations caused by global climate warming.* On the upper forest limit (timber line) of Uzhansky national natural park, the Carpathian biosphere reserve and some other protected objects preserved primeval beech and spruce forests. They are suitable for long-term monitoring necessary for studying adaptation of forest formations to global climate change.

*Genetic significance.* In oak, beech, spruce and fir primeval forests in different edaphic conditions and vegetational belts, were formed by a selection of interesting genotypes, phenotypes. Such forest types are the natural reservoir of genetic resources, and they should be conserved and used in silvicultural practices. Primeval oak and beech forests kept the gene pool of wild relatives of series cultivated fruit plants – *Sorbus torminalis*, *Cerasus avium*, *Malus sylvestris* et al. They are important for improvement of the genetic structure of such species.

*Ecomodel value of primeval ecosystems for forest science and practice.* Foresters substantiated a system of forming close-to-natural forests, methods of selective forest management and forest environment stability. Primeval forests have a value as ecological model for this system.

*Biodisperse value.* The areas of natural forests may be enriched by a spontaneous migration of biological species and their genetic resources adjacent to commercial forests, and thus, improve their biological stability.

*Educational significance for forestry expertise.* Primeval forest ecosystems are the “natural laboratory” where one can watch the forest-creating process. Rich ecological information about their functioning should be used in order to create ecologically stable culture phytocoenoses.

*Landscape and aesthetic value.* The development of civilization is accompanied by a transformation of the natural landscape, and presently, this process continues. Therefore, in a denaturalized environment, it is needed to conserve natural forests from the landscapes and aesthetic considerations. In these forests, the harmony and beauty of everlasting nature preserved, which meets spiritual and emotional human needs.

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## **Conflicts and synergies between multilateral biodiversity-related agreements in the Carpathian region**

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In the last half-decade many multilateral environmental agreements (MEA) have been negotiated and adopted by the international community. Just in the field of biodiversity conservation bearing on the Carpathian Mountains there are six global conventions under the UN and an additional two under UN Economic Commission for Europe (UNECE) and the Carpathian Convention's Biodiversity Protocol. Additionally, numerous soft law instruments exist that aim to protect biodiversity and enable its sustainable use. However the numerous biodiversity-related hard and soft law instruments are not necessarily working synergistically. Understanding the interactions between biodiversity-related MEAs and soft law instruments can help to streamline their implementation.

The uncoordinated proliferation of MEAs has led to fragmentation, overlaps and inconsistencies. Countries report on overloaded meeting agendas, duplication of tasks, failed national coordination and complicated reporting procedures. (UNEP 2012) In response, the International Environmental Governance (IEG) reform process led by UNEP has been active since 2002. It has consistently called for increased cooperation and coordination among MEAs in order to harvest potential synergies between the policy instruments. The enhanced collaboration in the chemicals and waste regime among the Basel, Rotterdam and Stockholm conventions set a good example for work in other clusters of MEAs. (Wehrli 2012)

In 2012 the United Nations Environment Programme (UNEP) Governing Council made a decision to enhance synergies among the biodiversity-related conventions. The process focuses on enhancing synergies on the science-policy interface; harmonization of reporting; streamlining of meeting agendas; joint information management and awareness raising; and capacity building, compliance, funding and review mechanisms. (UNEP 2012) This process has potentially positive implications for the Carpathian region.

The Carpathian Convention acts as a platform on several issues, including biodiversity, in

order to bring together stakeholders and harmonize their activities. It is not a prohibitive or normative convention, and does not add extra burdens to its parties; its role is rather to catalyse activities and projects in a proactive manner. Until now the Convention has formalized agreements with some MEAs (e.g. Convention on Biological Diversity, Ramsar Convention) and regional conventions (e.g. Alpine Convention, Danube Protection Convention). In other cases (e.g. UNESCO World Heritage Convention, European Landscape Convention) the Carpathian Convention fills in gaps by being responsive to regional issues. (Egerer 2014)

With moves towards defining and adopting the Carpathians as an independent European macro-region (Egerer 2014) there are potentials to increase cooperation on biodiversity protection and sustainability. The Carpathian Convention has the potential to enhance the effectiveness of international MEAs by being able to complement them with regionally relevant implementation tools and measures. This paper examines the role of the Carpathian Convention in coordinating international instruments and catalyzing biodiversity conservation activities in the region, assesses its achievements to date, and proposes further steps to enhance its effectiveness.

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### **The Carpathians – a Central Park of Emerging Cities: Mountain environment as a question of social relations**

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In Europe many mountainous regions are situated between the cores of growing metropolitan areas and become integrated into them as specific functional parts. They look as rural but they are part of urban value chains like real estate business, outdoor activities or the transformation of agricultural production to food industry.

This asks to answer three questions:

1. What are the dominating development paths of urban development in mountains under a European point of view?
2. What are the dominating individual practices which are relevant for the use of space and regional development strategies in mountains?
3. What is the specificity of mountains and the specificity of mountain urbanization?

The answers to these questions base on empirical research especially in the Alps and recent regional development theories.

#### **1. Economic-spatial processes of urbanization: What happens?**

Since the 1990s we can observe the renaissance of urban agglomerations which profit economically from a globalized economy and concentration processes of public and private infrastructure due to economies of scale. Politically, agglomerations are supported due to a new societal understanding which began in the 1980s with the decline of the welfare state. While the welfare state favoured a regional equilibrated development the new paradigm pushes a polarized hub model. This counts for the Alps and it counts especially for the Carpathians as in the countries of the former Eastern Bloc cities were only favoured when they had functions of representation towards an international public. With the societal turn of 1990 the new West European model was applied also on the East which meant especially the new significance of the capital regions, the desindustrialisation of certain regions and the re-industrialisation of other parts due to European relocations. The capital regions and other metropolitan areas are developing as the centres for the knowledge-based high-end services, headquarters and research and development. Peripheral areas which were in the past the target for public investment in regional development become important for a certain understanding of environmental protection, the development as natural parks or as wilderness areas. The “in-between” becomes peri-urban for residences. High altitude settlements become gentrified resort towns with a mixture of intense tourism and second home residences. This development can be summarized as „Metropolises and parks“. It is to be characterised as urbanization.

What is the mountain specific aspect of this development? There are strong similarities between the development in the lowlands and in mountains. For example the multilocal dwelling for leisure reasons takes place in mountains as well as in big cities like Paris, Zurich or Hamburg. It is often said that mountains are more vulnerable than lowlands against the impacts of pollution. This might be true in some points. But one should pay attention not to overstretch this argument. Big cities use similar arguments to justify their needs on investment showing the high significance of specific urban problems. Therefore we should restrict the specificities of mountains (and especially the mountain urbanization) on its different trajectory, i.e. on the fact that in Europe the big cities developed outside the mountains and that this means that the mountain areas today are the functional peripheries of



Europe. If we could today plan towns and rural areas without regards on historical heritage it would be possible to place the cities into the mountains and to develop the plains as agricultural fields. Therefore I would call the main specificity of mountains: They developed in the historic context as peripheries and will not become the core because the existing towns occupy already this function.

## **2. Why is this a problem? – Impacts on mountainous regions and societies**

In the frame of the paradigm change of the 1990s cities become collective actors who act more and more as private enterprises in a global competition. Mountain cities and mountain regions have not the same demographic and economic power as lowland cities but are challenged to act in the same way – to be responsible for their own development according the principles of subsidiarity. This is only possible if they specialise on economic activities where they have a place specific monopole (like raw materials) or a temporal monopole (due to advantages of uniqueness like attractiveness for leisure). These advantages are rather fragile compared to the agglomeration advantages which are constituted in lowland metropolitan areas and which allow (generally viewed) higher value adding than in the mountain peripheries. Consequently mountainous regions are forced to valorise their specific natural resources in a way that risks overuse (e.g. in tourism or raw material extraction) or they have to answer to the expectations of the urban majority in the lowlands (which means to offer second home residences or National Parks).

In this interpretation

The economic structural change of mountainous regions is linked with a shift from a “regional view” to a “landscape view”. But this predominance of biophysical aspects does not change the problem: the transformation of mountainous areas is rather a societal problem than an environmental problem. It is the accessibility to resources of clean air, unpolluted water, and aesthetically appreciated views which count and which are accessible according the individual purchasing power. The impacts of climate change touch those who are not able to migrate to regions not affected. As long as certain groups of actors are able to buy these resources from elsewhere (and others not), the ecologic question is a societal problem as it can engender social cleavage and break societal cohesion.

It is not without cause that in mountainous regions questions of use and questions of preservations are always contested. Local jurisdictions want their autonomy to act without restrictions, the urban majority in the lowlands wants to use the aesthetic resources of mountains as specific advantage of location and symbolic capital.

Local and external population converge when they promote a mountain specific development. But the understanding of “mountain specific” is different. Mountain specificity might be problematic and even unsustainable when it is based on a highly specialised monostructural development which overstretches the capacity of existing resources and installs infrastructure with high environmental and social impacts which will probably not be reversible. These impacts can be summarized as follows:

- Devalorisation of existing mountain value chains, ways of life and identities
- New power of decision making of metropolitan regions which mostly lie outside the mountain ranges
- New regional winners and losers: Valorisation of specific mountain resources without limitations (overuse); decline of regions without specific profiles (underuse)
- The regional assets turn from local based agricultural, tourist and manufacturing production to the valorisation of “landscape” by external economic actors and real estate owners.
- Overuse of specific resources like soil (→ urban sprawl) water and minerals.

## **3. Normative aspects: What would be wishful?**

Under the aspects of social cohesion, regional participation and the use of resources for the following generation mountains should keep their socio-economic and biophysical diversity. This means that mountain economies should search for mountain-specific activities but this specificity should not be interpreted in a selective use only according to the needs of the external demand:

leisure, real estate and raw materials. Mountains should keep their traditional uses to maintain its socio-economic diversity to avoid processes of segregation and minimize gentrification. Exclusive uses ("cold beds" in second home residences) should be avoided to make mountains accessible to all without destroying its assets. The separation of socio-economic functions should be avoided as it causes a double consumption of resources at different places. National policies should consider that all parts of a territory have to be cared for to avoid social cleavages and separatist regionalisms. This means that the principles of subsidiarity and self-responsibility of mountain regions have its limits and should always be seen in a supra-national level.

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## Measuring well-being in forest-dependent communities: A case study in the Ukrainian Carpathians

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The concept of community "well-being" is one of the frameworks for community assessment along with other concepts such as local community quality-of-life studies, community health, resilience or community capacity. Measuring well-being in a community is vital to knowing how that community is faring, therefore, it provides critical information for decision-making regarding sustainable development in regional communities. The concept is focused on understanding the contribution of the economic, social, cultural and political components of a community in maintaining itself and fulfilling the various needs of local residents (Kusel and Fortmann, 1991). In the 2003 Millennium Ecosystem Assessment, well-being includes basic material needs for a good life, the experience of freedom, health, personal security, and good social relations. Together, these provide the conditions for physical, social, psychological, and spiritual fulfillment. Well-being in forest-dependent communities has long been discussed in the context of community sustainability, a term that includes the more general notion of forest community well-being. This includes not only economic indicators (i.e., per capita income, employment) but environmental quality and socio-cultural indicators that characterize community well-being. The level of education, parenting,



recreation and leisure, social relationships between members of the community and intangibles such as the spiritual level of development affect the well-being of the community.

With up to 50% of the land cover, forests dominate the landscapes of the four *oblasts* that make up the Ukraine's Carpathian Mountains. In a broad sense, economic, environmental, social, cultural and aesthetic functions of forests contribute considerably to the well-being of forest-dependent communities' in the Ukrainian Carpathians. In this paper, the authors analyzed data that were obtained within the framework of the 2011 program "Improving Forest Law Enforcement and Governance in the European Neighborhood Policy East Countries and Russia" (FLEG) in detail with SPSS. In-depth study of forest-dependent communities in mountain region of the Ukrainian Carpathians was held with 50 questionnaires. More than two-thirds of the respondents said that is very important to protect forests and survey results confirmed the hypothesis about the importance the role of forest resources and ecosystem services for forest dependents communities. Forests provide a wide range of natural assets, including household goods, cultural values, physical and biological products, and other services that are vital to the livelihood and well-being of many people (Panta et al., 2009).

An important factor in ensuring the well-being of those communities is their access to forest resources (Melnykovich et al., 2011). The authors also analyzed the ease for local communities to legal access to obtaining forest products including wood and non-timber forest products, hunting and grazing rights. Although the analysis highlighted the environmental and spiritual aspects of well-being, it also noted that these communities have a number of drawbacks including: low incomes, poor level of entrepreneurship in rural areas, low employment, illegal labor migration and a natural decline in population.

International agreements, resolutions, conventions, declarations and laws of Ukraine currently do not offer desired result in ensuring the legal mechanism for transparent process of communities (as well as other stakeholders) participation in of forest resource management for improving their well-being. This circumstance contributes to poor awareness of forestry-dependent communities with their rights on resource management, absence of mutually fruitful cooperation between communities and forestry managers and in most cases – deficit of local residents (communities involvement) into forest resource decision making processes.

Forest ecosystems and their provisioning services are still very important component of well-being for many communities in the Ukrainian Carpathians even they cannot be treated as fully forest-dependent communities. The well-being of rural local communities in mountain regions depends directly from sustainable development of forestry. There is a potential to improve current forest policy and law towards increasing the role of communities in decision making in the field of forest resource sustainable management, conservation and restoration.

Smart development of forest-dependent mountain territories and communities requires new specific strategies based on green growth innovations that would integrate scientific and local/traditional knowledge about the array of forest ecosystem goods and services. Such strategies should allow for increasing of human well-being without destroying mountain ecological sustainability.

Acknowledgement. This publication utilizes empirical data which was collected in the framework of ENPI FLEG program "Improving Forest Law Enforcement and Governance in the European Neighborhood Policy East Countries and Russia". The program is funded by the European Union and the three implementing partners include: the World Bank, WWF and IUCN. The contents of this publication are the sole responsibility of the authors and can in no way be taken to reflect the views of the European Union.

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## Potentials for integrating intergenerational practices into protected area management and rural tourism development

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Establishment of protected areas (PA) constitutes a key way of preserving biological diversity - an important aspect of sustainable regional development. However, objectives of protected areas reach beyond natural protection and include preserving traditional and cultural practices, supporting socio-economic development of the surrounding local communities, such as through tourism, as well as education and research. This diversity of objectives, in addition to the numerous tasks of nature protection, poses a number of challenges for successful PA management.

Regarding Protected Area management, which includes economic development of the surrounding areas scientific literature acknowledges the importance of participation by the local stakeholders and social cohesion. One approach, which has been shown to enhance participation and improve social cohesion, and could potentially be useful in other aspects of protected area management, is Intergenerational practice (IGP). However, its potential role in natural resource management has not been considered by the research community to-date.

The proposed paper explores the potentials of integrating intergenerational learning into the protected area management through three research questions:

- 1) What are the challenges of Protected area management, which could benefit from IGP?
- 2) How can IGP help address Protected Area management challenges, including rural tourism development? and
- 3) How could IGP be stronger integrated into the current Protected area management practice, including rural tourism development?

Relevant management challenges were selected from literature and interviews with protected area managers of the Carpathian countries. Intergenerational practices were proposed for each challenge, with examples derived from literature, interviews with protected area and regional development experts, working in the Carpathian and Alpine region, from two projects: 1) "Big Foot: Crossing Generations, Crossing Mountains," and 2) Innovation in Rural Tourism (InRuTou). The Big Foot project aimed at testing intergenerational learning approaches in the three rural municipalities

in Bulgaria, Greece, and Italy and preparing a Transferability Tool Kit, to be used in the Carpathian countries. The InRuTou project aims at understanding the needs of the local populations in several Carpathian rural communities: in Poland, Romania and Ukraine, as well as in Apennines in Italy and Alps in Austria with respect to knowledge and skills in sustainable community-based tourism development. The results of the qualitative content analysis indicate skills, knowledge, attitudes and values, which older and younger generations could contribute to protected area management and rural tourism development, and suggest several ways in which intergenerational practices could contribute to tasks and challenges of protected area management, including rural tourism development. Recommendations are proposed for integrating Intergenerational practice into protected area management and rural tourism development on the global, regional and local, policy and practice levels.

Acknowledgements. The project Big Foot. Crossing Generations, Crossing Mountains has been funded with support from the European Commission. Exploitation of the project results is supported by UNEP Vienna - ISCC.

## **The implementation deficit in the European Union: insights from Natura 2000 policy in the Carpathian countries**

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The EU policy for nature conservation aims to assure the long-term survival of Europe's most valuable and threatened species and habitats. At the same time it recognizes that man is an integral part of nature and the two work best in partnership with one another. This is particularly important for ensuring the interests of the local, rural population that lives in close contact with the nature.

However, policy implementation is recognized as one of the most troublesome stages of the environmental policy cycle in the EU and often defined in term of implementation deficit. There are various reasons to which such deficit might be attributed e.g. discrepancy in policy goals among different levels, insufficient results achieved through implementation, disrupted implementation process etc. Nevertheless the outcome of implementation deficit lies in unfulfilled policy aims.

The theory of multi-level governance (MLG) is frequently used to conceptualize the current complex architecture of the EU and to explain policy development. On the one hand it aims to address and offer solutions of the implementation deficit e.g. through involving broader range of stakeholders, which may bring additional resources and visions to the process of decision-making and implementation. On the other hand, brings additional challenges for putting policy into practice due to the system's complexity. This is especially true for the local level of policy implementation where the policy is put into practice. Thus this paper aims to identify specific implementation challenges and opportunities of the EU MLG system on the example of Natura 2000 policy in Slovakia and Poland.

The paper seeks to answer the question: what are external and internal factors in multi-level governance system influencing emergence and functioning of implementation structures on the ground? Where internal factors might be defined as the one developed within the policy process and attributed to the local context, whereas external includes broader scope of influence from outside the system.

The Carpathians is one of the few wilderness spots, with unique areas of preserved primeval beech forest and a substantial population of large carnivores, remained in the European region. Thus nature conservation in the area has special significance for supporting biodiversity and wildlife richness in Europe. At the same time the Carpathian countries currently are in the period of rapid

socio-economic development, that closely connected with infrastructure development (including tourism) and intensive economic growth that leads to increased pressure on the environment. Thereby, competing interests (socio-economic vs environmental) arise in the Carpathian natural areas. Furthermore, these cases represent the dynamic re-structuring of the policy sector since the EU framework is based on the participatory approach of nature conservation in opposite to the strictly hierarchical (top-down) logic inherited from the communist regime. Nevertheless it is important to stress that the nature conservation policy was fairly well developed compare to other sectors of environmental policy during the communist time, even though it was largely based on the conservative, preservationist approach. Hence it is fruitful to analyze how newly proposed logic and structures interact with existing ones.

The year 2012 was set as a deadline for Natura 2000 sites designation in these countries, therefore certain implementation structures have been already set, but not yet settled. The scrutiny of such cases helps to reveal policy dynamics, as well as identify current challenges and opportunities.

The research is largely based on the materials of the interviews with broad range of the relevant EU, national and local stakeholders, as well as official documents, project reports, and scholarly literature

The paper concludes that: generic regulatory framework (The Birds and Habitats Directives) on the one hand allows high degree of flexibility and adaptation of policy to the local environment. On the other hand, it supposedly contributes to the implementation deficit due to unclarities of goals and means of their achievement among Member States. The Natura 2000 implementation patterns in the Carpathian countries to large extend repeated the patterns of the “Old” Member States.

Furthermore, the preliminary results show that availability of the resources (financial, expertise etc.), together with existing management capacities are the main internal factors influencing implementation. Additionally presence/absence of different types of conflicts and controversies on the ground proved to be significant. Regarding, external factors it range vary greatly from national socio-cultural traditions to the active/passive steering from the EU and other external actors through projects and other means.



## **PARALLEL SESSIONS**

### ORAL PRESENTATIONS

#### **Hydromorphological changes in the Botar River Basin under human impact**

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The ultimate objective for the European Union in water sector is to achieve and/or maintain good ecological and chemical status of all water bodies by 2015. Ecological status of any water body is based on three “pillars”: biological quality, physical-chemical quality and hydromorphological quality. The former may be considered key, as existence of life in aquatic environment is an indicator of healthy water ecosystem. At the same time hydromorphology is the edifice for life in water ecosystem and that is why also very important.

Special attention in EU water legislation is paid to transboundary river basins and the necessity of cooperation between countries for the improvement of ecological status of water resources within it. Even if a river basin is partly situated within the territory of a non-EU country, European water legislation (Directive 2000/60/EC, 2000) induces joint efforts for its protection. Plenty of examples of such transboundary rivers may be found in Ukraine, among them the river Botar with watershed located within three countries: Ukraine, Romania and Hungary, in interfluvies of the Tisa and Tur rivers. The Botar river is a tributary of the Tisa. The length of its main channel is 53 km, and the drainage area is 383 km<sup>2</sup>, main part of which is in Ukraine – 273 km<sup>2</sup>, in Romania – 100 km<sup>2</sup> and in Hungary – 10 km<sup>2</sup>.

High human impact, presence of dense drainage system and transboundary character of the Botar basin requires coordinated efforts between the countries and elaboration of joint river basin management plan. Regrettably, there is no monitoring network in the Botar basin for systematic hydrological observations. Only in the beginning of the 1930s such observations took place for several years at one gauging station in Ukraine. Since 2005 periodical hydrological observations have been performed on one tributary of the Botar in Romania.

Based on historical cartographic records of the 19th century as well as on modern maps and remote sensing data, reference conditions for the river were determined. Information concerning hydraulic engineering structures and land use in the watershed were also taken into account. Field investigations updated information on the hydromorphological state of water bodies within the territory of Ukraine.

It was determined that forest cover decreased up to 20%. Due to reclamation works in the river basin, the hydrographical network has changed significantly. Main tributaries such as Pleshka, Veshteg, Kholt, Botarch were partly canalized. Aiming to redirect a part of the water flow which forms in mountain area, the canal New Botar with a sluice in it was constructed from the Botar to the Tisa river. Water intakes operate in the upper reaches of some tributaries. This caused significant changes in their hydrological regime and some rivers started to run dry.

Hydromorphological assessment was done in accordance with Water Framework Directive of the EU. Determination of hydromorphological status of water bodies was performed based on the extent of deviation of state from reference conditions. Guidance standard EN 14614 (2005) defines 5 quality classes, from 1st – high – which refers to (or approximates) natural conditions to 5th –



bad – which states for dominant human pressure and apparent risk of inability to return water body to the proper state and of shifting it from the category of “natural” to “heavily modified”. Taking into account significant human impact on water ecosystems, Water Framework Directive of the EU aims to achieve and/or maintain good ecological status (class 2) for all water resources in the EU.

Within the Botar river basin in the territory of Ukraine, 6 water bodies (WB) were identified as natural river water bodies, while others as artificial and heavily modified ones. It is worth to point out that water body may represent the whole river as well as its part (WFD CIS Guidance Document No. 10, 2003) which is discrete, significant and characterized by specific physical features. Water bodies identified in the Botar basin represent 5 rivers – Botar (two WB), Mlynovytsa, Pleshka, Kholt, Botarch. Field survey was carried out in September 2013. Hydromorphological assessment was done in accordance with guidance standard EN 15843 (2010).

The assessment identified a wide range of hydromorphological conditions in the Botar basin: from reaches which are in reference condition to class 4 – poor state. Two water bodies are in class 1 (WB 1 – river Botar and WB 5 – river Kholt), two water bodies are in class 2 (WB 2 – river Botar and WB 3 – river Mlynovytsa) and the remaining two water bodies (WB 4 – river Pleshka and WB 6 – river Botarch) are in moderate hydromorphological state – class 3. Natural conditions with minimum human impact are usually relevant to the upper reaches of mountain rivers. Meaningful in this context is WB 1 – the upper reach of the Botar river, which is in reference condition. It is important to preserve such state. Hydromorphological state of other rivers varies with different intensity from close to natural state to modified through human activity. The most hazardous situation is relevant to the rivers Pleshka and Botarch. Major reaches of these rivers are in moderate and poor hydromorphological state.

The most important reasons for the degradation of hydromorphological quality are: hydraulic facilities and bank protection done by local population without any coordination and scientific grounds of water management authorities; clogging of river channels with woody debris and household waste; illegal water intake in upper reaches; deforestation in upstream parts of the watersheds.

There are some other factors which significantly reduce hydromorphological quality (floodplain urbanization; embankment, levees and river channel straightening; distortion of river continuity), however, they are often inevitable, and it is necessary to find a balance between optimum and sustainable states of human activity and hydroecosystems of the territory.

A comprehensive range of general and discrete recommendations concerning the protection and improvement of hydromorphological quality of rivers as well as flood protection measures are proposed. Such approach corresponds with statements proposed for other Carpathian rivers (Obodovsky et al., 2012) and meets the requirements of two EU Directives (Directive 2000/60/EC, 2000; Directive 2007/60/EC, 2007).

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## **The influence of beaver dams on the hydraulics of embanked river beds in the upper Olt River catchment**

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Reintroduction of beaver (*Castor fiber*) in Romania was initiated in 1998, almost two centuries after disappearance of the species (last beaver was mentioned in 1824). Thus, in the basins of the Olt, Mures and Ialomita rivers 182 beavers imported from Germany were introduced. The estimated population size in 2006 was 270 individuals, while currently it is estimated at more than 1,600 individuals.

During the last century the natural habitat of beaver was largely occupied or altered by land reclamation works (drainage, embankments, etc.). As a result, due to continued growth of the beaver population, some families settled on river bed areas embanked to protect agricultural land, settlements or other economic objectives.

A characteristic of the ecology of beavers is their ability to build dams and, thus, to modify the landscape to increase its suitability for beaver occupation. The presence of dams on river beds lead to changes in river bed geometry (in longitudinal profile and, also, in cross-sections) and in flow regime. The subject of this study is to evaluate alterations in riverbed geometry and the influence of beaver dams on the channel conveyance. Nationally this topic has not been addressed yet, and in Europe there are only few studies on this topic.

The investigations were conducted in the south-eastern Transylvania, in the upper basin of the Olt River, on 5 tributaries of the Negru River. This territory falls into a grid of coordinates E26° 01 ' N45° 48 and E26° 18 ' N46° 06 '.

On 5 embanked sectors (one for each tributary) populated by beaver families, high-precision terrestrial measurements and mappings were carried out. The length of the sectors is between 280 m and 640 m, totalling 2100 meters. On each sector 3 to 5 dams (20 on all sectors) were identified. Their height is between 0.3 m and 2.3 m. The analysed riverbed sectors are characterized by low channel slope (generally less than 1%) and the occurrence of a two-stage channel (minor channel sized to convey low to medium flows and the larger channel bounded by earth embankments, sized to convey flood flows). The river margins are covered by grasses, willow (*Salix sp.*) shrubs and clumps of alder (*Alnus glutinosa*) trees, with the presence of woody species being mandatory for beaver settlement. The measurements were focused on the longitudinal profile of the valleys, significant cross-sections and the geometry of beaver dams.

To estimate the effect of beaver dams on the hydraulics of the riverbeds, simulations were performed using Mike 11 software. Two scenarios were defined: one considering the presence of beaver dams and the second analysing the same channels without dams. In the model, beaver dams were approximated by the weirs with culverts. Weir geometry was defined by the dam crest line.

Beaver dams change the longitudinal channel profile by raising the level of the channel bed and reduce the active cross-section. The presence of dams decreases flow velocity due to the reduction in channel slope and to the backwater effect. As a result, the flow conveyance of the riverbed sectors populated by beaver diminishes due to the decrease in flow velocity and the reduction in flow cross-sectional area.

Due to the special shape of the embanked river beds (the two-stage channel cross-section) and because of the location of beaver dams in the minor channel of the river, their impact on the active cross-section of the river is relatively small (active cross-section of the flood channel is rarely reduced by more than 20%). Adding the effect of a lower flow velocity, the reduction of flow conveyance of these river sections is greater. Generally, the simulated peak flows routed through these sectors are greater

than the peak flow of a 100-year event. A comparative analysis of the considered scenarios leads to the conclusion that critical cross-sections (in hydraulic terms) are not those with beaver dams.

## **Carbon and nitrogen sequestration and distribution of soil organic matter fractions as a consequence of land use in an abandoned pastureland in the Tatra Mountains**

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The process of reforestation goes back till 60's of 20<sup>th</sup> century in the Tatra Mts, since pasture had been banned due to nature conservation (Tatra National Park). Since that time some pasturelands has undergone natural succession while some have been reforested within the land renaturation works.

The aim of the study was to determine the differences in the organic carbon and nitrogen stocks as well as organic carbon fractions between three contrasting land-use areas existing on the same abandoned pastureland: grassland which has not undergone shrub succession yet, the area afforested with larch (*Larix decidua*) and the area afforested with dwarf pine (*Pinus mugo*). The pastureland was abandoned in the late 60's, whereas afforestation was conducted in the 80's of 20<sup>th</sup> century. Study area is located on the E faced slope of the Jaworzynka Valley on homogenous calcareous bedrock.

Three square sample plots (10x10 meters) were established in every part of the former pastureland. On every plot 9 pits were excavated. Soil horizons in all profiles were described and the samples from every horizon were taken. In the central point of every sample plot there were established reference soil profiles.

C and N content and amount of carbonates were analyzed for all soil horizons. The amount of OC was determined by subtraction carbohydrate C obtained by the Sheibler's method from C obtained in CHNS analyze. Fine earth in A horizons of selected profiles was separated by combined particle-size and density fractionation into fPOM (free particulate organic matter), oPOM (occluded particulate organic matter), a residual, sand-sized fraction (>20µm) allocated in microaggregates and mineral-associated organic matter (Leifeld, Kögel-Knaber, 2005).

After 30 years of different land-use there are significant differences in the organic carbon and nitrogen distribution.

Thick organic horizons in soils under the dwarf pine shrubs developed, while organic horizons under larch forest are weak developed and they do not exist in soils under the grassland. The largest carbon stocks in whole soil profile are noted in the soils under the larch forest (mean 5 kg/m<sup>3</sup>). Under the dwarf pine and the grassland they are smaller (ca. 4 kg/m<sup>3</sup>). The biggest part of organic carbon is cumulated in A horizons. In soils under the meadow it comprises whole organic carbon stock, whereas under dwarf pine and larch forest it is 65% and 97% respectively.

In contrast, the largest nitrogen stocks were found in soils under the larch forest and the grassland (0,5 kg/m<sup>3</sup> and 0,3 kg/m<sup>3</sup> respectively), whereas under the dwarf pine they are the smallest (0,2 kg/m<sup>3</sup>). The smallest amount of nitrogen in soils under dwarf pine is the result of presence thick, weak-decomposed organic horizons.

The highest amounts of particulate organic matter (POM) are noted in soils under dwarf pine,

where POM organic carbon makes up nearly 30% of SOC. In both – soils under the grassland and the larch forest POM makes up about 20% of SOC. The differences between land use are well pronounced in the amounts of the less decomposed fPOM, which comprises nearly twice as high SOC content in soils under dwarf pine (11,5% of total SOC) as under the grassland and the larch forest (6% and 7,2% of total SOC respectively). The majority of POM fraction is oPOM occluded in macroaggregates, which contains 13%, 14 % and 18% of total SOC in A1 horizon in soils under the larch forest, the grassland and the dwarf pine shrubs respectively. Carbon content of residual sand-sized OM fraction (>20µm) allocated in microaggregates is, in contrast, much more higher under the grassland and the larch forest than under the dwarf pine shrubs.

Nitrogen content in POM fractions exhibits similar tendencies as SOC: the highest amount of POM nitrogen is observed in soils under the dwarf pine shrubs with significant differences in fPOM fraction, and similar content in oPOM fraction. C/N ratios are the smallest for residual sand-sized OM fraction and slightly smaller for oPOM than for fPOM, which can be assigned to more advance of decomposition in the material associated in macro- and microaggregates. There are no differences observable in C/N ratios between land-use.

The obtained results suggest that the conversion of pastureland into the forest and shrubs vegetation occurred about 30 years ago causes increasing the total organic C stocks. The differences in processes of carbon accumulation between different land-use areas are pronounced. In soils under dwarf pine SOC accumulation occurs mainly in organic horizons and as fPOM in the mineral horizon which forms are relatively unstable and susceptible to decomposition. In contrast, in soils under the meadow, SOC accumulation occurs mainly in relatively stable microaggregates. In soils under the larch, which is open forest with abundant grasses (*Calamagrostis sp.*) in the forest floor, total C stock is the highest with tendency to accumulate in both: fPOM fraction and organic matter associated with microaggregates.

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## Formation, persistence and environmental role of vegetated islands in a mountain river

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Vegetated islands are characteristic landforms of braided mountain rivers. Long-term observations and recent morphological and botanical surveys conducted in the gravel-bed Czarny Dunajec River, Polish Carpathians, were used to determine the processes and patterns governing initiation and development of vegetated islands and their floristic complexity. Dendrochronologically estimated years of island inception were compared with the timing and magnitude of flood flows in the

period 1970-2011 to infer about controls on the formation and persistence of islands in the river.

In the high-energy, braided river, islands originate as a result of deposition of large vegetative particles, mostly large wood, on gravel bars and the associated vegetative regeneration of living wood or the growth of seedlings and saplings in the shelter of wood accumulations. Tree-ring dating of the largest trees growing in particular island zones indicated a predominant upstream island growth in the river. It results from repeated accumulation and subsequent regeneration of living wood on the head of islands and contrasts with progressive downstream island growth in the rivers supplied with large, stable logs of the tree species without the capability to re-sprout. The lack of islands from the years 1982-1996 most likely reflects the removal of relatively young islands by two major floods in the 1990s. After 1997 the occurrence of low to moderate floods facilitated the formation and persistence of islands. The plant inventory demonstrated that species richness increased non-linearly with the increasing age, area and shoreline length of islands. Islands supported more plant species than the riparian forest and attained comparable species richness at an early stage of development. Relatively young islands contribute to the floristic complexity of the river corridor by providing diversified habitats which are frequently disturbed by flood waters and are thus occupied by plant communities whose herbaceous components highly vary among particular islands. Larger, more mature islands are less frequently disturbed by erosive flood flows and may act as diversity reservoirs for the reach after major, destructive floods.

With the high biocomplexity of river reaches with island-braided channel pattern and the rapid island development in a favourable physical setting, creating conditions for island formation should be a good means of the restoration of mountain rivers with degraded hydromorphological quality.

## POSTER PRESENTATIONS

**Interdisciplinary analysis of natural and anthropic vulnerability of the mountain slopes within the touristically developed areas of Brasov**

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As a consequence of anthropization, the territories destined to tourism development within the Brasov depressional area and the surrounding mountain areas have become increasingly vulnerable to slope instability which also affects elements of the touristically developed patrimony (Bălțeanu D., Rădița, A, 2001).

The purpose of this work is to highlight main causes of the damage to heritage monuments or other touristic development by the vulnerability of the morphological support, in this case the foundation ground. The morphological support is subject to the effects of geological and geomorphological processes (risk associated with natural phenomena of hydrologic and geomorphological nature) but especially the anthropic impacts related to heritage and changes produced over time (land overloading), and the recent tourist establishments (i.e. WARD, 1990, CHILTON et al., 1997, Mafteiu M., Ionescu I., 2001). A complex analysis can offer the necessary scientific and practical support to identify solutions for the rehabilitation and preservation of anthropic environment having scientific and patrimonial value, which are exposed to risk. An integrated interpretation (in hydrogeophysical and geomorphological terms) of these researches creates solutions for mitigating the risk factors and represents the basis of an efficient work methodology.

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## Surface ozone variability and land use change after extreme wind event

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Extreme wind event in November 2004 caused widespread destruction of slope forests in the Tatra National Park, Slovakia. Relevant changes of land cover motivated researchers to investigate the damaged forest ecosystem and its response to different environmental conditions (Fleischer, 2011). Surface ozone (O<sub>3</sub>) is a minor but not negligible compound of the ambient air. Control strategies for reduction of O<sub>3</sub> precursor emissions have been applied in Europe during the last two decades. In spite of these reductions air quality indices suggest that highland sites are more vulnerable to health and environmental risk than lowlands where the most of emissions from road transport and industry are produced (Bičárová et al., 2013). Both anthropogenic emissions from long-range transport and biogenic precursors (BVOC) from forest vegetation play relevant role in the tropospheric photochemistry, especially in mountainous and rural locations. The purpose of this work is to describe the variability of O<sub>3</sub> before and after the windstorm of 2004 with different amount of local BVOC precursors from forest vegetation.

Acknowledgement. This research was supported by the Grant Agency SR under projects VEGA No. 2/0053/14, No. 2/0089/14 and by the Slovak Research and Development Agency under the contract No. APVV-0429-12. The authors are grateful to the Slovak Hydrometeorological Institute for providing of EMEP data.

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## The avalanche denudation in Gorgany Mountain massive (Ukrainian Carpathians)

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In research of mountain areas relief is mainly characterized as an unchanging component of landscape. However, it is also a dynamic part of natural territorial complexes, that are characterized by relatively slow dynamics changes. Relief formation and dynamics are influenced by many

processes, including mass movements. This genetic group of processes includes those related to snow activity, which may act as a relief-forming factor]. In dynamic geomorphology, snow activity is associated with two types of processes: nival and avalanche processes. Avalanche denudation was mostly investigated by the researchers of the soviet period. In 1981 B. P. Agafonov and S. A. Markov determined maximal avalanche denudation intensity at 0.31 mm/year. Considerable contribution was made by L. A. Kanayev and others, who studied avalanche denudation in the Tien Shan Mountains.

Avalanche processes are part of relief dynamics of mountain areas. They both directly and indirectly affect orographic characteristics of avalanche-prone surfaces, inducing the process of avalanche denudation.

The study area, Gorgany Mts, is characterized by fluvial-denudational relief. Those landforms prevail in mountains with an unstable snow cover. On those surfaces direct and temporal water flows transport fragmented, eroded material into river channels. As a result of such processes large and deep gullies develop that also function as avalanche paths.

Avalanches have a special influence on relief. Avalanche furrows that have appearance of parallel ridges form in transit zones. Through considerable crushing power, a large avalanche can destroy nearby slopes, and an avalanche formed by wet snow may form impact pits at slope base. Intensity of relief-forming processes is expressed by the rate of denudation that reaches 0.5-0.6 mm/year within avalanche-prone landforms of fluvial origin.

Based on relevant indexes and knowledge of the area with such avalanche complexes, it is possible to calculate approximate intensity of avalanche denudation in the study area. Methodology of avalanche denudation research is based on the mean value of maximum index of avalanche denudation intensity within natural avalanche complex. This index, according to earlier, soviet research in different mountain systems and morphologic structures amounts to 0.2 mm/year. To determine a corresponding index, it is necessary to define the area of natural avalanche complexes as the percentage of the general area of the investigated territory. Next, avalanche denudation intensity is calculated by multiplying the mean value of maximum avalanche denudation intensity and the calculated percent of the total area.

In our opinion, applying this methodology creates a problem related to expected index of avalanche denudation intensity and its extrapolation to different mountain systems. Extrapolation is inadvisable, because by using this methodology a calculation error will grow with increasing proportion of the area of avalanche complexes (so for the area of avalanche complexes amounting to 100%, the error of intensity of avalanche denudation will amount to 0.11 mm/year, or about 30%).

The Gorgany have 5 or 6 longitudinal ridges that are cut by deep transversal valleys. The width amounts to 40 km, and the length between Mizunka and Prut river valleys is about 75 km. The Gorgany are typified by a three-tier (separate Gorgan type) vertical morphological zonality, distinguished by P. M. Cys. The highest tier is treeless or with low forestation, with a presence of 35-45° landslide slopes. In the middle tier the steep slopes also prevail, but they are covered by forests. The lower tier is typified by accumulation and erosional terraces and a significant number of accumulation cones.

The Gorgany, considered an area with significant avalanche activity [7, 9], are characterized by relatively high altitudes (as for the Ukrainian Carpathians), and local relief of 500-1000 m. Avalanches form on slopes covered by debris, different grasses, occasionally juniper and dwarf pine. Here, snowpack thickness reaches 1.5-3 m. In accordance with genetic avalanche classification, prevailing types are blizzard and avalanche of snow-melting with winter-spring regime of their formation [7].

The study area was located in the Kotelec', Petros and Doriv river basins. Major peaks include Grofa (1748 m), Paren'ky (1736 m), Mala Popadya (1597 m), Velyka Popadya (1740 m). Basing on methodology of avalanche denudation research, we calculated avalanche denudation intensity index. Using imagery interpretation 22 avalanche natural terrain complexes with the total area of 5,12 km<sup>2</sup> in 2010 were distinguished within the study area of 50,65 km<sup>2</sup>.

Total areas of avalanche complexes registered after 2005, 2007 and 2008 are also shown in Figure 1. In accordance with the calculations conducted with the proposed methodology, we obtained the following avalanche denudation intensity for the area of the Gorgans: 2005 – 0.01938

mm/year; 2007 – 0.01954 mm/year; 2008 – 0.01994 mm/year; 2010 – 0.02022 mm/year.

The process of avalanching influences the formation and dynamics of natural territorial complexes. This influence is most strongly manifested by the least resistant landscape components, but it also affects relief. These changes are caused by the process of avalanche denudation and depend on its intensity. The intensity of avalanche denudation in the Gorgans and the dynamics of avalanche influence on the formation of slope topography will grow in the future. Such conclusion can be drawn from imagery interpretation that testifies to the increase in avalanche area within the model area.

It is worth mentioning that within the study area, the formation of avalanches directly influences not only slope topography but also the formation of fluvial forms of permanent and intermittent watercourses.

Research of avalanche processes, including intensities of avalanche denudation is necessary, because that information gives an opportunity to analyze the dynamics and forecast possible further development of avalanche systems.

### **Landslides in 3D – Taking stock of landslides, taking a look at the effectiveness of chosen methods**

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Highland regions exhibit a high activity of exogenic processes which directly influence their relief. The Carpathians are heavily transformed by mass movements, especially landslides. 50 thousand landslides have been recorded in the area of 19,600 km<sup>2</sup>, which amounts to 3 landslides per square kilometre, on average (Rączkowski, 2007). The material losses caused by the landslides made this subject a widely discussed one in both Polish and international literature.

The scale of the phenomenon calls for a review and evaluation of the methods used in landslide surveys and inventory. The traditional methods include: topographic map analysis, geomorphological and geological analysis as well as field mapping, recently greatly improved with the common application of GPS technology. In those cases the precision of acquired data depends on the knowledge and experience of the surveyor. Another widely used method of collecting terrain data is photointerpretation of the study area. The data on the relief is derived from a LPIS photogrammetric model, which serves as a base for generating a raster terrain DEM (Digital Elevation Model) and an array of maps such as tilt map or aspect map. The most up-to-date and the best method for landslide forms survey is the Light Detection and Ranging (LiDAR) laser scanning method. A cloud of points, obtained with this method, gives full detail on the parameters of the landslide, such as its range and volume. The advantage of this method stems from the properties of the laser which penetrates vegetation. This allows to achieve two outcomes: a numerical model of the terrain and a numerical model of its cover. By generating a terrain model with the cloud of points from aerial scanning, we can determine the position and height of a specific point with a precision of up to one centimetre. Such precision allows a more efficient monitoring of the landslide-susceptible slope surfaces, as we collect an exact image of ongoing movement, both horizontal and vertical. The analysis of the terrain models before and after landslide allows to determine the volume of the material that underwent movement.

The development of measurement methods over the last 15 years improved precision of landslide surveys and monitoring, making them less time-consuming tasks. Application of the most up-to-date research methods allows to obtain more accurate data on Carpathian landslides and may enhance management of the areas prone to landslide activation.

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## **Disastrous floods in the Carpathians: historical-geographical and landscape- ecological aspects**

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Catastrophic floods represent hydrological anomalies and are considered as natural disasters that cause significant material and financial losses and are often accompanied by loss of life. It should be emphasized that the notion of catastrophic flooding is purely co-anthropogenic because estimation of flood severity is ultimately done in terms of damage to economy and society. Deficiency of free space with high density of population and long duration of economic development do not leave enough chances for successful regional management. In the context of the need to optimize environmental management, it is important to determine: (i) the range and nature of the causes leading to catastrophic consequences of outstanding floods, and (ii) objectives and specific measures to reduce their negative impact.

The purpose of this study is (i) to analyse the causes and effects of catastrophic floods, understood as a natural and human phenomenon, in the historical and geographical context and using the approach of landscape ecology; and (ii) to develop conceptual proposals for the reduction of negative impacts of floods on society.

The high number of catastrophic floods and the extent of the associated material losses call for clarification of several issues. Their clear separation and understanding determines further development of preventive measures. The first question is to determine the causes of floods, or extremely high water levels in rivers. Let us turn to historical records of large floods, presented in various publications.

Nowadays it is common to emphasize the negative role of human activity in stimulating flood occurrence. However, the historical facts rebut this. In the 11th to 17th centuries the Carpathians, Galicia and Bukovina were quite wooded with the properties of their geosystems allowing regulation of river flows. Despite this, numerous floods occurred at that time. According to documentary sources, long rains caused catastrophic floods in adjacent regions: Polish Subcarpathians (1219, 1253, 1310, 1649, 1735, 1744), Wallachia and Transylvania (1310, 1700), Germany (1310). In Russ (almost entirely forested country) major floods documented in annals occurred in 991, 1000, 1002, 1224 and later.

Thus, the main cause of flooding is the occurrence of heavy rain, not only anthropogenic factors (deforestation) which are now referred to in all doubtful cases. Recurrent extreme events are also the manifestation of natural phenomena.

The second issue is understanding the morphological structure of river valleys, particularly their bottoms. Fundamental decision requires the definitions of “floodplain” and “terrace” in specific geomorphological conditions, relevant not only for the Carpathian region.

Floodplain is the part of a valley bottom, that is regularly or occasionally flooded by the river. Within its limits fluvial lithofacies are deposited, which are formed by specific hydrological regime, and hence these surfaces are settled by plant associations and fauna adjusted to such conditions. Within this area, river bed and low and high floodplain are usually distinguished. Terraces are the surfaces on a valley bottom, which are no longer modified by fluvial processes.

According to different authors, in the Prut River valley the height of the first terrace is 3-4 m, and the second terrace - 5-8 m. In the lowland part of the Cheremosh River the first terrace rises 3-5 m above the bed, whereas the height of the second terrace at Vashkivtsi decreases to 5 m. In the Dniester valley the height of the first and second terraces is similar as in the Prut valley.

However, there is a contradiction between the interpretation of highly elevated terraces and the fact that the first terrace regularly suffers from flooding, and the second - in part. A question arises whether the first terrace of the rivers, heavily populated and cultivated, fits its natural functions and definition or it is rather a high floodplain.

Therefore, the first "terrace" is, in fact, still shaped by fluvial processes and does not comply with its current definition. In the last stage of the Holocene the process of formation of the current floodplain, with the first terrace above it permanently rising above the extent of flood stages, still continues due to deep bed erosion. Probably, it is necessary to combine the first and the second levels on the valley bottoms into one, thereby removing the illusion of invulnerability of the area to flooding.

The third aspect of the problem of the safety from flooding relates to mental and psychological factors of human activity. It is necessary to ask: if the area is regularly flooded with large material losses and casualties, then why the residents of these areas continue the development of the area? Historical and archaeological data indicate that practically no archaeological sites occur within the "first" terrace. It can be inferred that common sense dictated the population not to settle in this area, which cannot be said of the recent period with extensive and intensive management of the area.

Usually regular flooding cannot reach the scale of environmental disasters, if certain preventive measures are adopted. The fact of the incomplete evolution of the first terrace in the valleys of the region should lead to proper conclusions. First of all, in the areas threatened by flooding it is necessary to prohibit any construction or long-term residential facilities for household purposes. Based on the positive experience of other countries facing similar problems, it is advisable to look at the architectural tradition and to start constructing houses on stilts or with high foundations. If landowners continue building in the potential flood zone, they should only be permitted to do so with some technical safety requirements and under the compulsory insurance of buildings and property.

### **Modelling hydraulic parameters of flood flows for a Polish Carpathian river**

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During the 20th century many sections of Polish Carpathian rivers were heavily modified by channelization and channel incision. Recent research demonstrated negative effects of these changes on the components of river biocoenoses such as fish fauna (Wyżga et al., 2009) and



benthic macroinvertebrates (Wyżga et al., 2012). However, negative consequences of river channelization and channel incision are not limited to their impacts on river ecosystems, but they are also manifested in increased flood hazard to valley sections downstream of the modified river reaches (Wyżga, 1997).

Erodible river corridor is a restoration measure aimed to mitigate the negative effects to river ecosystems and the conditions of flood water storage. It consists in a part of the valley floor within which the river is allowed to develop its channel freely, while migrating within the corridor. A few years ago such an erodible corridor was delimited in two reaches of the Biała, a gravel-bed river in the Polish Carpathians, that was heavily affected by channelization and channel incision in past decades. In these reaches, short channelized sections located in the vicinity of bridges alternate with longer unmanaged channel sections which either avoided channelization or in which the channel has widened after maintenance of the channelization scheme was abandoned. Effects of these alternating channel morphologies on the conditions for flood flows were investigated in a study of 10 pairs of closely located river cross-sections with constrained and freely developed morphology. Moreover, unmanaged cross-sections located upstream and representing vertically stable channel conditions were compared with downstream, unmanaged cross-sections exhibiting considerable channel incision. Discharges of particular probabilities were determined for each cross-section using an empirical formula. The morphology of the cross-sections together with data about channel slope and roughness of particular parts of the cross-sections were used as input data to modelling performed with the Hec-ras software.

The results indicated that freely developed cross-sections, usually with multi-thread morphology, are typified by significantly lower water stage at particular flood flows than single-thread, channelized cross-sections. Considerable differences between the two types of river cross-sections were also found with respect to average flow velocity, unit stream power, bed shear stress as well as Reynolds and Froude numbers. Marked differences in the hydraulic parameters of flood flows also exist between wide, vertically stable unmanaged cross-sections and relatively narrow, incised unmanaged cross-sections. Apparently, river incision and accompanying channel narrowing exert a similar impact on the hydraulics of flood flows as do the artificially forced channel changed caused by river channelization. Only within wide, multi-thread channel sections could a flow of a 100-year flood be conveyed with reasonably low shear forces exerted on the banks and bed of the channel. In contrast, in constrained, single-thread channel sections, water velocity and shear forces would be considerably higher, inevitably causing bank erosion and bed degradation.

The study indicated that even though the restoration of the Biała has only begun, it already brings beneficial effects for the flood risk management on the river, increasing the channel storage of flood water and slowing down the passage of flood waves in relatively unmanaged valley sections.

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## **Influence of tectonic discontinuities on the occurrence of springs in the western part of Podhale region (Polish Central Carpathians)**

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The occurrence of springs is largely determined by geological structure. Nevertheless, spatial distribution of discharge zones not only reflects lithology but also strongly depends on the occurrence of zones of tectonic discontinuities - especially in areas recently affected by tectonic events. This poster presents the results of analysis of the relationship between occurrence of springs and the location of tectonic discontinuities in the western part of Podhale region (Polish Central Carpathians).

The study area encompassed the Spisz-Gubałówka Foothills west of the Biały Dunajec River and east of the Polish-Slovak border. Information about the location of *known or suspected* tectonic faults was derived from digitized geological maps and Digital Elevation Model (DEM) of Podhale region. DEM was used to identify tectolineaments from shaded relief maps (illuminated from different directions), condensed contour map and anaglyphs of shaded relief images. Furthermore, lineaments were also identified with the use of topographic grain algorithm in MicroDEM software. Subsequently, study areas located within different lithostratigraphic and tectonic units of the Podhale Synclinorium were designated. During the field research all of the springs within the study areas were mapped with the use of GPS receiver. Then, analysis of the spatial correlation between the occurrence of springs and the location of faults and tectolineaments was conducted using the ArcGIS software.

The results of the analysis indicate significantly higher spring density and spring discharge in the selected zones of known or suspected tectonic discontinuities in the Podhale Synclinorium. Moreover, springs located along linear trends designate major tectonic directions of the region.

## **Methods for long-term monitoring of large wood recruitment and mobility in two Polish Carpathian watercourses**

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In watercourses draining forested river corridors, fluvial processes are determined not only by the amount and character of mineral sediments but also in-channel woody debris. Regular monitoring of the recruitment of trees to mountain river channels and their downstream transport plays an important role in the assessment of flood risk and interpretation of its causes. Such monitoring has been conducted in two Polish Carpathian watercourses.

In October 2009, 429 trees growing along three sections of Kamienica Stream were tagged with numbered metal plates and subsequently checked at monthly intervals to determine the timing and causes of their delivery to the stream and the distance of log transport during flood events. To date, 20

trees have fallen to the channel as a result of windthrow, bank erosion and overloading with snowfall. A considerable proportion of spruce trees in the riparian area are affected by bark beetle infestation. The weakened trees are more susceptible to breakage by wind and this type of delivery is characteristic of conifers growing along the stream. Trees of deciduous species mostly get into the channel as a result of windthrow, bank erosion by flood flows, landslides and overloading by snow. Based on the number on the metal plate fixed to a fallen tree, it is possible to determine the distance of the tree transfer, from its initial position on the banks or the former position within the stream. As the study period lacked major flood events, the largest travel distance of fallen trees did not exceed 100 m.

The channel of the Czarny Dunajec River is too wide to be spanned by fallen trees and thus woody debris can be transported long distances during floods. The collisions of floated wood with in-channel or bank structures and wood jamming in bridge cross-sections can result in considerable flood damage. Here, we used similar monitoring methodology as for Kamienica Stream but with use of telemetry. Trees growing on the river banks were tagged with radio transmitters of unique signal frequency. After their recruitment to the channel during a flood, the fallen and relocated trees will be searched with antennas and signal receivers.

The distance of downstream transfer of fallen trees and preferential locations of wood retention differ between channels narrower and wider than the height of riparian trees. Results from the monitoring will help to better recognize the flood risk caused by the delivery of large wood to the channels of mountain watercourses of different size and will be useful in the formulation of management recommendations that will allow to maximize environmental benefits resulting from the presence of in-channel large wood and to minimize the flood risk it causes.

## **Catastrophic winds in the Tatra Mountains in 1968, 2004 and 2013 – types, meteorological conditions and scale of devastation**

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Strong winds in the Carpathians occur frequently, causing destruction of large forested areas. The Western Carpathians lie on the movement trail of air masses characterized by various physical properties. Occurrence of high and long mountain chain not only affects the accumulation of air masses, but also causes retention of a high pressure system on its south-east foreground. This leads to the occurrence of situations characteristic of generation of strong foehn winds.

Detailed synoptic analyses show that extremely high wind velocities were observed in the case when powerful axis of low troposphere jet streams at 2000–2500 m altitude was over the Tatra Mountains, the highest massif in the Western Carpathians. The existence of the above-mentioned situation favours large-scale stability of the pressure systems. It is assumed that decisive in the formation of these phenomena is a high-pressure blockage which hampers the movement of secondary low pressure systems (Budziszewska et al., 1970).

Another type of destructive wind with high velocities was observed in the southern part of the Tatra Mountains within the Slovak territory. This type of wind, with widespread disastrous effects called “kalamita” in Slovakia, is characterized by violent and sudden flow of cold air masses from NW to SE (Balon et al. 2005). The occurrence of such cold winds depends on two main conditions: fast movement of low pressure system from west to east, over Germany

and Poland, and inflow of cold Arctic air masses, related to cold atmospheric front, towards the south, over the Tatra Mountains.

Strong winds (up to 100 km /h) on either side of the Tatra Mountains appear several times a year, whereas extremely strong winds (above 150 km/h) occur episodically and bring enormous damage to forests. In the Slovak part of the Tatra Mts (between Tatranska Lomnica and Tri Studnický), 5.3 million cubic metres (around 13 000 ha) of forest fell during windstorm on 19th November 2004 (Konôpka, 2005; Minar et al., 2008). In the Polish part of the Tatra Mountains, fallen trees covered the area of 300 hectares after the extremely strong warm wind, named “halny” in Poland, which blew for 3 days during 4–7 May 1968. Similar strong warm wind occurred on the northern slopes of the Tatra Mountains at Christmas time 2013. The destruction of forest is still being estimated in this area. Regardless of the damage to the forest areas, extremely strong winds during these times resulted in damage to inhabited areas, causing the destruction of numerous roofs of houses.

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### **Some features of the hydrological regime of Harman Marsh, a Natura 2000 site in the south-eastern Carpathians**

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Harman Marsh is a small wetland (5.34 ha), included in a larger Natura 2000 site also comprising Lempes Hill. The site is located 18 km north from Brasov City inside its metropolitan area, in the residential area of Harman village. Geomorphologically, the marsh is located in the centre of the Brasov Depression (N45° 43' E25° 39'), the biggest intramountain depression of the south-eastern Carpathians.

The protected habitats are settled by numerous plant species, including glacial relicts, some very rare and even endemic (*Armeria alpina*, *Pedicularis sceptrum carolinum*, *Primula farinose*, *Drosera anglica*). These species depend on a particular hydrological regime vulnerable to human pressure felt due to expansion of the residential area up to marsh boundary, and to groundwater exploitation as drink water resource for the population of over 200,000.

The purpose of this study is to determine groundwater and surface water movement inside the marsh and soil hydrological regime, to which the existence and vitality of protected species and habitats are inextricably linked. The research is a part of a LIFE project, founded by the European Commission, which will be completed in 2018.

The poster presents groundwater movement correlated with some rainfall and evapotranspiration data for the period summer–fall 2013. In this period maximum rainfall recorded was 50 mm, whilst daily potential evapotranspiration varied between 2.26 and 5.21 mm.

In order to determine hydraulic conductivity and other soil properties, soil samples were collected and analysed. To achieve a more accurate 3D terrain model, precise terrestrial measurements were made and in order to determine the groundwater head, 12 shallow wells (100-252 cm) were drilled and the water level was periodically measured.

The results proved that groundwater intake is decisive in maintaining an optimal soil moisture inside Harman Marsh, whereas precipitation and evapotranspiration appeared insignificant, in statistical terms, in water head variation. Drinking water exploitation from the ground resources together with the expansion of the residential area and some agricultural practices could have serious consequences for the existence of this habitat.

## Rare soil types of the Ukrainian Carpathian habitats

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The diversity of soil types in the Ukrainian Carpathians is determined by the diversity of geological structure, hydrological and climatic regimes and complex history of the formation of vegetation in mountainous terrain.

Some of the studied soil types are rare, that is those that occur on a very limited area under of a specific set of habitat characteristics. These soils usually are not presented on soil maps; these soils form habitat environment, creating the most valuable habitats in the region.

The problem of the lacking data on environmental properties of rare soils first appeared during the attempts to determine the types of natural habitats of the Ukrainian Carpathians. Our work was thus aimed at identifying and studying rare soils in natural habitats of the Ukrainian Carpathians in order to establish their conservation value. Research was conducted within the international research project "Identification and classification of types of habitats (habitats) in Ukraine: the introduction of standards and the methodology of the European Union (pilot project in the Ukrainian Carpathians)."

Six subtypes (5 types) with a special structure of the soil profile and properties have been identified and described. They are formed by locally common parent rocks under atypical hydrothermal and orographic conditions.

Brown mountain meadow alpine acid soil (Cambic Leptosols) forms in very cold and wet zone of the Carpathians, at an approximate altitude of 1800 m asl. This kind of soil is connected with three types of alpine habitats: forb-grass communities, tall grasslands and Alpic acid moss snow-patch communities; and may occur in conjunction with the primary natural *Nardus stricta* communities. These underdeveloped soils, with peat-sod horizon (Hdt, thickness 3-10 cm) form on the parent material and provide the primary accumulation of organic matter and humus in the soil profile. They develop into sod-peaty acidic soils (Leptic Histosols) with peat (T) horizon

20-30 cm thick, in combination with the occurrence of brown mountain meadow under alpic acid moss snow-patch communities.

Brown acidic subalpine soil (Leptic Cambisols) is associated only with high meadows and subalpine forests. It is formed on well-drained eluvium of sandstone and crystalline rock taluses. This type of soil is characterized by short-profile, highly disintegrated regolith with medium and fine loamy material and high content of humus, and strongly acidic reaction. Brown acidic subalpine soil differs from other brown soils by clearly marked sod-humus horizon with signs of turf-creating process. These soils in undisturbed state remained only within 4 types of habitats, namely in the subalpine altitudinal belt, deciduous shrub with creeping willows and participation of *Salix silesiaca*, *Duschekia viridis* communities and alpic pine forests.

Alluvial sod-brown soils (Haplic Fluvisols) occur only within *Salix starkeana* communities, located along rivers. Permanent alluvial regime and the dominance of turf process provide them with good water filtering capacity, size distribution and significant content of organic matter.

Rare soil types form in regions of the Ukrainian Carpathians where the surface is underlain by Cretaceous loamy limestone. Specific geochemical conditions led to the formation of saturated soils with high calcium content in the absorbing complex, that are rare in the region. Rare habitats with calciphytic plant species occur in conjunction with these soils.

The impact of rocky subsoil is noticeable around the springs with cold hard water, that occur on tufa and travertine, where a thin peaty-gley calcareous soil (Calcic Histosols) has formed.

Greensward carbonate (Rendzic Leptosols) soils have been described within some localized habitats in xerotherm zone of the south-western slope of the Ukrainian Carpathians. They form habitats of dry grass, mixed grass, Pannonia xerotherm lowland and grasslands of forest and subalpine zones, the existence of which is limited by the presence of carbonates in soils. Greensward calcareous soils have a thin (25 cm) and poorly differentiated profile with a clearly marked humus layer (humus content 6%). They are characterized by neutral to weakly alkaline reaction of the soil environment and the dominance of calcium absorbing complex.

The sod-calcareous soils (Leptic Calcisols) of beech forests *Cephalanthero-Fagion* represent one more type of rare soils of the forest belt of the Carpathians, which have not been described yet from the area. They are characterized as soils of varied thicknesses (30 to 70 cm), which occur on limestone, dolomite, and calcareous flysch slopes of the southern aspect. The inclusion of limestone fragments and soil aggregates ensures good water permeability, slightly alkaline soil reaction and high absorption capacity. The carbonate content in the soil increases with depth from 15-18% in the horizon H+Hd to 70-76% in the transition to bedrock. The soil profile is rich in humus, with its content decreasing gradually with depth from 6 to 2%. Soils with similar characteristics are described in the steppe zone of the Crimean Mountains and are defined as sod-calcareous mountain-steppe soils. In the forest zone of the Ukrainian Carpathians, based on setting properties, we propose to identify such soils as sod-calcareous mountain forest soils.

Rare soils cover less than 2% of the area of the Ukrainian Carpathians. However, these soils are the environment for 15 natural habitats of the region (17% of the total amount). Most of these habitats belong to the highly valuable area with isolated distribution and are threatened by human impact. The quality of the soil and the conditions of its functioning are crucial for preserving diversity and reducing threats for habitats that have a direct edaphic restriction. Introduction of habitat approach to nature protection will implement the principles of real protection of rare soils in the Ukrainian Carpathians.



## ORAL PRESENTATIONS

### **Wetlands of the Svydovets massif – important areas of biodiversity, their threats and conservation**

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Svydovets massif is a region of the Ukrainian Carpathians, which is characterized by the most rich floristic diversity, primarily due to significant heterogeneity of its geological structure and relief. A considerable area of the massif is occupied by the highlands with numerous wetlands and lakes, such as Apshynets, Gerashaska, Vorozheske etc., mainly distributed on the northern slopes of the mountain ridge. Wetlands also occur in the forest zone, in the form of small bogs or riverines, where they occupy a much less area. Wetlands belong to the most sensitive and threatened ecosystems worldwide. They are also considered the most biologically diverse of all ecosystems. The factor that distinguishes wetlands from other land forms or water bodies is the characteristic vegetation that is adapted to its unique soil conditions.

During 2002-2012 the research of hydrophilous flora and vegetation on the territory of the Svydovets massif has been conducted. As a result of the study we have determined communities belonging to 17 alliances highly connected with wetland habitats. In particular, those habitats comprise spring and streamside vegetation, wet meadows, vegetation of stagnant, acid, dystrophic waters, shrub and woodland communities of flushed soils and vegetation of acid oligo-mesotrophic peats. We have established 8 natural habitat types of community interest whose conservation requires the designation of special areas of conservation (Natura 2000 habitats). Two of them belong to freshwater habitats, one – to natural and semi-natural grassland formations, 3 – to raised bogs and mires and fens and 2 – to the forests type. Two of them belong to priority habitat types.

We have also detected a number of rare and endangered species having a high level of constancy in wetland communities: 17 of them are included to the Red Data Book of Ukraine, 11 species are in the Red List of vascular plants of the Carpathian Mountains, 5 of them are considered as relicts, one species is endemic. One of the greatest achievements of our research was the finding of rare and highly endemic Carpathian calciphilous higrophyte species – *Saussurea porcii* Degen (European Red List) on the Apshynets meadow in the stream valley between Troiaska and Tataruka Mt. According to the literature sources only some isolated populations of the species are known from Chyvchyny and Chornohora Mt. (Ukrainian Carpathians) while on the territory of Romania it is considered to be extinct. The results of our research show that a lot of rare and threatened species of the Carpathians are still being preserved within bog communities on the Svydovets massif, namely: *Drosera rotundifolia* L., *Oxycoccus palustris* Pers., *Pinguicula vulgaris* L., *Scheuchzeria palustris* L., *Carex pauciflora* Lightf., *C. dioica* and others. In particular, the most southern isolated habitat of the rare boreal species – *C. dioica* has been recently found on the slope mesotrophic bog at the foot of Stig Mt. and is the upper limit of its distribution in Ukraine.

There were also a few interesting findings of hydrophytes. In a small shallow Vorozheske lake at the altitude of 1470 m it has been found *Batrachium trichophyllum* (Chaix) Van den Bosch.



This habitat is the upper limit of the species distribution in Ukraine and is one of the highest in the Carpathians. In 2012 it was confirmed the locality of *Potamogeton alpinus* Balb., included to the Red List of vascular plants of the Carpathian Mountains, in the Gerashaska lake (1577 m). *Sparganium affine* Schnizl is another rare species has been found in this lake. It is included to the Red Data Book of Ukraine. But many literary reports about its only finding at the beginning of XIX century in the Gerashaska lake, have not been confirmed by the herbarium collections. In autumn 2012 we have detected 2 sterile specimens of the species from this lake in the herbarium of the Charles University in Prague (Deyl, 19.08.1929). Now it has been considered to be extinct in flora of Ukraine.

Although most of the alpine lakes such as Apshynets and Vorozheske have been given the status of hydrological nature monuments of local importance, but it does not ensure the conservation of biodiversity at the adjacent wetland territories and aquatic vegetation. So in order to provide the effective protection of these localities this area should be included to the Carpathian Biosphere Reserve. During the last years mountain tourism become one of the fastest growing industries in the region. There is a boom in the construction of new, and the expansion of existing facilities for downhill skiing across many parts of the Ukrainian Carpathians, particularly in the Svydovets massif. The development of mountain tourism and continued growth of the recreational potential of the tourist centers caused a significant increase of the anthropogenic load on the vegetation. It's clearly seen for the highlands (subalpine zone) of the Ukrainian Carpathians as the most vulnerable ecosystems, where even the slightest violations can lead to their degradation. This activity has a negative impact primarily on the landscape diversity, as it is accompanied by destruction of the most attractive natural objects, including the shores of mountain lakes. Due to the absence of environmental impact assessments, the impact on the environment is unknown. A number of factors, including rising energy costs, climate change and biodiversity loss, as well as water pollution, changing of watercourses and as a result the desiccation of many wetland areas suggest that many of them are critically endangered.

## Ecosozological assessment of the Carpathian spider fauna

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The Carpathians cover an area of 190,000 km<sup>2</sup> and, after the Alps, form the next most extensive mountain system in Europe. The Carpathians consist of a chain of mountain ranges that stretch in an arc from the Czech Republic (3%), through Slovakia (17%), Poland (10%), Hungary (4%) and Ukraine (11%) to Romania (53%) and Serbia (2%). Ecosozological assessment of the Carpathian spider fauna was/is done in framework BIOREGIO project with objectives to improve knowledge on insufficiently known Carpathian spider fauna and ensure a favourable conservation status for threatened species. Summary knowledge of the Carpathian spider fauna has not yet been made. There is only the Carpathian List of Endangered Species (Witkowski et al. 2003) which include spiders very marginally. It lists totally only 17 species with many incorrect data. From the Carpathian country there are only the national red lists for whole territories of several countries, namely Czech Republic, Slovakia and Poland. Few species have a legal protection safeguarded; in Hungary (15 species, only one from Carpathians), in Poland (7 species, including four found in Carpathian Mts.) and Slovakia (15 species, 13 from Carpathians).

From methodological aspect it is respected the borders of the Carpathian region in the Carpathian Biodiversity Information System (CBIS), with 309 orographic units (available on [www.carpates.org/cbis/orogs.html](http://www.carpates.org/cbis/orogs.html)), species nomenclature from *Fauna Europaea*. For a red listing the Guidelines for Application of IUCN Red List Criteria at Regional Levels (IUCN 2003) was applied.

The following four steps were used to process the existing data on spider species (class Arachnida: order Araneae) present in the Carpathian region in Czech Republic (CZ), Hungary (HU), Poland (PL), Romania (RO), Serbia (SR), Slovakia (SK) and Ukraine (UA):

1. Documenting of spider fauna in the studied Carpathian Mts. Any data available were used, literature sources, spider collections in museums, individually owned databases and also own unpublished data. (In order to find out whether the species belongs to the Carpathians, an intersection of GIS layer of orographic units and a point GIS layer of studied sites was carried out.)
2. Preparing the national Carpathian red lists by experts from individual Carpathian countries. All the spider species recorded in the Carpathian part of individual countries were evaluated according to the IUCN criteria (IUCN 2013) and classified as Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC) and Data deficient (DD).
3. Uploading of data in the specifically designed online database for the purposes of BioREGIO Carpathians project. National data were entered into database as well as submitted in an Microsoft Excel spreadsheet.
4. Preparing the whole Carpathian red list. All the 1069 spider species documented in the Carpathian orogeographic units were evaluated according to the listing in the national red lists, taking into consideration the IUCN criteria for higher (Carpathian) level. The taxa in categories VU, EN, CR, RE, were selected as a basis for elaboration of the draft Carpathian Red List. Final categorisation (VU, EN, CR, RE) of the species on Carpathian level was done on the basis of common consultations and discussions of the project partners. Check list and also Red list of the Serbian Carpathians was developed based on data from a monograph "The spiders of Serbia" (Deltchev et al. 2003).

Altogether 1069 spider taxa (cca 21.76% of 4913 European species) were found in seven Carpathian countries (CZ, HU, PL, RO, SR, SK, UA). The level of knowledge on spiders in individual Carpathian countries is different. The best data are from Slovakia (the SK Carpathian dataset listed more than 95 thousands spider records from about 4000 localities and from 85 orographic units, Slovakian Carpathians are divided into 86 orographic units). The highest richness of spider fauna is documented from Slovak, Czech, Romanian and Poland Carpathians (926, 671, 619 and 570 species, respectively). 386 species were recorded in the Ukrainian Carpathian Mountains. There are less data available from Hungarian and Serbian Carpathians (182 and 203 species). In summary,

the following numbers of taxa were listed under the categories RE?, CR, EN, and VU in the National Red lists: 0 (HU), 14 (UA), 15 (SR), 25 (RO), 86 (PL), 170 (CZ) and 201 species (SK). Altogether 49 endemic species were found in the Carpathians (4.6% of 1069). The majority of “endemic species” is concentrated in Romania (41 species). The results are available in project database on the project web page with the data on the occurrence and classification of species into the IUCN categories in individual national red lists and in the Carpathian Red list. These Red Lists includes very rare threatened spider species and they are presented by authors. Also information on the distribution and endemisms of spider species within the Carpathians is available.

The presented results highly are suitable for widespread use in nature protection, ecology and also in the decision making processes on the national and supranational (European) levels.

Acknowledgement. Work was done in framework of the CBC Programme - South East Europe - a project BIOREGIO Carpathians and in the framework of VEGA project 2\_0117\_13

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## Wind farms may affect spatial distribution of terrestrial mammals – a case study in Beskid Niski Mts. (Northern Carpathians)

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Carpathian foothills are regarded as one of the most favorable areas of Poland for the development of wind farms. With the increasing expansion of wind turbines, the question of their effects upon wildlife becomes more frequent in scientific literature. While the data on the impacts of wind turbines on birds and bats are relatively extensive, the literature concerning their effect upon other terrestrial species, e.g. mammals, is very limited. Consequences of an appearance of wind turbines on terrestrial mammals are rarely included in environmental impact assessments, therefore only limited amount of new knowledge is generated with the context of monitoring the development of this source of energy. Nowadays there is considerable uncertainty about whether and, if so, how wind power affects terrestrial wild mammals (Helldin et al., 2012). As it is well known that mammals can be affected by various types of human disturbance and exploitation, it is reasonable that also wind power has effects. The aim of our study was the assessment of an influence of wind turbines on the space use patterns of selected species of terrestrial mammals and Phasianidae. The field study was conducted in January 2014 at three wind farms: Łęki Dukielskie

(49°36'N; 21°40'E) - consisted of 5 wind turbines (total power 10MW), Rymanów (49°36'N; 21°50'E) - consisted of 13 wind turbines (total power 26MW) and Bukowsko (49°29'N; 22°04'E) - consisted of 9 wind turbines (total power 18MW). The wind farms were situated in Beskid Niski Mts., lower part of Carpathians with favorable wind conditions. An incidence of terrestrial mammals and Phasianidae was estimated on the basis of track counts along transects, being set between wind turbines and oriented towards the outside of the wind farm up to the maximal distance of 1200m. The field study was conducted during snowy period and the day after the snowfall. Every track recorded along the transect was marked with GPS receiver, and using the DNR GPS the shapefiles with waypoints were created. We used Multiple Ring Buffer Analysis in ArcGis software to delimit 12 distance zones from the wind turbines, the width of each zone was 100m. Multiple Buffer Zones allowed us to select each waypoint (representing the single track) within a distance range from the wind turbines. We covered 40 transects of the total length of over 32 km. Recorded there, were tracks of 13 animal species, among which red fox (*Vulpes vulpes*), domestic dog (*Canis lupus familiaris*), roe deer (*Capreolus capreolus*), Common Pheasant (*Phasianus colchicus*) and European hare (*Lepus europaeus*) were dominating. To avoid miscounts resulting from various daily travel of each species, the response of each species to wind farm presence were assessed separately. After the primary data analysis we have identified three types of animals response to wind turbines. Red fox did not show any clear reaction to those structures, although its track numbers were significantly higher within the first 100m distance zone. Roe deer and European hare tended to avoid the proximity of turbines, that was clearly shown up to the distance of 500m. Common Pheasant showed the inverse response to wind turbines, as their track numbers were the highest near the turbine (up to 100m) and remained common in following four zones up to the distance of 400m from the wind turbines. Other species were represented by not numerous tracks and could not be reliably assessed. Red fox is a common predator with high environmental plasticity; and wind turbine noise nor occasional human presence does not seem to affect on its behavior. Roe deer and European hare could be affected by noise from the turbines, by traffic and other human activity associated with maintenance work or by increased accessibility for leisure traffic and outdoor activities. Wind turbines seem to attract Common pheasant, which may stay near the turbines because of gastroliths accessibility or lower predation risk from the predatory birds.

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## Response of rare plant species to current changes of vegetation in the Ukrainian Carpathians

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The main drivers of current changes of vegetation in the Carpathians are abandonment of traditional land use and global warming, which fully concerns the Ukrainian part of the mountains. Obviously, these processes affect the populations of rare species, their abundance and distribution in



the region. Significant changes in occurrence of many rare species were revealed due to analysis of the previous publications and herbarium data in comparison with their present distribution as well as long-term monitoring of the state of populations in different massifs of the Ukrainian Carpathians.

Land use change. The vast majority of the Carpathian grasslands are secondary, i.e. resulting from the large-scale deforestation in the past. Such species-rich semi-natural grasslands that have developed over centuries of sustainable land use, harbour populations of many rare species. Some of them, mostly low-growing herbs (e.g. *Arnica montana* L., *Dactylorhiza fuchsii* (Druce) Soó, *Pseudorchis albida* (L.) Á. & D. Löve, *Traunsteinera globosa* (L.) Rchb.), demonstrate their highest vitality and size of populations particularly in secondary post-forest grasslands. However, *the massive abandonment of grazing and mowing during the last decades causes rapid natural reforestation* accompanied with the wide spread of dense-turf (*Deschampsia caespitosa*) and dwarf-shrub communities (*Vaccinieta myrtilli*). They replace the vast areas of former *pastures and hay-meadows all over the Ukrainian Carpathians that endangers many low-growing herbaceous species*, which need open microhabitats for their recruitment (Kobiv, 2012). The most dramatic losses have happened in calcareous grasslands that are very rare in the Ukrainian Carpathians where limestone is scarce. Such habitats occur mostly in the Chyvchyny Mts. at the Ukrainian-Romanian border. This region is remarkable in the biogeographical context, because many species have limits of their ranges here. As calcareous grasslands recede, many rare low-growing herbaceous taxa decline or get extinct (e. g. *Aquilegia nigricans* Baumg., *Arabis hornungiana* Schur, *Festuca saxatilis* Schur, *Minuartia oxypetala* (Wol.) Kulcz., *Polygala amara* L. subsp. *brachyptera* (Chodat) Hayek, *Potentilla thuringiaca* Bernh. ex Link). Some of them are narrow-range and can get completely extinct from the Ukrainian territory that already happened to *Thlaspi kovatsi* Heuffel (Kobiv, 2010). Effective conservation or restoration of their populations needs maintenance of limited traditional land use.

That concerns also some petrophilous species (e. g. *Erigeron atticus* Vill., *Erysimum witmannii* Zawadzki, *Sempervivum marmoreum* Griseb., *Silene zawadzkii* Herbich) that decline due to overgrowth of their rock habitats with shrub or elfin woodland vegetation.

The response of tall forb species to natural succession is totally different, because the change of vegetation is favourable for them. Rare components of tall herb communities belonging to *Adenostylion alliariae* alliance increase their abundance or colonize new habitats (e.g. *Achillea lingulata* Waldst. & Kit., *Aconitum moldavicum* Hacq. ex Rchb. subsp. *hosteanum* (Schur) Graebn. & P. Graebn., *Campanula serrata* (Kit.) Hendrych, *Centaurea kotschyana* Heuffel ex Koch, *Delphinium elatum* L. subsp. *nacladense* (Zapał.) Holub, *Gentiana punctata* L., *Laserpitium latifolium* L.). Their expansion is most evident in post-pastoral grassland and petrophilous communities.

Climate change effects are most noticeable at the upper elevations and concern mainly cold-tolerant high mountain species, which are vulnerable to the expansion of more competitive plants into their habitats. There are convincing data on extinction or decline of some high-mountain species in the Ukrainian Carpathians that proved to be vulnerable to climate change and occur on the lower limit of their altitudinal range here (Kobiv, 2009). These are, for example *Dryas octopetala* L., *Hedysarum hedysaroides* (L.) Schinz & Thell., *Luzula spicata* (L.) DC., *Oreochloa disticha* (Wulfen) Link, *Oxyria digyna* (L.) Hill, *Pedicularis oederi* Vahl, *Saxifraga aizoides* L., *S. androsacea* L., *S. bryoides* L., and *S. carpatica* Sternb., *Trifolium badium* Schreb., *Veronica bellidioides* L. Several cold-tolerant species – *Agrostis rupestris* All., *Saxifraga oppositifolia* L., *S. pedemontana* All. – even got completely extinct in Ukraine in the second half of the last century. Some of such endangered species are chionophilous and confined to snow-beds (e. g. *Saxifraga carpatica*) or stone screes caused by snow shifts on steep slopes (e. g. *Cardaminopsis neglecta* (Schult.) Hayek). They decline as their habitats decrease due to warming. More common high-mountain species also tend to recede. For example, the lower limit of distribution of an arctic-alpine species *Pedicularis verticillata* L. in the Chornohora has shifted for as much as about 300 m upwards since the end of the XIX century (Zapałowicz, 1889) and it became quite rare in the Chyvchyny and Svydovets Mts. now.

It is remarkable that most vulnerable both to global warming and land use change are short-lived low-growing species (e. g. *Arabis hornungiana*, *Cardaminopsis neglecta*, *Oxyria digyna*, *Pedicularis*

*oederi*, *P. verticillata*, *Thlaspi dacicum* Heuffel, *Th. kovatsii*). They are unable to reproduce clonally and often need open microsites for their recruitment. Therefore, the size of their populations is very unstable and they are prone to decline because of vegetation change.

Thus, the distribution of the rare species in the Ukrainian Carpathians as well as the size and viability of their population are significantly determined by the current change of vegetation and climate in the region, while the direction and the range of such shifts depend on biological characteristics and ecological demands of species. As natural change of vegetation is gradually gaining momentum (Kuemmerle et al., 2009), its effect upon the rare species is increasing.

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### Changes in plant population pattern under the natural and man-induced ecosystem transformations of high mountain zone of Ukrainian Carpathians

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Natural ecosystems of Ukrainian Carpathians (UC) during last 20–40 years were essentially transformed in response to the land use change and the intensity of human-related activity. In 70–80es of 20<sup>th</sup> century nature reserves were organized. The successions observed, cause the rearrangement of population pattern of many rare and endemic species. In 90es the pasture and mowing exploitation of mountain meadows and pasturelands decreased. Simultaneously the recreation impact arose. Among the environmental factors global climate change is the main driver of biodiversity transformation (Kyyak, 2013). Restoration processes of the large high-mountain areas currently are accompanied by the area, number and density magnification in populations of trees, shrubs and dwarfshrubs - *Picea abies*, *Pinus mugo*, *Alnus viridis*, *Juniperus sibirica*, *Vaccinium*- species. This occurs especially rapidly in subalpine communities, but in the alpine zone, particularly at the altitude 1750 – 1800 m asl, the distribution of these species increased. *Juniperus sibirica* is the most actively spreading shrub in the alpine zone.

The area of Red Data Book (RDB) species *Loiseleuria procumbens* at Chornohora mountain ridge is expanding, 2 new localities marked at a distance of 2 and 5 km from the nearest



populations. Foundation of population is probably observed at these locality. Positive dynamic is observed in young isolated *Senecio carpaticus* population (RDB), Carpathian-Balkan endemic, appeared in Chornohora approximately 25 years ago 5 km from the nearest one at the Mt Rebra after the establishment of reservation and termination of sheep grazing. Progressive changes of *Rhododendron myrtifolium* (RDB) populations, Carpathian-Balkan endemic, are marked both, in alpine communities of protected territories and in that, have undergone significant transformations due to pastoral activity. Natural restoration of rare species *Callianthemum coriandrifolium* is observed at the Mt Brebeneskul (Chornohora) – the only one locality known in UC. During 1995-2013 number of individuals increased from 680 to over 2500, also increased the total density and percentage of flowering plants. Contours of three “primary” loci were gradually converging during this period. Recreation is the main threat to this population. Hiking trail is crossing the habitat, during the vegetation period nearby plants are trampled heavily and the absolute individual parameters are decreased (Tzaryk et al., 2009). Populations of alpine species *Carex curvula* and *Oreochloa disticha* at the lower altitudinal limit of distribution are currently under the negative influence of global warming.

From 1995-97 grazing of subalpine meadows in Chyvchyny finished and its intensity at some minor parts became much lower. According to restoration of plant cover, emerged only one known large population of the East-Carpathian endemic *Heracleum carpaticum*. Other populations of this species are smaller and have a lower number. Endemic *Galium pawlowskii* is a range-margin species in Chyvchyny mts. In the case of natural biotopes’ rapid transformation colonizing strategy of the populations is changing from “phalange” to “guerrilla” when interspecies competition increases. Under the overgrazing at some mountain grasslands near the settlements populations express negative dynamics, and have all the features of pasture degradation.

Plant populations of the open rock high-mountain communities (*Rhodiola rosea*, *Antennaria carpatica*, *Dianthus carpaticus*) due to the patch distribution and isolation are vulnerable to both natural and man-induced factors. Fragmentation of the populations is connected with phytoclimatic changes the same as man-induced, because of periodical gathering with decorative or medical purpose. Negative trends in populations are associated with their response to warming. In particular it refers cold resistant arctic-alpine species *Rhodiola rosea*, *Antennaria carpatica*. This is accompanied with changes in structural organization of populations (spatial, sexual, reproductive) and viability reduction.

Within the range of *Pulmonaria filarszkyana* in UC it is possible to distinguish 3 population and subpopulation groups, which differ by a set of group parameters, location, size, number, character of recovery and degree of isolation: “mainland” populations, local populations and isolated subpopulation formations. In case of ecological optimum formed “mainland” populations, that make the core of metapopulation. They have a developed structure and are the source populations for local isolated sink populations. Environmental changes determined by vegetative cover renewal and anthropogenic impact can induce a decrease in the number and density of population, and subsequently its fragmentation (Bilonoha, 2011). At the subalpine zone under the intensive grazing and raise of spruce forest timberline isolated habitats disappear altogether or represented by single individuals. *Centaurea mollis*, which elevation limit of distribution reaches the alpine zone of UC, is characterized by positive dynamics due to the increased length of the growing season. Although in these populations only propagation was observed, during the last 5-7 years occasional seed set is detected and in stabilized populations with sufficient number and area the single individuals of generative origin appeared.

Direct man-induced impact doesn't influence significantly on the plant populations of snowbed communities. The reason is that habitats are located in remote and distant places from tourist routes. Reducing the duration of snowfields in the studied ecotopes eliminates habitat sustainable water supply and makes them dependent on weather conditions, particularly precipitation. At the periphery of habitats projective cover and density decreased in *Dichodon cerastoides*, *Saxifraga carpatica*, *Veronica alpina*. Simultaneously, total projective cover of the major keystone species increased twice

in the central parts of habitats. Lack of soil moisture when seedlings emerge is one of the reasons for increased mortality of pregenerative individuals and a result of aging populations *Veronica alpina*, *Luzula spadicacea*, *Gnaphalium supinum*, *Saxifraga carpatica*, *Dichodon cerastoides*.

There are substantial adjustment in the positions of herbaceous species in the structure of plant communities. Rare and endemic plant species' populations: *Loiseleuria procumbens*, *Senecio carpaticus*, *Heracleum carpaticum*, *Rhododendron myrtifolium*, *Callianthemum coriandrifolium*, *Galium pawlowskii* are advancing. Instead, the negative dynamics is essential in alpine and arctic-alpine species: *Oreochloa disticha*, *Rhodiola rosea*, *Carex curvula*, *Antennaria carpatica*, *Veronica alpina* and others. The described processes are mainly the result of succession because of grazing termination or decline, restoration of plant cover and climate warming. More attention should be paid to reproductive parameters of individuals and populations, as the most sensitive to changes in the environment.

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## Soil mites – a useful tool for the grasslands' ecological characterization from Trascău Mountains (Western Carpathians – Romania)

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According to FAO 2011, the permanent meadows and pastures from Romania are about 4.543.000 ha, which represents 19.05% from the total surface of Romania and 2.49% from Europe's area. Natural grasslands ecosystems are very important, due to their high diversity of plants and animals (including invertebrates) which provides diverse ecological services for society, as: food production and quality, climate change amelioration, revitalizing crop lands, protecting water quality and cultural heritage value (Littlewood et al., 2012; Hartel et al., 2013).

The terrestrial invertebrates from grasslands provides numerous ecosystem services, influencing the plants and land productivity, stimulating the interspecific competition, representing in the same time a valuable food source for higher trophic levels. In process of grassland ecological restoration, terrestrial invertebrates are considered a useful tool (Barrios, 2007; Jesus et al., 2009; Schon et al., 2012).

The soil fauna is not very well studied in Europe, being often a neglected component of the grasslands biodiversity. The edaphically invertebrates are characterized by the most abundant populations (over 100.000 m<sup>-2</sup>), being an useful biological indicators for the grassland environment

(Maharning et al., 2009; Schon et al., 2010; Garcia et al., 2010). One of the most important soil group for grassland ecosystems, used as bioindicators, are predators mites-gamasids (Acari: Mesostigmata) (Gulvik 2007; Ruf & Bedano, 2010).

The present study was made in Trascău Mountains, situated in the south-eastern part of the Apuseni Mountains (Western Carpathians), in their southern limit, represented by the Ampoi valley (research area).

In June and September 2013, 150 soil samples were investigated from six grazed grassland ecosystems. The altitude varied from 415 m to 912 m. In total, 50.140 ind./sq.m were counted, belonging to the following soil mite orders: Prostigmata (2.19%), Oribatida (72.03%) and Mesostigmata (25.72%). From Mesostigmata order, 46 species were identified. These mites were grouped in dominance and constancy classes, highlighting the specialized and generalized species from each ecosystem.

The following abiotic factors were investigated: soil temperature, which recorded values between 9.52° C ( $\pm 1.09$ ) and 32.67° C ( $\pm 0.41$ ); soil water content, with values from 48.44% ( $\pm 1.56$ ) to 83.84% ( $\pm 1.89$ ); soil pH with values between 4.59 ( $\pm 0.01$ ) and 5.57% ( $\pm 0.05$ ). The environmental variables influenced the structure of soil mite communities. Direct correlations were established between numerical abundance of gamasids and soil water content ( $R = 0.158$ , with  $p < 0.05$ ) and between numerical abundance and pH ( $R = 0.127$ , with  $p < 0.2$ ). Indirect linear correlation was established between soil temperature and numerical abundance ( $R = -0.243$ , with  $p < 0.05$ ). Bray Curtis cluster analysis revealed similarities and differences between soil mite populations from the six grassland ecosystems.

Each investigated grassland ecosystems was characterized by specifically environmental conditions and by characteristically structure and dynamics of the soil mite population parameters. These features allowed using the soil mite fauna as a valuable biological tool for grassland's ecological characterization.

This study was carried out in the framework of the projects: RO1567-IBB01/2014 from Institute of Biology, Romanian Academy and no. 50/2012 (ASPABIR)- Priority Uefiscdi Partnerships.

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## **Plant species diversity of grasslands within a rivulet catchment area in the Romanian Carpathians in relation to anthropic impact**

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In the Transylvanian region, the Ampoi Valley stretches along the course of the Ampoi river, penetrating deep into the heart of Apuseni Mountains and making its way through the Vladeasa, Trascău and Metaliferi Mountains. As well as these areas of great biodiversity value, the Ampoi Valley also crosses the region where mining activities have had the greatest impact on the environment. In the Zlatna area, during the communist period, atmospheric deposition of heavy metals had a great impact on both grasslands and forests. The plant at Zlatna functioned from 1747, extracting copper- and lead-bearing ores that were also rich in gold and silver (Clepan, 1999). This plant was modernised in 1988 and functioned till 2003. The dispersion chimney of the plant (220 m height) created atmospheric pollution not only in the immediate area but also at big distances. The Paul rivulet flowing from Trascău Mountain is a tributary of the Ampoi river situated close to the dispersion chimney and its catchment area was affected over time due to atmospheric deposition from the Zlatna plant. People from this area use the grasslands for grazing and hay productions; thus there is also an overgrazing impact on the grasslands. Both these big impacts highly modified the vegetation cover and structure leading to frequent landslides, areas without vegetation, modified water regime *etc.*

In this context, our goal has been to produce tools that include erosion control and metals-buffering services provided by grassland plants as factors within Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA) of projects, plans and policies implemented in catchments with current and past mining and smelting activities (ASPABIR, 2012).

In 2013, we mapped the heavy metal distribution along the Paul rivulet catchment area using XRF and set up 12 investigation plots 50 m<sup>2</sup> at different altitudes (468-972 m) in relation to the different degrees of soil pollution. In every plot, we recorded the species composition and cover of the vegetation in 25 subplots, each of 10 m<sup>2</sup>.

In order to assess the diversity aspects, the natural conditions and also the anthropogenic impact among the different grasslands, the data set were statistically processed. Species diversity (Shannon index), dominance (Simpson's index) and evenness (E index) were calculated using the procedures BioDiversity Pro 2.0, PAST (Hammer *et al.*, 2001) and XLSTAT software. The graphical representation of the diversity differences among the plots were highlighted using K-dominance analysis based on species abundance. The relative similarity of species composition was assessed using a Bray-Curtis dendrogram. Multi-dimensional scaling (MDS) analysis gives an overview of the abundance distribution in the 12 plots.

The species diversity in the plots varied between a minimum of 30 species (plot 5 at 602-616 m altitude) and a maximum of 88 species (plot 4 at 531-543 m altitude) and was correlated with overgrazing impact and natural soil structure rather than to soil pollution. These two plots were situated in close proximity, within the same area of the rivulet catchment. Those plots with a low number of species typically had a shallow soil with the bedrock near the surface and were also overgrazed. In contrast, high species number was associated with well-structured deep soil in meadows that the private owners mow for hay. Bray Curtis similarity of the species composition also isolated plot 5 from the rest of the plots.

Evidence from Shannon evenness, Shannon-Weaver diversity and Simpson dominance indexes indicate that in the areas with low species diversity, there is a dominance of one or two species with individuals unequally distributed within and between plots. Simple correlations of these indices show that in those vegetation communities studied, species abundance and equitability play an important role in Shannon-Weaver diversity variation ( $R=0.723$ ,  $p<0.01$ ).

Most of the species recorded are xerophytic, hemicryptophyte and perennial. The species number recorded in 12 studied plots varied in relation to the season when the inventory was performed, the degree of the anthropic impact, natural substrate, slope and aspect (exposition). Those species with the overall highest coverage percentage were *Agrostis capillaris*, *Nardus stricta*, *Rumex acetosella* and *Trifolium pratense*, i.e. very similar to that of apparently unaffected grasslands elsewhere on the Trascău Mountain. However, the precise local coverage of these species varied greatly with respect to the anthropic impact in the area (overgrazing and pollution) and these species were not uniformly distributed in all investigated plots but achieved dominance in a few plots.

The grasslands of the Paul catchment can be included within the category of sub-steppic calciphilous grasslands, recorded from the Trascău Mountain. The processes of soil formation influence the dynamic of vegetation cover. Once the soil substratum has accumulated, grasslands with a good vegetation cover replace the grassland types characteristic of shallower soil areas (Gergely, 1970). The phytocoenoses are dominated by species with xerophytic characters but including numerous mesophytic species, resulting in a heterogeneous species composition.

There is great heterogeneity of micro-habitats within plots with, for example, abrupt transition from xerophilous vegetation to hygrophilous vegetation as a result of changes in the substrate (calcareous, acidic, argillous, etc) or gradient and aspect (exposition) within a small area.

The grassland types are present in patches, those used for hay production are scattered among grasslands where overgrazing has led to destruction of the vegetation cover resulting in landslides in areas with more or less steep slopes.

Despite the Zlatna plant ceasing to function in 2003, the heavy metal concentration in the soil remains high and, together with natural and other anthropic factors, determine a very varied species diversity and coverage in the grasslands from Paul catchment.

Acknowledgement: Project financed by UEFISCDI in the framework of Contract 50/2012 “Accounting for the service providing units of plants in the environmental assessment of plans and projects with biogeochemical impact at multiple scales in Rivers basins”(ASPABIR)

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## What drives plant invasion in mountains in a changing world - climate, disturbance, or both? A case study in the Ukrainian Carpathian Mountains

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The climatic niche, disturbances, and propagule pressure are key factors for plant invasion dynamics in mountainous areas but their relative roles are rarely discerned. When human activities at higher altitudes increase, knowledge on the relative impact of human pressures vs. climate on the distribution of invaders is crucial for management. In this study, the relative importance of different categories of predictors was determined for the distribution of 11 alien invasive plant species in a mountain range. The study region encompasses the entire range of the UA Carpathians.

Utilizing the Alien Plant Ranking System (APRS Implementation Team 2000) and taking into account reports by regional experts (Botta-Dukát and Balogh 2008), we determined the 11 potentially most harmful (to regional biodiversity) alien invasive plant species to be: *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. Information on the biology and ecology of the species in the UA Carpathians can be found in Simpson and Prots (2012).

The binomial generalized regression models were fitted on 5 predictors approximating climatic extremes, disturbances, topography, and spatial proximity to established populations - with occurrence as the binary response variable. The relative importance of each predictor and the strength and direction of parameter effects were determined using information theory approaches. Distribution maps with hotspots of invasion were then created by weighting species presences by the relative importance of disturbance variables.

The importance of predictors varied markedly among species. While model fitting for a majority of species gave strong relative importance to climatic extremes, disturbances, in particular distance to roads and settlements, and an autocovariate depicting spatial aggregation of locations due to biological processes and propagule pressure, received highest weights across species and showed the strongest parameter effects. Ranking of the invaders revealed that species responding most strongly to disturbances and least to climate can be found in great numbers at higher altitudes.

The results of this study clearly demonstrate that, although climatic patterns are pivotal for invasion dynamics in a mountainous region, disturbances are consistently (across species) the best descriptors of species distributions. All mixed-effect models demonstrated that the climatic niche is a significant limiting factor for the distribution of most of the 11 study species. Also these species strongly respond to propagule pressure and anthropogenic disturbances along linear habitats and individual species may be limited by disturbance patterns more than by climate, as the low Akaike weights (> 0.3) for climatic predictors as opposed to disturbances indicate in *A. negundo*, *H. sosnowskyi*, *I. glandulifera*, and *Reynoutria* spp.. The predictor distance to settlement and roads has Akaike weights of close to 1 for all species, regardless of the importance of climate. This indicates that compared to the 3 other predictors used in this study, anthropogenic disturbances are the single most important factor explaining invasion dynamics. *Heracleum sosnowskyi* for example, is adapted to cold climates and depends strongly on water and human vectors (e.g., vehicles) for propagule dispersal. This is well reflected in the weights given to distance to humans and water as opposed to climate factors in the models. Thus, a very important conclusion is that species differ



greatly in respect to their relative susceptibility to climate vs. dependence on anthropogenic (roads and settlements) and/or natural disturbances (water). Some species are strongly limited by climate, disturbances, and topography alike (e.g., *Echinocystis lobata*) and others appear to have extremely wide climatic niches and are primarily limited by disturbances (e.g., *Heracleum sosnowskyi*).

The ranking of species based on their response to disturbances and subsequent delimitation of invasion hotspots with the UA Carpathians indicate that hotspots (in terms of number of invaders that are strongly limited primarily by disturbances) are found in densely populated area where all species occur. While it is logical that a higher number of species can be found in areas of higher propagule pressure and probably repeated introduction events, it is worrisome to see that a few hotspots are located in the interior of the mountain range, close to or within protected areas. Species less limited by climate and highly responsive to disturbances have been able to expand their range further into the mountains than other invaders. Meanwhile, the sources of disturbances along linear habitats, i.e., natural flooding that may increase in the future and be exacerbated by invasion and human traffic that may intensify with touristic development, will increase in the future. Our results strongly suggest that managers in the UA Carpathians, plagued by scarcity of resources devoted to conservation management, must prioritize strategies and target the elimination of populations of invaders within the hotspots delimited in this study.

## Effect of the restoration of mountain gravel-bed river on ground beetle communities on exposed riverine sediments

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During the 20th century rivers draining the Polish Carpathians were considerably degraded due to human disturbances. Widespread channelization works and in-channel gravel mining have resulted in rapid channel narrowing and incision, simplifying habitats and decreasing biodiversity of the riverine and riparian ecosystems. The Raba is a Polish Carpathian river with highly degraded hydromorphological conditions. An erodible corridor has recently been established on the river to improve habitat conditions for riverine and riparian biota.

The impact of restoration measures on river biological diversity is still poorly known. Jähnig et al. 2009 showed that re-establishment of multiple channel pattern has had a varied short-term effect on different biotic elements, from a strong effect exerted on vascular aquatic plants through a less pronounced increase in the diversity of ground beetles to no change in the diversity of benthic invertebrates. To determine the influence of restoration-induced changes in channel morphology of the Raba River on the richness and composition of ground beetles inhabiting exposed riverine sediments, the invertebrates were surveyed in 12 channelized and unmanaged channel cross-sections. At each cross-section, ground beetles were collected by motor-driven suction apparatus

at 12 sample points varying in distance to the river and elevation above low-flow water table.

Non-metric multidimensional scaling indicated no significant differences in similarity patterns between ground beetle assemblages from channelized and unmanaged cross-sections. However, when the width of the active river channel was taken into consideration, two groups of the assemblages collected in wide, unmanaged cross-sections and in narrow (either channelized or unmanaged) cross-sections were clearly differentiated by ANOSIM analysis. Average similarities among the assemblages collected in wider cross-sections were lower than among those collected in narrow cross-sections ( $F=107.2$ ,  $p < 0.00001$ ), showing greater spatial variation in species composition among the sites in more natural channels. The abundance and species richness of the assemblages from narrow river cross-sections were significantly lower in comparison with those from wide cross-sections. Analysis of the variation in composition of ground beetles among 144 sample sites indicated significant differences between assemblages collected at different distances from low-flow channel and in the cross-sections of different active channel width. The highest mean density and species richness of ground beetles were recorded at the sites located close to low-flow channels in the widest river cross-sections.

The positive impact of the river restoration was also visible at the population level. The average density of gravel bar specialists was markedly greater in the wide, multi-thread river cross-sections. Nestedness analysis indicated that the investigated ground beetle assemblages were significantly nested and their rank in the analysis correlated with active channel width ( $R = -0.76$ ,  $p < 0.001$ ) and the number of low-flow channels in a cross-section ( $R = -0.64$ ,  $p < 0.001$ ). Such ordered structure of the assemblages indicates that species-poor assemblages from narrow cross-sections were the subsets of species-rich assemblages occurring in the wide cross-sections. Notably, rare species mainly occurred in the rich communities of the wide cross-sections.

Results of this study indicate that it is mostly the size and morphology of suitable habitat (gravel bars) and not solely its presence that decides about the success of the restoration of ground beetle communities in mountain rivers. Re-establishment of multi-thread channel itself has no or only a marginal effect on the composition and diversity of ground beetles. Much more significant is the widening of the active channel, which determines the heterogeneity of microhabitats and the availability of flow refugia. The presence of ground beetle population in single-thread channel sections is a result of recent migrations from the unconstrained river sections. Narrow, channelized river sections are characterized by a rapid increase in flow velocity with increasing discharge, which may be a limiting factor for the terrestrial invertebrates. In wider, unmanaged channel sections, the increase in flow velocity with increasing discharge is slower and the availability of exposed refugia associated with multi-thread river morphology enables the ground beetles to escape to the upper parts of gravel bars during floods.

This study has been prepared within the scope of the restoration project KIK/37 '*The Upper Raba River Spawning Grounds*' supported by a grant from Switzerland through the Swiss Contribution to the Enlarged European Union.

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## POSTER PRESENTATIONS

## Climate change – The Rise of the Pathogens

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Climate change has brought with it a new era for plant pathogens, with varying degrees of virulence.

The aspen spot fungus (*Asteroma frondicola*) is a leaf pathogen which attacks *Populus* sp. and has been observed throughout Europe and Northern Asia. Rarely seen in Norway before 2000, it has since spread rapidly following the natural dispersal of *P. tremula*. It can now be found following the coastline up to Rogaland county (unpublished data). *A. frondicola* is not considered to be an important pathogen, but there is a concern that this rapid advancement may be followed by other, more virulent pathogens (Solheim & Bjoner, 2013).

*Phytophthora* spp. is a genus of pathogenic oomycetes which can attack all types of plants, the most infamous species being *P. infestans* which causes dry rot in potato (Sinclair & Lyon 2005). There is an increasing number of species that attack and kill healthy trees, due to two main factors: an efficient worldwide dispersal and a large degree of hybridisation between species, creating ever more virulent species. They spread via soil water and plant remains (both compost and via international trade) and are becoming an increasing problem worldwide. Many *Phytophthora* sp. are thought to be saprophytes in indigenous plants in the Far East, and that they become pathogenic when they are moved to different climates and host plants.

Climate change is increasing the spread in several ways: increased amounts of precipitation lead to more soil water and a faster spread of the fungi's motile oospores. A warmer climate is doubly beneficial to *Phytophthora* spp.: the fungi prefer warmer temperatures and a warmer climate would encourage more use of oriental, ornamental plants where *Phytophthora* may be undetected.

*P. ramorum* kills oaks in Europe. In Norway, it was introduced with German *Rhododendron* plants and has spread to *Larix* sp. and *Vaccinium myrtillus*. *Fagus sylvatica* is dying from *P. plurivora* and *P. cambivora*. *Phytophthora* spp. are being found whenever new areas are tested.

The first records of *Phytophthora* in Ukraine are from 2011, when *Phytophthora gonapodyides* and *P. lacustris* were found in the rivers Stryj and Yasenytsya and a lake in Skolivs'ki Beskydy National Park (Matsiakh et al. 2012).

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## The „forest“ dragonfly species of *Cordulegaster* genus in the Slovak part of the Carpathians

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In the Palaearctic zoogeographical region the *Cordulegaster* genus can be divided into two taxonomic groups' *boltoni* and *bidentata* (Boudot, 2001). There can be found *C. heros* subsp. *heros* Theischinger, 1979 from the *boltoni* group and *C. bidentata* subsp. *bidentata* Sélys, 1843 in Slovakia. Both species belong to the biggest European dragonflies. From the ecological point of view there are characterised as „forest“ species. The natural habitats of *C. heros* are the meandering forest brooks which are from 0,5 to 2 m wide. Moreover a significant feature of the optimal habitat is a sandy bottom. They scarcely move away from the stream. The typical habitats for *C. bidentata* are forest spring areas and streamlets (from hypocrenal to epirithral). Imagoes of *C. bidentata* move away far from the brooks. We can see it on the edge of the forest and on forest roads (Janský, David, 2008). At present *C. heros* occurs in 81 localities in Slovak Carpathians and *C. bidentata* occurs in 58 localities. They differ from each other by hypsometric characteristic. Thus we can say that *C. bidentata* prefers occurring in average altitude 607,9 m (from 182 to 1530 above sea level, SD units = 200 m, N = 76). *C. heros* occurs in altitude 309,3 m (from 160 to 516 m above sea level, SD = 79 m, N = 81). We know more localities of *C. heros* as it is listed in the Annexes II and IV of the European Habitats Directive. Both *C. heros* and *C. bidentata* are listed in a prepared Red List of dragonflies in Slovakia (category Least Concern).

Acknowledgement: The research was supported by the Slovak national grant foundation VEGA, No. 2/0184/11.

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## European beaver in Bieszczady National Park

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The presence of European beaver *Castor fiber* (L.) in Bieszczady National Park is the result of the reintroduction that began in 1993. The aims of the reintroduction were to restore the historical range of occurrence of this species, and to support re-naturalization activities by increasing water retention and biodiversity thanks to creating new niches for other species. Reintroduction was continued until 2006. Realised beavers came from Suwalszczyzna. During 20 years, beavers built up a stable population in the Park. Currently (2012) they occupy 30 sites: 25 in the upper valley of San River and 5 in other part of the Park. The population number is estimated at c.a. 155 individuals. Beavers activity stimulated positive changes in ecosystems of the Park – enhanced hydrologic and geomorphologic conditions, as well as increased the level of biodiversity, especially due to increased number of hydrophytic plants and animals related with riparian habitats. Reintroduction of the beavers in the Park fulfilled its aims. They successfully acclimatised to severe mountain conditions establishing a stable population, and significantly contributed to re-naturalisation of formerly degraded ecosystems of the Park.

## Spider fauna analysis of Ukrainian Carpathians

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Summary knowledge of the araneofauna of Ukrainian Carpathians has not yet been made. The Carpathians in Ukraine interfere in its western part and extend on 3.66 % of the country area (22 101.75 km<sup>2</sup>). They are divided on the basis of the Carpathian Biodiversity Information System (CBIS) to 69 orographic units (ORO) and represent around 11 % of the whole Carpathians territory. Spider research has a long tradition in the Ukrainian Carpathians. This fact is reflected in the large amount of published articles from the 18th and 19th centuries by Wajgiel, Koch, Nowicki, Chyzer, Kulczyński, Pilawski, etc. After the First World War several Czech, Hungarian and Romanian arachnologists, such as Baum, Kratochvil, Balogh, Loksa, Kolosvary, Rosca, studied the spider fauna of Ukrainian Carpathians. In the second half of the last century, spider research was done mainly by Legotay. Problem is that precise localization of her research areas in her publications is often missing and it is often not possible to identify if records are from the Carpathians or from the Praecarpathians, Transcarpathian Lowland. More systematic research of the arachnofauna of Ukrainian Carpathians started in period of last decade with the appearance of Ukrainian arachnologists. For spider fauna



analysis we used all available data from the literature (43 articles), data from the spider collections and also the data from the database of the author (excerpt data and localization of studied sites indicating the coordinates and then overlapping layer of localities and layer of ORO units was done). The result is a database of 386 species from 36 ORO units and from more than 100 localities. If we took the data from the Legotay thesis "Spiders of the Ukrainian Carpathians" total number of spider species rises to 494 (there are data from the Carpathians, Praecarpathians and Transcarpathian Lowland). Knowledge of the fauna of spiders is uneven. Some areas are better investigated as namely highly Polonyny Chornohory, Vnutrishni Gorgany, ai., another ones have only poor data or are absolutely unknown. No research has been done in 21 ORO units. On the basis of present knowledge we have analysed the distribution of individual species and prepared a first version of the National Carpathian Red List for spiders according to IUCN criteria for regional red lists. This List includes 82 spider species and it is presented by authors. Of the identified species several very rare species are red listed in categories Endangered (EN) or Vulnerable (VU) as *Dolomedes plantarius*, *Hylyphantes graminicola*, *Taranucnus bihari*, ai. Also the rare Carpathian endemic spiders were listed, namely *Lessertinella carpatica*, *Carpathonesticus galotshkai*, *Coelotes pastor carpathensis* and *Palliduphantes milleri*. The presented Check and Red lists are suitable for widespread use in ecology and nature protection.

Work was done in framework of the project BIOREGIO Carpathians and in the framework of VEGA project 2\_0117\_13.

## Are small mammals a vector of *Mycobacterium bovis* for European bison population in Bieszczady Mts?

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One of the greatest threats to European bison in the Bieszczady Mts. is the occurrence of bovine tuberculosis (bTB) – a disease caused by acid-fast bacilli of *Mycobacterium bovis*. In Bieszczady Mts. the bTB among European bison are noted since 1996 and despite the activities taken to eliminate the disease, there are still reported new cases of infection.

In this context it is important to find tuberculosis reservoirs in the environment. It is known that the source of infection for the European bison may be wild animals such as wolves, badgers and deer, as well as domestic cattle. So far, small mammals - rodents and shrew is the group of animals that were not investigated for the presence of *M. bovis*. Small mammals due to the common occurrence of both meadow and forest habitats and high abundance may be a potential reservoir of *M. bovis* in the environment.

In order to verify this hypothesis, in the fall 2011, the trapping of small mammals were conducted in areas where the infected herd of European bison resided or remains of individual dead due to tuberculosis were found (Forest District Stuposiany, Poland). Thirty-three individuals of three species *Myodes glareolus*, *Apodemus agrarius* and *Microtus agrestis* were caught. The material for microbiological analysis were lungs, livers, spleens and lymph nodes of small mammals.

The tissue samples were subjected to typical acid-fast bacilli isolation procedures –



homogenizing in a 5% oxalic acid, culturing on Lowenstein-Jensen, Stonebrink media. *Bacillus* was isolated from three individuals of *M. glareolus*. Analysis revealed the presence of *M. gordonae*. In the studying sample *M. bovis* was not found. We concluded that the small mammals probably are not a vector of *M. bovis* for European bison.

## Effect of forest management on the amount of dead wood and saproxylic diversity in the Hungarian Carpathians

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Large proportion of forest biodiversity is connected to dead wood. Forest management considerably decreased the amount and quality of this important structural component. While most of the studies concerning the effect of dead wood on forest biodiversity were focused on near natural reserves, its amount and importance in biodiversity is less studied in managed stands. This project investigated the amount and quality of dead wood and the biodiversity of fungi and bryophytes connected to it in Mátra Hills, Hungarian Carpathians. Near natural forest reserves were compared to managed stands structured according to forest types (turkey oak – sessile oak forests, sessile oak – hornbeam forests, beech forests) and stand age (20-50, 50-80, more than 80 years).

Approximately 100 forest stands were studied, living volume were estimated by relascope sampling, standing dead wood was inventoried in 1000 m<sup>2</sup> sized plots, while lying dead wood by line intercept method. Bryophytes, corticoid and poroid fungi occurring on dead wood were surveyed in 1000 m<sup>2</sup> sized plots.

The average amount of dead wood was 27.6 m<sup>3</sup>/ha, which was 7.4% of the living volume. The average amount in the reserves was considerably higher (82.4 m<sup>3</sup>/ha) than in the managed stands (22 m<sup>3</sup>/ha). The proportion of standing dead wood was higher (40.1%) in managed stands than in the reserves (22.4%). In the third age class the amount was higher (38.5 m<sup>3</sup>/ha) than in the first two classes (20 m<sup>3</sup>/ha). According to forest types in beech forest the amount was 31.2 m<sup>3</sup>/ha, in turkey oak – sessile oak forests 26.9 m<sup>3</sup>/ha and in oak – hornbeam forests 23.6 m<sup>3</sup>/ha.

Species richness of bryophytes considerably depended on the amount of dead wood, but true epixylic species were missing from managed stands, dead wood was colonized mainly by epiphytic and opportunistic species. The species richness of fungi was much higher than that of bryophytes, their biodiversity depended considerably on the amount of fine woody debris in managed forests.

Although the amount of dead wood is reduced in managed forests still it plays a key role in their biodiversity. Because the near natural forests can maintain the source populations in the region, the increment of dead wood in managed stands could considerably increase the biodiversity of bryophytes and fungi.

The study was supported by Swiss Contribution Programme (SH/4/8).

## Preliminary survey of polypores in Mátra Mts (Hungarian Carpathians)

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Polypores are a very significant morphological group of wood decay macrofungi that plays an important role in the nutrient cycle of forest ecosystem. Most of the species are saprotrophic, thus they depend on the amount and quality of dead wood, which is often lacking in managed forests. Considering that several polypores are sensitive to their substrate, this group is good indicator of the virgin forests. In this study we surveyed the polypore species of the Mátra Mts (Hungarian Carpathians). Although sporadic data of the polypores of this area were known, a systematic study has been not conducted before. Poroid fungi occurring on dead wood were surveyed in 117 (108 managed forest, 9 forest reserve) 1000 m<sup>2</sup> sized plots, in different forest types (turkey oak – sessile oak forests, sessile oak – hornbeam forests, beech forests) and stand age (20-50, 50-80, more than 80 years).

Until now, approximately 60 polypore species were found in the examined plots. The most common species are *Bjerkandera adusta*, *Fomes fomentarius*, *Junghuhnia nitida*, *Phellinus ferruginosus*, *Polyporus varius*, *Schizopora paradoxa* agg. and *Trametes versicolor*. Besides the above mentioned, we collected some uncommon species in few plots: *Antrodia malicola*, *Antrodiella fragrans*, *Dichomitus campestris*, *Ischnoderma resinosum*, *Postia alni* etc. Furthermore some specimen belonging to the genus *Ceriporia*, *Junghuhnia* and *Skeletocutis* have been found, which seems to be new species for Hungary.

The study was supported by the Swiss Contribution Programme (SH/4/8).

## Species diversity and life-traits distribution of ground beetles along incised Polish Carpathian rivers: implications for conservation

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Ground beetles are a group of terrestrial invertebrates characteristic of riparian ecosystems. Their diversity and distribution in riparian areas may be considerably affected by river incision

caused by human disturbances. The impact of river incision induced by channelization and gravel mining on the structure of ground beetle assemblages in riparian habitats was thus investigated on three rivers flowing in the foreland of the Tatra Mountains in southern Poland. Ground beetles were collected on three benches of different elevation in 11 incised and 14 vertically stable cross-sections of the rivers. In total, 5821 individuals representing 106 species were collected. The effect of river incision on the diversity and abundance of ground beetles depended on bench height. Only on the lowest bench, inundated about once per year on average, species richness of the assemblages was significantly reduced in incised river cross-sections. On this bench, the abundance of the specialists of exposed riverine sediments, i.e. small and medium-sized predators with high dispersal power and spring breeding strategy, was highly negatively affected by river incision. On the highest bench, large, brachypterous species with spring and autumn breeding strategy, typical of undisturbed habitats, were more abundant in incised cross-sections. As this bench is practically not subjected to flooding even in vertically stable cross-sections, these species probably benefited from the occurrence of riparian forest along most incised river sections, whereas the riparian areas along vertically stable sections are subjected to higher agricultural pressure. This study shows that in the mountain region where high precipitation helps to maintain moisture of the riparian habitats, river incision has a negative impact only on the specialists of exposed riverine sediments.

## Geo-distributed analysis of forest phytomass Polish Carpathians

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Research of forest ecosystems as major carbon sinks is important due to the presence of the greenhouse effect and climate change. Polish Carpathian Mountains cover about 7% of the country and cover the northern and western part of megaslope of Eastern Carpathians. Forest cover in Poland as of 2012 is about 9164 thousand hectares, which corresponds to 29.3% of forest cover [1].

Purpose of research/paper/study is to develop tools for geo distributed analysis and assessment of forest carbon deposited based, on the statistical data on stocks of vegetation, species composition, distribution by age and classes using other forest inventory indicators that are the official sources.

For determination phytomass and forest carbon deposited it uses the IPCC methodology developed by the Intergovernmental Panel on Climate Change [2]. With the use of advanced information technologies, we analyzed forest cover Silesia, Lesser Poland and Subcarpathian voivodship area which is partially occupied by the Polish Carpathians.

Based on digital maps forests of Poland Corine Land Cover and statistics for future stem wood in the forests of the Polish Carpathians, including species composition (pine, spruce, fir, other conifers, beech, oak, hornbeam, birch, alder, poplar, aspen and other deciduous), age group, we formed geo distributed database and calculated the territorial distribution of the total phytomass forests. An algorithm for determining aboveground and underground phytomass as a single tree for known reserves and forests in general, different composition, age and site conditions. An algorithm for determining aboveground and underground phytomass as a single tree for known reserves and forests in general, different composition, age and forest conditions.

structure, composition of the stand, stock, phytomass, growth, deposited carbon, etc.. Included respective reservoirs issue: wood destroyed by fire, dead, injured and confiscated wood.

Keywords: forest phytomass, geo distributed analysis, deposited carbon absorption, emission.

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## Post-windstorm processes in bird assemblages and habitats: a case of the Tichá valley (Tatra Mts, Slovakia)

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With the theories of non-equilibrium thermodynamics (Jørgensen, Svirezhev, 2004), ecological complexity (Holling, 2001), ecological succession, disturbance and patch dynamics (Pickett, White, 1985) in mind, I studied breeding bird assemblages in post-windstorm patchy environments at the bottom of the Tichá valley (Tatra Mts) using belt and point transects.

Bi- and multivariate analyses of bird species composition, structure, habitat relationships and their changes in the years 2006–2013 (i.e. 2–9 years after the windstorm of 2004) show no significant departures from the general pattern observed along the valley gradients (Topercer, 2000). No significant annual differences in species richness or relative abundances were found either in the lower (more intensely disturbed) or middle part of the valley. However, fluctuations in species richness and turnover in the lower part have dampened since 2010, implying relatively short reorganization phase  $\alpha$  (6 years) and thus also strong local ecosystem resilience. A seemingly counterintuitive trend of decreasing species richness indicates that besides the non-equilibrium thermodynamics, changes in habitat heterogeneity and grain size are also involved via the propagating *Sorbus aucuparia* stands that homogenize habitats and link the phase  $\alpha$  to exploitation phase  $r$ . In the middle part the pattern is similar, but reorganization rates seem slower with a phase shift along the thalweg gradient.

Mean relative abundances exhibit an initial rapid increase (chiefly in the lower part of valley) that responds to the release of large resource stocks by the windstorm. Bird abundances have stabilized 5–6 years later at the levels corresponding to the density of 400–680 breeding pairs.km<sup>-2</sup> and richness of 29–37 species. This adds support to both the above estimate of reorganization phase length and the notion of strong local ecosystem resilience. Moreover, it documents favourable status of local bird assemblages and substantial carrying capacity of unmanaged windthrow for birds. Therefore no-intervention management provides a viable alternative to conventional pre-emptive and salvage logging in the Tatra National Park.

Acknowledgement. The research is supported by the grant VEGA No. 1/0705/11 to I. Krno.

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## Changes in grassland vegetation in Polish Carpathians as an effect of abandonment

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Semi-natural mountain meadows in Europe are among the most species rich phytocoenoses. Their origin and continued existence is closely associated with the traditional, extensive use. Socio-economic changes taking place in Central and East Europe during the last decades caused a decrease in the profitability of animal husbandry and, consequently, the abandonment of meadows and pastures.

The aim of the study was to compare the species composition of managed and unmanaged grasslands in the Polish Carpathians. Altogether 1476 phytosociological relevés were used (1102 for managed and 361 for unmanaged grasslands) made after the year 2000 and collected in a database (Zarzycki and Korzeniak 2012). Comparison between managed and unmanaged communities were made within three main groups of communities: false oat-grass meadows, bent-grass meadows and mat-grass swards. The strength of species association to managed and unmanaged group was shown by the Phi coefficient, what is the positive fidelity value between a particular vegetation unit and a species (Tichy 2002).

The false oat-grass meadows are the most common in the submountain and low mountain situations on fertile soils, often on former arable land. Species associated with the managed grasslands are: *Trifolium repens*, *Prunella vulgaris*, *Cerastium holosteoides* and with unmanaged: *Holcus lanatus*, *Arrhenatherum elatius*, *Cirsium arvense*.

The bent-grass meadows are widespread mainly in the 400-900 m asl altitudinal zone. They are usually species rich, often with protected and rare plant species. With managed grasslands are connected typical meadow species: *Trifolium pratense*, *Dactylis glomerata* and *Trifolium repens*. With the lack of use the species typical for mat-grass swards, like: *Vaccinium myrtillus*, *Nardus stricta*, *Carex pilulifera* are mainly associated.

The mat-grass swards survived in the Polish Carpathians exceptionally (only 78 phytosociological relevés was done). Their occurrence depend on poor, acid soil and pastoral use. Grazed areas are associated with the species like: *Festuca ovina*, *Agrostis capillaris*, *Anthoxanthum odoratum*. The lack of use indicate *Solidago virgaurea*, *Gentiana asclepidea*, *Deschampsia caespitosa*.

The influence of abandonment on species composition is significant, however it depends on plant community and habitat conditions.

Acknowledgements: The work was supported by the Polish Ministry of Science and Higher Education (research project N N305 283137)

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### ORAL PRESENTATIONS

#### **Beech Primeval forests of the Gorgany Nature Reserve – potential site of the UNESCO World Natural Heritage Site**

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Gorgany Nature Reserve represents a natural model of a site without human intervention in the central part of the Ukrainian Carpathians. It is 5344.2 ha in area, including 3,073.2 ha of natural forests. Reserve contains the only in Europe and in the world primeval forest site of a relict species belonging to the early Holocene period – Swiss pine.

With a continuous massif it covers three climate zones, relict and endemic vegetation, habitats and animal populations. The reserve contains a vertically and horizontally homogenous belt of the five primeval forests subformations and demonstrates stages of pristine vegetation development starting from the early Holocene.

Old-growth and virgin forests were preserved in this area on a total surface of 2112.2 ha. In the period 1996-2012, 48 permanent sample plots were established in the reserve with total area of 27.4 hectares. The sample size of the plot was 0.5-1 ha.

Beech - spruce - fir forests are distributed within 990 and 1250 m a.s.l., spruce-Swiss pine and fir - spruce forests between 965 and 1580 m a.s.l.

The highest productivity is observed in the beech-fir-spruce forests. For the beech-fir-spruce, fir-beech and spruce-beech-fir primeval forests an age phase lasts for 350-400 years (with a maximal standing volume of 930 m<sup>3</sup>/ha), and for Swiss pine-spruce forests – approx. 300 years (414 m<sup>3</sup>/ha). The age of the trees were assessed by the cores. The virgin forests – except the spruce and spruce-Swiss pine ones, have a three layer structure and they are characterized by a complex spatial structure (M Chernyavskyy, M. Shpilchak, O. Slobodian., 2013).

Therefore, majestic primeval forests of the Gorgany Nature Reserve (2112.2 ha ) together with the reserve's unique vegetation complex represent a potential UNESCO World Natural Heritage site. This is a serial cluster nomination, which represents the biggest part of the globally unique remaining primeval forest sites with beech subformations together with beech-fir, beech-spruce-fir, Swiss pine-spruce and spruce-Swiss pine montane primeval forests (M.V. Chernyavskyy., M.B. Shpylchak., 2011). Naturally they are completed by a complex of evolutionary replaced stony debris areas through stages of lichens, mosses, vascular plants up to green alder and mountain pine dwarfish communities and relict coenosis of pine-birch with *Betula obscura*, pine and Swiss pine-spruce.

Processes of land ecosystem formation are vivid and extremely impressive and have started right after the last Glacial Age and continue nowadays. The processes of species formation and evolution, especially the ones for endemics and relict species are important for

investigations of regeneration mechanisms and conservation of similar ecosystems across the world.

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## Indicators of the climate change impacts on Norway spruce forests in the Czech Republic

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Quantification of ecosystem function reduction connected with forest damage caused by global environmental changes (a synergistic effect of climate and pollution factors) will result in evaluating the loss of forest ecosystem services (provisioning, supporting, regulating, socio-cultural) sensu Millenium Ecosystem Assessment Project. According to scenarios of climate change the vertical shift in site conditions can be supposed. Changed site conditions could act as a predisposition stressor for individual tree species as well as whole forest stands to activate additional, especially biological stressors. Their impacts on Norway spruce forests seem to be particularly significant.

For environmental risk estimation of Norway spruce ecosystems under climate change, the space means of the basic climatic characteristics (above all mean daily diameter, daily precipitation sum) and three climatic extremes (number of days with daily precipitation sum < 1 mm in the periods longer than 10 days, number of days with maximum temperature > 30°C, number of temperature breaks in early spring) for each „forest vegetation degree“ in the frame of all so called „natural forest areas“, were computed. In addition, the information about the movement of water between the soil and the atmosphere were taking into account. These indicators can be considered as possible limiting factors from which we can derive the expected change in the geographic distribution of conditions suitable for Norway spruce growth.

Aggregate typological units („forest type sets“ and „management types“), in combination with „forest stand types“, were used for environmental risk estimation at „natural forest area“ and whole Czech Republic levels. Endangered forest stands, occurred in given „forest type set“, „forest vegetation degree“ and „natural forest area“ were estimated using comparison of basic and derived climatic parameters between 5 time period (1961–2099). Measured data from climatic stations were used for the period A (1961–1990) and B (1991–2009); for periods C (2010–2039), D (2040–2069) and E (2070–2099) the data were modeled by climatic model ALADIN-Climate/CZ. In addition, the more detailed analysis of the Beskydy Mts. was performed.

The results of forest vegetation degree analysis for the whole area of the Czech Republic

documented that in the time period C (2010–2039) there should be no distinct vertical shift. On the contrary, the shift of two forest vegetation degrees may be expected in periods D – E.

According to the stress climatic factors it is possible to differentiate so called “warm” natural forest areas, where climatic conditions of their forest vegetation degrees do not meet the criteria of Norway spruce ecological valence and “cold” natural forest areas, where climatic conditions are still convenient for spruce growth (mostly mountain areas since 700 m a.s.l.). Generally, it is possible to presume that in the periods D and E (2040–2099) the climatic conditions will not be suitable for Norway spruce growth in upland country of the Czech Republic.

In the Beskydy Mts. it is possible to expect the expansion of the Norway spruce forest stands in the 3rd forest vegetation degree by 17 % and in the 4th forest vegetation degree by 58%. The representation of the 5th and 6th forest vegetation degrees will decrease significantly by 74 % till 2099. These changes in climatic conditions could lead to outbreaks of the biological pests, especially *Armillaria mellea* and *Ips typographus* and extensive forest decline as we can see at present in the territory of the Slezské Beskydy Mts.

(Acknowledgement. This research was supported by the projects of the Ministry of Education, Youth and Sports of the Czech Republic CzechGlobe (CZ.1.05/1.1.00/02.0073).

## Deconstructing the “cathedral old-growth”: structural variability in Carpathian primary spruce-fir systems

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### INTRODUCTION

Much of the early research on temperate old-growth forests both globally and in Europe focused on establishing reliable definitions, structural indicators, and developmental classification systems. The science later transitioned to work on natural disturbance dynamics and functional processes associated with primary and late-successional forest ecosystems. However, in Europe opportunities for this type of research have remained scarce, due to the highly fragmented nature of remaining old-growth, which is often found in patches less than the minimum dynamic area required for observations of spatial patterning related to disturbance dynamics.

Conservationists and scientists are left with two distinctly different conceptions of late-successional forests. Many continue to emphasize an idealized notion of old-growth, imposing strict structural definitions and rigid classification, sometimes requiring complete absence of any human disturbance. A competing view stresses the inherent variability within late-successional systems, often attributed to the interaction of natural disturbances and multiple pathways of stand development. In this paper we explore this interesting divergence of perspectives on late-successional forest structure and dynamics, referencing two datasets from the eastern Carpathians in Ukraine.

### METHODS

To examine forest structure and variability in old-growth Carpathian spruce-fir forests, we collected inventory data at two locations in western Ukraine, the Gorgany Nature Protection reserve

and the Verkhovynskyy National Nature Park. At Gorgany we inventoried three stands (two old-growth and one mature); at Verkkovyniski we sampled three early old-growth stands believed to have established through natural regeneration. At both locations, we inventoried forest structure and composition using an intensive sample of randomly placed, variable radius prism plots, linked by line intercept transects for estimating downed coarse woody debris volume. Dominant canopy trees were cored at breast height, with total age determined using correction factors after examination under a dissecting microscope in the laboratory. One or two trees were cored at each plot, yielding a sample of 6-15 trees per stand. Field data were input into the Northeast Ecosystem Management Decision Model to generate an array of stand structure and composition metrics, including variables determined by previous studies to be indicative of stand structural complexity. The variable set included estimates of aboveground tree biomass generated from diameter-based allometric equations.

## RESULTS

Live aboveground biomass was significantly ( $\alpha = 0.05$ ) greater in old-growth stands (279.14 mg/ha) at Gorgany as compared to the mature reference stand there (181.25 mg/ha) and published values for mature stands. Similarly mean live aboveground biomass was relatively high at the higher elevation Verkhovynskyy stands (191.08 mg/ha), yet significantly lower than the mean for old-growth at Gorgany and not significantly different from the mature reference site. While these comparisons suggest the potential for distinct differences related to stand age, the contrast between old-growth biomass at difference sites also indicates other important sources of variability, such as elevation, site productivity, and disturbance history.

While old-growth sites did have higher biomass on average, this was not always the case. There was overlap between the high end of the mature age class and the low end of the old-growth age class. At Gorgany mean live aboveground biomass ranged from 255.49 to 302.98 mg/ha, while at Verkkovyniski this ranged from 175.86 to 202.79 mg/ha. More striking still was the pronounced variability in biomass both among and within old-growth sites; the standard deviations were significantly higher ( $P < 0.05$ ) for old-growth as compared to mature sites based on  $F$  tests. Aboveground biomass at plot (or patch scales) was highly variable within the Verkhovynskyy stands, ranging from as low as 113.58 to as high as 262.62 mg/ha within one stand alone. All the stands showed similar variability at patch (within stand) spatial scales, despite relatively low (estimated at  $< 10\%$  of stand area) frequencies of canopy gaps.

Spruce and fir at the Gorgany sites achieve maximum ages of approximately 350–400 years, although dominant tree ages show a marked range of variation below these maximums among plots at our sites; ranging as low as  $< 150$  years of age. The age of dominant spruce trees at Verkhovynskyy was both significantly lower and far more variable, ranging between plots (patches) from 44 to 190 years based on increment coring. The standard deviation of tree age was significantly higher ( $P < 0.001$ ) in our old-growth sites at Verkhovynskyy in comparison to those at Gorgany. Biological legacies, such as very large ( $> 80$  cm dbh) remnant old-growth trees, were observed at Gorgany but not at Verkhovynskyy.

## DISCUSSION

Spatially heterogeneous structure should be viewed as the defining characteristic of old-growth forests, recognizing the dynamics that drive system functioning and production of ecosystem services. The high degree of variability in aboveground biomass we found both within and among late-successional stands is reason to question an idealized notion of old-growth based on an archetypical condition. The variability in dominant tree ages we found is consistent with a contemporary view that the spatial structure of primary forests is shaped over time by the interaction of site differences and a range of disturbance types, intensities, and frequencies, including multiple pathways of development related to disturbance history and the type, density, and pattern of legacy structures.

Forest development classification in Europe often focuses on discrete, clearly discernible stages of development. These are sometimes applied at the patch scale, such that regenerating or

naturally disturbed patches are not classified as old-growth. In North America, by comparison, gap phase development, a range of patch structures and conditions, and spatial variability generally are seen as the dynamic that define primary forest landscapes. Consequently classification is applied at the larger scale encompassing patch mosaics. Once a primary or old-growth forest has diversified in structure horizontally, classification into discrete patches is viewed as largely arbitrary. Even gap delineation is now viewed as problematic in systems characterized by continuous variation in tree survivorship patterns.

Recognizing the potential for wide variability is important for understanding the diversity of functions and ecosystem services provided by late-successional forests. Scientists, managers, and conservationists must embrace the different types of values – habitat, carbon, hydrologic, aesthetic, etc. – provided by a full range of late-successional structural conditions across multiple spatial scales, acknowledging the fundamental role of natural disturbances in shaping these.

## Dieback of Norway spruce forests in the Ukrainian Carpathians – current state and future

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In the Ukrainian Carpathians Norway spruce stands occupy an area of approximately 600 thousand ha of the forests in different proportions. More than 38% of Norway spruce stands are located outside the natural range of spruce forests, replacing oak and fir-beech forests. Among them stands of medium canopy cover are dominant; 70% of the area is occupied by spruce stands with canopy cover between 0.6 and 0.8. Norway spruce stands with the highest canopy cover are found on 12% of the area. Also, the spruce forests are characterized by high productivity and 71% of the area is occupied by such stands with the highest yield classes.

In the last decade processes of spruce forests' dieback have been significantly invigorated in certain regions of the Ukrainian Carpathians. The largest area of spruce forests dieback is marked in the Lviv Region where more than 40% of the area is covered with these forests. The inventory of health conditions in the spruce forests had demonstrated a dramatic increase of dieback processes in the Lviv Region from 3400 ha in 1994 to almost 20 thousand ha in 2013. Intensive dieback was noticed in artificial spruce forests replacing oak and spruce-fir-beech forests at altitudes up to 800-850 m above sea level. The drying and dieback of spruce forests are the result of complex interactions between abiotic, biotic and anthropogenic factors. The cumulative effect of various factors is manifested in strengthening the influence of each of them. In general, Manion (1991) showed how the three groups of factors (predisposing, inciting, and contributing) which affect the spruce dieback could be distinguished. The natural conditions of the territory and the regional specific forest management in the spruce forests in the Ukrainian Carpathians allow for grouping these factors.

**Predisposing factors.** This group combines the biotic and anthropogenic factors that contribute to the deterioration of spruce forests conditions. The forest management actions carried out in the past are considered one of the main reasons for the deterioration of sanitary conditions of modern spruce forests. In the late XIX<sup>th</sup> and the early XX<sup>th</sup> centuries the spruce was planted in the natural range of fir-beech and oak forests. This was due to the demand for spruce wood that made



this tree species advantageous for cultivation. The derived spruce stands of the first and second generations in the rich soil conditions outside the natural range had shown high increments and offered the opportunity to produce forest stands with a standing volume of 800-1000 cu.m/ha at 80-100 years of age.

However, the further spruce cultivation in these conditions led to the sudden deterioration of spruce forests. Discussions about drying derived spruce forests have started in the middle of the XX<sup>th</sup> century (Gorshenin and Shevchenko, 1954). The phenomenon was especially noticeable in the last decade. In this respect, the determining factors are the temperature control and the high temperatures during the growing season negatively impacting the spruce which is a boreal tree species. The sudden temperature changes in winter as well as in spring and summer times weaken trees and make them prone to the action of biotic factors.

Equally important in the dynamic of this process is the soil moisture because the spruce drying is activated after dry years, especially in the absence of rain at the beginning of growing season (May-June). The effect of abiotic factors is amplified by the structure of forest stands and the soil conditions for their growth. The drying process is most active in old and pure spruce stands: in almost all derived spruce forests older than 100 years the intense dieback of trees was observed.

**Inciting factors.** This group includes factors that cause the deterioration of local spruce forests. Their effect begins with small plots and areas but can quickly spread to the surrounding areas causing dieback and drying on a larger scale. So, first spruce dieback was observed on the southern slopes of the mountains and then the processes covered the slopes of other aspects. The sudden deterioration of spruce forests is also connected with the deterioration of functioning mycorrhizae. The lack of soil moisture in a saturated root soil causes the death of mycorrhizae which dramatically worsens the mineral nutrition of trees.

**Contributing factors.** Based on deterioration of spruce stands the influence of negative factors of biological origin is activated. In the spruce monocultures the functional changes among the heterotrophic organisms, in particular soil nematodes, take place, which reduces the share of saprotrophy and predators and significantly increases the number of herbivorous parasite species that feed on fine roots. The damage of roots, in its turn, contributes to the spread of root rot pathogens.

In the drying spruce forests the development of root pathogens is activated by: *Armillariella mellea* s.l., *Heterobasidion parviporum*, less *Heterobasidion annosum*, *Phaeolus schweinitzii*, *Climacocystis borealis* and others. The research works in the spruce forests carried out in Lviv Region shows that the areas of root rot are constantly growing. In 1987-1989 200-450 ha of spruce stands were affected by root rot and from 1990 onward an annual increase in the area damaged by root rot is marked. In the last 3 years the areas affected by root rot exceed 22000 ha.

The spruce dieback is accelerated by the mass development of bark beetles and related species of xylophagous insects. During 1987-1992 centres of mass reproduction of European spruce bark beetle were not observed; since 1993 150-460 ha of spruce stands populated by this species have been revealed each year. The spruce deterioration seems to be the reason of further dramatic increase of amount of spruce bark beetle. After 2003 the annual affected area was 1.1-1.5 thousand ha and reached a maximum of 1883 hectares in 2009. Since 2010 the reduction of plantations inhabited annually by spruce bark beetle down to 1441 ha in 2013 has been observed. In drying spruce stands nematode damages (*Bursaphelenchus mucronatus*), which block stem vessels and worsen the water supply of the crowns were noticed (Kozlovsky and Kramarets, 2009); further on the spruce dieback may be accelerated.

Another important factor contributing to the drying of spruce forests is the current forest management activities including an insufficient level of rehabilitation works as well as reproduction of spruce young plants which would meet soil and climatic conditions of the territory.

In our opinion for improvement of health conditions of derived spruce forests could be possible by the introduction of forest management and technological measures which provide:



- the transition to the application of selective system of forest management;
- the performance of measures for the improvement of the health status of spruce stands (e.g., active fight against bark beetles, timely elimination of root rot foci);
- the measures for reconstruction of young spruce forest stands by using indigenous tree species;
- the establishment of forest plantations under the canopy of drying spruce forests with tree species which would meet soil and climatic conditions of the territory, using the natural successions for the forest restoration.

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## Artificial regeneration of forest at high mountain altitudes in the Beskidy Mts. Polish Carpathians”

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The Norway spruce dieback which occurred in the Western Carpathians caused introduction of alternative to classic way to regenerate the forest at upper mountain forest zone. The alternative was using the biogroup method that imitates the natural formation of trees biogroups in the forest.

The research was conducted in Wisła forest district and in Węgierska Górka forest district. In the first place was planted three species: stone pine, spruce and fir in the second place: stone pine, mountain pine and spruce. The experimental plots were set up in 2010 in 3 replications. There was two group seedlings with covered root system - with mycorrhizae and without mycorrhizae and was divided in four variant of fertilization (control, dolomite, magnesite, serpentinite) and in biogrupes (0,5x0,5m) and in traditional silviculture methods (1x1 m).

The research was carried out in 2010, 2011, 2012 and 2013 measured parameters such as survival, height of seedlings, growth, number of seedlings without damage. Furthermore collected samples soil and needle which analyzed in the Laboratory of Geochemistry of the Environment and Areas Intended for Reclamation in the Department of Forest Ecology.

The research have shown that type of fertilization, mycorrhizae and method of planting trees affect on survival and growth seedlings. Comparison both regenerate the forest methods proved expediency mycorrhizae seedlings in biogroups, especially for stone pine and fir.

## Single – tree inventory in a Pannonian-Balkan turkey oak-sessile oak forest after 40 years of free development

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In the Carpathian region the remnants of virgin forests, semi-natural forest stands and forest reserves are particular natural heritage of high value. In Hungary in the deciduous forest belt 13 forest types (mainly beech and oak forests) were considered of having European interest, and nominated as Natura 2000 forest habitat type.

The network of the forest reserves (FR) in Hungary, which was established in 1991, enables investigation of natural processes in several forest types. The basic hypothesis behind presupposes that the forests of this network show a tendency to the natural state both from compositional and structural aspects, resulting in several forest structural element that are often missing from managed forests. As oak dominated forests are used by humans since millenniums, their natural state is less understood; hence the investigations of the shift in their composition and structure after non-intervention measures are essential.

The aims of the study were 1) to perform a detailed forest stand survey of a sampling area selected in an old Pannonian-Balkan turkey oak – sessile oak stand which was left for free development as a permanent core area for long term investigation; 2) to describe the main structural and compositional features of the forest stand for later evaluation of changes. 3) and for the qualitative assessment of the presence of natural structural elements after 40 years of abandonment.

Vár-hegy Forest Reserve (FR), our study area is located in the south-western part of the Bükk Mts., its geographical coordinates are: lat./long 47°54' N, 19°57' E. Within the FR a 3 hectare core area was selected in the Pannonian-Balkan turkey oak-sessile oak forest type, where each single tree was mapped and surveyed. The following data were collected: position, species name, dbh, height, health state, social position. Standing and lying dead wood was also detected, species, diameter, and the rate of decay were documented. Sampling and regeneration layer was also surveyed using fixed circle sampling plots in 50 x50 m design.

In the data processing stands belonging to other forest type (Downy oak scrub woodlands) were separated, the basic statistics for Pannonian-Balkan turkey oak-sessile oak forest type (2,25 hectares, Natura 2000 habitat code: 91M0) were counted.

Forest historical studies show (Mázsa et al. 2009) that in the core area the turkey oak-sessile oak forest stands was regenerated around 1875-1885. The last management action in the core area took place in the late 1960s. Cutting of shrub layer and some cutting of trees began, but clear cuttings were postponed being afraid of browsing damage of the over-populated game. The disease causing oak decline throughout Europe appeared in the Vár-hegy stand as well in the 1970–1980s. Consequently, light sanitary cutting was performed in the core area in the 1980s. However the area was designated only in 1993 as forest reserve, the forest has been left for almost free development since about the 1960's.

Altogether 1263 live individuals of 14 woody species were present at the 2,25 ha with DBH larger than 5 cm. The most abundant species in the tree layer based on relative density were *Quercus petraea* and *Acer campestre* (211 and 190 stems/ha), respectively. These species were followed by *Quercus cerris* (59 trees/ha) and *Cornus mas* (28 stems/ha). Together these four represented greater than 92% of all overstory layer. Over 96% of tree biomass was represented by these three most dominant species alone, though several other species were found with lower ratios, as *Crataegus laevigata*, *C. monogyna*, *Fraxinus excelsior*, *Sorbus torminalis*, etc. Diameter distribution for all stems showed two peaks: one in the 5-10 cm and the other one from 25-45 cm

size classes. Separating the diameter distributions by species groups, more than half of *Quercus* individuals had a diameter among 30–40 cm. In the case of *Acer campestre* 83% of individuals (157 piece) had a diameter less than 10 cm, similarly to the other admixed species. In the sapling layer 12 species were documented, the most abundant was *Cornus mas* representing 38% of all stems, and *Acer campestre*, *Crataegus laevigata*, *C. monogyna* and *Prunus spinosa* were the next most abundant species.

In crown position a clear pattern emerged where *Quercus* species were most abundant in canopy positions and *A. campestre* and other admixed species in subcanopy positions. The total amount of dead wood was 44,6 m<sup>3</sup>/ha, 32 snags/hectares and 66 lying dead trees /hectares were found. The majority (40,9 m<sup>3</sup>, 92%) was constituted by *Quercus petraea*.

According to our field measurement results, the appearance of the attributes of natural state – was only partly detectable. Although 14 woody species were found in the 2.25 ha area, which could be considered as a basis of a diverse community, their ratios show uneven distribution. The high ratio of *Q. petraea* and *Q. cerris* reflects the former forest management acts, as admixed species are almost missing from the canopy layer. Furthermore, size classes were not differentiated; only two main DBH classes were present. The canopy layer was overwhelmingly dominated by two oak-species (*Quercus petraea*, *Q. cerris*), and the regeneration and sampling layer was dominated by *Acer campestre*. The number of large trees was insignificant. On the other hand, the amount of dead wood (44,6 m<sup>3</sup>/ha) can be considered quite high compared to other managed forest (Horváth et al. 2012), which shows that natural processes gained place from the dead wood point of view. The high amount of CWD was not the single result of the abandonment, but also the consequence of the former oak decline. As the close forest stand opened, several gaps were formed, and mass regeneration started, mainly with *Acer campestre* and other admixed species. One of the most striking phenomena is that no *Quercus petraea* samplings were detected.

Productive oak forest types are poorly represented in the European forest reserve network (Parviainen 2005). The old-growth Várhegy Forest Reserve is an earlier managed but now close-to-nature oak dominated forest representing Pannonian oak woods. Spontaneous regeneration after the oak decline started, resulting in a mixed forest stand with high proportion of *Acer campestre* and other shrub and admixed species. It is very likely, that this particular stand, but probably the other Pannonian oak-dominated forests left for free development (Horváth et al. 2012), will change in the future towards species rich, mixed forests with a lower proportion of oak.

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## Early silviculture of Norway spruce plantations in Romania: „classical” or „dynamic”? A case-study

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Norway spruce (*Picea abies* Karst.) is the most important softwood tree species in Romania, covering over 22% (1.43 million ha) of the national forest land. The species is mostly regenerated artificially and forms pure and dense plantations (initial stocking usually 5,000 plants/ha - 2 x 1 m - \*\*\*, 2000a). These young stands are subsequently tended by low intensity silvicultural interventions (cleaning-respacing - \*\*\*, 2000b) targeting (a) quick early height growth and (b) early canopy closure. Such approach had fully achieved the two targets but created many stability problems (especially snow damages such as snowbreaks or snowfalls) to the young, pure and dense Norway spruce plantations.

Under these circumstances a research project aiming to compare two tending scenarios (”stand silviculture” vs. ”crop-tree silviculture”) during the application of cleaning-respacing in a young Norway spruce plantation was launched in 2009. The fieldwork was carried out in a 0.5 ha pure Norway spruce plantation (sub-compartment 112D, Management Unit III Piatra Mare, ”Kronstadt” Private Forest District) established with a stocking of 5,000 plants/ha (2 x 1 m) in 2001. In 2009, two research plots of 300 sq.m (20 x 15 m) were established and all trees were access pruned up to maximum 2.5 m height. In both plots potential final crop trees were selected based on the *vigour* (the thickest), *quality* (with as thin and horizontally placed branches as possible; without defects such as forks, wounds, etc.) and *spacing* (as evenly distributed as possible) criteria. Subsequently a cleaning-respacing intervention was performed in the two plots as follows:

- a. Plot no. 1: ”classical” intervention, of *mixed* type, specific to the ”stand silviculture”: it has aimed at removing the undesired individuals (e.g. ”twins”, forked, with wounds or cankers, as well as too crowded), without paying any special attention to the potential final crop trees.
- b. Plot no. 2: ”dynamic ” intervention, *from above* type, specific to the ”crop-tree silviculture”: it was performed solely around the potential final crop trees by removing the majority of competing surrounding trees from the upper canopy to provide a competition regime close to the ”free-growth” state.

In addition, 60 individuals spread independently all over the remaining stand were selected, pruned up to maximum 2.5 m height and orange dot-painted. Around these trees, an intervention similar to the one performed in plot no. 2 was carried out, providing the majority of them with a competition regime close to the ”free-growth” state.

After locating all trees in plots no. 1 and no. 2 in x-y coordinates, the following parameters were measured once a year between 2009 and 2013 on all trees within the two plots and the 60 potential final crop trees: diameter at breast height (d.b.h.), total height (h), four crown radii (cr1, cr2, cr3, and cr4, 90 degrees between them). Using these data the following mean arithmetic values were computed: mean diameter, mean height, mean slenderness index [ $SI = (h/d.b.h.) * 100$ ], and mean crown diameter [ $mcd = (cr1+cr2+cr3+cr4)/2$ ].

The main *results* of the project are as follows:

The cleaning-respacing performed in plot no. 2 (mostly *from above*) was much more intensive than in plot no. 1 (intervention *from below*) by both number of trees (53.33%, compared to 28.40%) and basal area (46.19% and 19.64% respectively), leading to much lower levels of stocking and

basal area. Under these conditions, the increase of basal area between 2009 and 2013 was much higher in plot no. 2 (140.16%) than in plot no. 1 (102.51%).

This fact is the result of much higher *individual* as well as *mean diameter increments* in plot no. 2 (5.05 cm - 54.01%) compared to plot no. 1 (3.98 cm - 43.69%), a similar effect to plot no. 2 being encountered in case of independent potential final crop trees (5.10 cm - 53.29%).

The levels of *diameter increments* of individual trees in the two plots are very different: if 100% of trees, regardless their locations, have grown in diameter at least 1 cm between 2009 and 2013, only 2% of the trees in plot no. 1 have added at least 6 cm in diameter, compared to 21% in plot no. 2.

In terms of *mean height increment* between 2009 and 2013, the highest value (4.15 m – 63.74%) was found in plot no. 2 (with the highest initial stocking), compared to 3.46 m (51.41%) in plot no. 2 and 3.94 m (56.85%) in the case of individual potential final crop trees.

Consequently, the *mean slenderness index* SI has grown with 9 units (from 71 to 80) in plot no. 1 and with only 2 units (from 73 to 75) in case of independent potential final crop trees; it was reduced with 3 units (from 73 to 70) in plot no. 2.

If 89% of trees have shown an *increased* individual slenderness index in plot no. 1 between 2009 and 2013, the proportion of trees with this behaviour was much lower in case of both trees in plot no. 2 (32%) and of independent potential final crop trees (61%). *Decreased* slenderness indices were more frequent in plot no. 2 (54% of trees) than in plot no. 1 (only 7% of trees).

Under these circumstances, the target values of mean SI (maximum 75-80), characteristic to a stand *stable and resistant to snow damages* at early ages have been maintained so far, especially in plot no. 2. However, the urgent need for the first intervention with thinning is obvious mostly in plot no. 1: the canopy gaps have been fully filled out by crown expansions and their further development, strongly correlated with the d.b.h. increment, is no longer possible.

These provisional results have shown the advantages of a high intensity and from above intervention ("crop-tree silviculture") over the classical low intensity and mostly from below or mixed cleaning-respacing ("stand silviculture") in young and pure Norway spruce plantations. The early results, consistent with the ones published short ago (Patraucean, 2012), have to be confirmed during the following interventions with thinning from above (part of "crop-tree silviculture") in plot no. 2 or mixed ("stand silviculture") in plot no. 1.

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## **Spatial structure and disturbance dynamics in an old-growth mixed forest of *Pinus cembra* and *Picea abies* from Eastern Carpathians (Romania)**

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Old-growth forest spatial structure is the results of the interaction between internal competition and external natural disturbance regime. Scale and frequency of the disturbance strongly affect forest structure and functions. Forest dynamics involve a very large range of spatial and temporal disturbance scale. Better understanding of disturbance effects on forest structure and the type of the dynamics induced is becoming increasingly important in order to formulate a scientific base for designing nature-based forest management strategies. This study presents the main results concerning the actual spatial structure (quantified according with the base diameter and age), the disturbance history and the relationship between them. The study area is represented by an old-growth mixed forest of *Pinus cembra* and *Picea abies* from Calimani National Park, eastern Carpathians (Romania). Three permanent plots (surface between 0.7 and 2.2 ha) were established in an altitudinal transect. For each tree were recorded the species, the main biometric parameters, spatial position and age. Spatial structure was quantified using Ripley function (using diameter and age as variable) and disturbance dynamics was established by boundary line method.

In case of timberline plot the spatial structure is aggregate (with the exception of small stone pine trees and large spruce trees) for all distance, structure confirmed by the analysis using the age as variable. The disturbance dynamics and stand regeneration history highlights an important advance of spruce limits in the last 50 years. The second plot targeted a forest out in late optimal development phase where the actual spatial structure is the effect of multiple wind disturbances. The spatial structure vary from randomize to aggregate depending on distance and variable (diameter or age). The first wave of regeneration is observed on 1850 with a maximum on 1890, following a high intensity wind damage dated by dendroecological methods around 1840. The second regeneration wave, dominated by spruce, start after 1940 with maximum in 1960-1970 and the intensity is 2-3 times higher that precedent period. The last plot was established in a forest regenerated after catastrophic wind damage (dated in 1840). Spatial structure is aggregate until 15 m and randomize after, if we use diameter as variable. According with age the spatial structure is quite different. The regeneration history, analyzed using dendroecological methods, highlights the stand establishing starting with 1850 until 1910 with a maximum in 1880. This type of stand developments is specific to a regeneration of open-field and the following stand structure, on dimensional level, is conditioned by competition processes specific to forest ecosystem.

Based on millennium tree ring chronology of stone pine from Calimani Mts. was possible to reconstruct the disturbance dynamics in the last eight century from this region. A significant increase of frequency of disturbance is observed the last century and the largest one been that from 1840 when over 70% from the trees included in the datasets show a significant growth release.

Acknowledgement: This work was supported by a grant of the Romanian National Authority for Scientific Research (CNCS – UEFISCDI), Project Number PN-II-RU-TE-2011-3-0040.



## Douglas-fir as possible alternative for declining Norway spruce in managed forests of the Western Carpathians

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Norway spruce (*Picea abies* (L.) Karst.) was widely cultivated in the 4<sup>th</sup> (beech) and 5<sup>th</sup> (beech with fir) forest vegetation zones in the Western Carpathians. These stands show symptoms of health decline over the last decades. The main reasons 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. Inevitable measure in declining stands is stand conversion and the change of species composition with orientation on soil-improving forest tree species.

One of the species suitable in condition of water stress and disturbed forest soils is, at last in managed forests, Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco). Douglas-fir (DG) is a most-frequently used introduced conifer in the West and Middle Europe, being appreciated especially for its high quality wood and ability to take water from deeper soil more efficiently than spruce.

DG is known to be able to overcome many difficulties accompanying global warming. It grows better on some sites and is less vulnerable to the drought than Norway spruce (Bartoš, Kacálek, 2011; Kantor, 2008). DG grows well in the lower rainfall areas if they are not much exposed. It is usually regarded as a species suitable for middle valley slopes and bottoms of at least moderate fertility. It can develop good root systems on deep, well-drained soils. Clayey soils are acceptable if on slopes and the tree species grows well on sandy soils; similarly like spruce is unsuitable to calcareous soils. Urban et al. (2013) found, that DG is less sensitive than spruce to the unfavourable weather and soil nutrient conditions. It can withstand higher temperatures than spruce, but does not grow well at higher altitudes, where spruce dominates.

It belongs to the group of the tallest tree species on frequently occurring volcanic soil in western parts of North America (Domec et al., 2008), where its relatively large water stem storage can help to satisfy higher transpiration demands (Čermák et al., 2007; Phillips et al., 2003). DG can develop root systems much deeper than Norway spruce and numerous studies conducted in the USA indicate, that it can take water from deep soil horizons (Brooks et al., 2006; Meinzer et al., 2007). Deeper root system makes it also more resistant to wind throw.

DG soil-forming function has also been widely analysed; negative influence of DG on pedochemical structure of humus forms and mineral horizons was ruled-out, even in case of less advisable monocultures (Kupka et al. 2013, Podrázský, Remeš 2008).

As DG, compared to spruce, is more drought-resistant (Nadezhdina et al., 2014; Urban et al., 2013), it might help to substitute spruce at lower altitudes, while not only compensating but even substantially raising the production function of forest stands (Podrázský et al., 2013).

Possible environmental risks have not been ruled out nor quantified yet, though preliminary results indicate that native fytocenoses are influenced less than in case of spruce (Podrázský et al. 2011; Augusto et al. 2003).

This paper was supported by the Czech National Agency for Agricultural Research under the contract No QI112A172 "Silvicultural measures at introducing Douglas-fir in the conditions of the Czech Republic".

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### **Disturbance regime in the natural temperate Spruce (*Picea Abies* K.) forests in Ukrainian Carpathians**

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Natural disturbance regimes and variation in their components, particularly size, frequency, and severity, play central role in shaping the forest structure and composition on stand and landscape (Pickett & White 1985; Abrams & Orwig 1996; Frelich 2002). Disturbances for example strongly influence fluctuation of the tree layer biomass and thus strongly affecting the carbon balance worldwide, which nowadays is under high attention due to carbon budget. For a long time, understanding of the natural dynamic was based on the studies that described the disturbance regimes by two contrary concepts: small-scale gap dynamics (Leibundgut 1982; Korpeľ 1995), or large infrequent disturbances (LID) forests (Schelhaas, Nabuurs & Schuck 2003). However, recent studies accept more complex interface and variability of disturbances, creating disturbance regime that often can't be separated only to LID or gap dynamic (Woods 2004). Therefore, here we present a combination of stratified sampling design together with the novel methods and technique to reconstruct the past disturbance history and dynamic of landscape unique in terms of forest naturalness and geography. In particular, the aims of our study were to: i) reconstruct the spatiotemporal pattern of past disturbances and interconnect results on plot, stand and landscape; ii) determine if disturbance rates differ among the stands; iii) describe the features of the identified disturbance regime.

The study was conducted in a natural montane spruce forest in the Ukrainian Carpathian Mountains. The Gorgany mountain range spreads approximately 75 km from the north-west to south-east of the Carpathians and contains one of the largest remnants of natural montane spruce forests (*Picea abies* (L.) Karst, Hamor *et al.* 2008). Based on the literature and remote sensing and field surveys, six study stands were selected. Within each stand, 15 - 20 1000 m<sup>2</sup> (horizontal radius 17.84 m) plots were placed according to a stratified random design Svoboda *et al.* (2014). All trees ≥ 10 cm diameter at breast height (DBH) were identified, labeled and mapped in a study plot. We recorded diameter at 1.3 m height, social status and species of all tree individuals. Tree height and crown projection were measured for five randomly selected trees in each plot. Using a random generator, we selected 25 non-suppressed trees per plot for the dendrochronological analysis; we took one core per tree at 1 m height.

Cores were dried, cut by a core microtome (Gaertner & Nievergelt 2010), measured and cross-dated using standard dendrochronological methods (Stokes & Smiley 1968). In total, 2394 tree cores (361 176 radial increments) were used for analysis of disturbance history. The reconstruction of past disturbance events was based on two main types of canopy accession: rapid early growth rate (open canopy recruitment) and abrupt, sustained increases in tree growth (Frelich & Lorimer 1991; Svoboda *et al.* 2014). To estimate the maximum disturbance severity at the plot level, we fit a kernel density estimation function (KDE) to the temporal distribution of the percent canopy removed in each study plot. Maximum disturbance severity (MDS) represents the severity of the strongest disturbance event that leads to the changes in the forest structure. Four severity classes were defined: light 0-20%, moderate 20.1-40%, heavy 40.1-60% and extreme >60% removed (adopted from Frelich & Lorimer 1991). Non-metric multidimensional scaling (NMDS) was used to express the relation between disturbance chronologies, topographic characteristics and climate. For the spatial analysis of the disturbance patterns two main approaches of spatial ecology were used: Mantel's and Moran's I tests.

The reconstructed disturbance chronology covers a time span of more than 350 years (starting from ca. 1650) and indicates variability in disturbance histories across the study stands. There was no evidence of a single stand replacing event that would have covered a stand or landscape scale or heavily remove the canopy on majority of study plots. Conversely, on the majority of the plots (56 %, N = 54) a moderate maximum disturbance severity (MDS) was observed. The plot level disturbance chronology allows us to fully explore temporal variability in past disturbances on a small scale. The oldest recorded event occurred in SY1 between 1650 and 1680 and covered a significant area at the

stand scale ( $N = 9$  plots, 90% from available). The largest disturbance event, which affected around 60% of the study plots over the entire landscape, happened between 1820 and 1840 and showed variability in percent canopy removed across decades. The ordination analysis revealed partial synchronicity in disturbance history among plots. There was no clear tendency that disturbance history regime was more synchronized among the plots within a given stand. Exceptionally, plots within the GR2 stand create a distinct cluster in the ordination space around the 1820 period. None of the physiographic features were significantly correlated with the ordination axes. However, both MDS and the time of its occurrence showed significant correlations with the two ordination axes ( $P < 0.001$ ,  $r^2 = 0.23$  and  $r^2 = 0.17$  respectively). Almost no stands showed evidence that geographically proximal plots had similar decadal disturbance histories, with the exception of GR2 (Mantel test  $r = 0.31$ ,  $P < 0.01$ ). This exception reflected the influence of two main disturbance periods (1820-1840 and 1910-1930), which affected 60 % and 35 % of the study plots in GR2 stand, respectively.

Findings suggest that the overall pattern of the disturbance history on the whole study landscape was diverse in temporal and spatial scales. We revealed, that the forests were not originated after one stand replacing disturbance event, nor driven by a single tree gap dynamic, but rather were affected by numerous events of different severities, extends and timing, which resulted to complex pattern of disturbance history. The complex spatiotemporal pattern with combination of different maximum severities of disturbances creates a high heterogeneity and complexity, thus suggests that moderate disturbance regime was prevailing in this forest over the last few centuries.

Acknowledgement: This study was supported by the Grant Agency of the Czech Republic, project No. P504/10/1644 "Natural disturbance regimes of mountain *Norway spruce* forests: the basis for ecological forest management".

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## POSTER PRESENTATIONS

**Beech and spruce primeval forests of the Carpathian Region and its structure models**

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Nowadays primeval forests of the Carpathian Mountains can only be found on the areas that are inaccessible for exploitation because of low road density, cattle grazing and existence of nature reserves.

Among all primeval forests in the region, pure beech (*Fagus sylvatica* L.) forests cover 16 600 ha, pure spruce (*Picea abies* (L.) Karsten) forests have 8 300 ha, beech forest with admixture of sycamore maple (*Acer pseudoplatanus* L.) – 4 800 ha and spruce admixed with fir (*Abies alba* Mill.) – 4 500 ha. Combinations of coniferous-beech primeval forest with spruce and with fir cover 2 700 and 1 000 ha respectively (Parpan, 2013). The core zone of Ukrainian-Slovak reserve object "Primeval Beech Forests of the Carpathians" covers 29 300 ha.

Studying the structure of virgin forests is essential for understanding the development of natural forests, while diameter distribution provides a good image about the tree stand growth.

Old-growth beech forests have been studied for quite a long time, while there is a lack of researches concerning old-growth spruce forests in the Ukrainian Carpathians. Hence, comparison of the pure beech and pure spruce virgin forests structure allows us to analyze not only structure of monodominant groups, but their growth and development features too.

The study was conducted in Borzhava old-growth beech forest massif of Svaljava State Forestry Enterprise (Transcarpathian region) and in old-growth spruce forest on the territory of Nature Reserve "Gorgany". Primeval beech forests (ca. 4 000 ha) are still present on the brown mountainous-forest soils within the territory of the Stoy mountain (1681 m.a.s.l.) between 800 and 1260 m. Gorgany mountain range is situated in the central part of the Carpathians. Steep slopes and rocky deposits cause difficulties with its accessibility. Pure spruce forests of Nature Reserve "Gorgany" are distributed mainly in the moderately cold thermal zone (1200-1500 to 1600 m.a.s.l.).

Research itself was conducted on the sample plots (with area ca. 1 ha) using method of prof. H. Leibundgut (1959, 1983). Definition of development phases and stages was done using method that was developed by WSL institute (2010).

During 2010-2013 comprehensive field work has been done on 7 permanent plots with beech and 12 plots with spruce virgin forest. Among the studies that have been done on these plots, there are: analyzes of stand spatial structure; mapping the location of all trees; measurements of diameter, height, crown length of vitality, state, role in the stand and merchantability; classification of trees using IUFRO method (1969). Distribution of tree diameters was approximated with the Weibull function.

The structure of virgin forest was identified using such an integral index as variability of tree diameters, which, in our case, varies over a wide range from 4 to 144 cm in beech and from 4 to 120 cm in spruce stands. According to the coefficient of variability (C), beech old-growth forests can be characterized with different types of dimensional structure. If the variation is less than 40 % (C < 40 %), forest belongs to the normal type of structure; if the C = 41-60 % – to intermediate, and if C > 60 % – to descending type. All 7 plots of primeval beech forests have descending type of structure, while spruce forests are characterized with all three types.

Structure and volume are integral indicators of virgin forest stability and its development



stage. During the optimal climax stage stand volume in the beech forests equals  $696 \text{ m}^3 \cdot \text{ha}^{-1}$ , while in the spruce stand –  $1044 \text{ m}^3 \cdot \text{ha}^{-1}$ .

Obtained data about structure and productivity of primeval beech forests can serve as model for the close to nature silviculture. Further researches will provide a possibility to allocate similar structures of old-growth stands on large areas.

Features of virgin forests, their age and spatial structure, peculiarities of natural regeneration and volume balance indicators can be used during the definition and justification of environmentally friendly forest management system in the Carpathians, e.g. selective cuttings, reconstructive cuttings, methods of secondary plant communities renaturalization, etc.

### **Genetic structure and breeding value of Scots pine from Carpathian Mts. as compared to the species distribution range in Poland**

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Scots pine is one of the most important forest-forming and utility species in Poland that consist more than 70% of forest stands in the country. In the mountains and highlands, pine is used as an admixed or a pioneer crop and it constitute about 24% of total forest area in Carpathian and Sudeten Mountains (Skrzyszewski, 2004). In the mountain regions, Scots pine is used as a nurse species planted in the areas occupied previously by spruce that was damaged e.g. by spiral disease or massive windbreaks such as those in 1999-2000. The use of best adapted reforestation material is curtail for successful rescue of the forest ecosystems. However, the level of adaptive traits differentiation and genetic diversity of Scots pine growing in the mountain regions is mostly unknown.

Our study focused on the analysis of genetic and phenotypic variability of Scots pine populations representative for the species distribution range in Poland that were planted on the experimental plot located in mountain conditions at the height of 620 m above sea level in the Beskid Sadecki Mst. (Sabor, 1993). Tested populations included origins classified to the race of lowlands pines (for instance the population from Rychtal and Bolewice), race of foothills pine from Nowy Targ and mountain pines from Piwniczna. The heritability estimates of several economical important traits such as growth and diameter of breast height crucial for stands productivity (mean stem volume in  $\text{m}^3/\text{ha}$ ), stem straightness or crown width and the analysis of breeding value of tested populations allowed us selecting individuals and populations best adapted to the mountains conditions. Based on provenance tests, it was found that local breeds are generally best adapted to local habitat and climatic conditions. Because of a high heritability of the quantitative traits including phenology variation, resistance to stress factors and growth characteristics, the observed diversity are likely a consequence of the impact of natural selection that favours individuals with phenotypes best adapted to local site conditions. Quantitative traits assessments were accompanied by the analysis of the genetic structure of the analysed populations based on chloroplast and nuclear microsatellite loci to evaluate the potential influence of demographic processes on the pattern of nucleotide and phenotypic



variability. Our results indicate that populations growing in mountains are characterised by different range of variability in almost every tested traits.

(Acknowledgement. The work was supported through the University of Agriculture in Krakow, Poland, Projects for young scientists BM/4425/2013)

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## Simulation of beech stand dynamics under climate change conditions in the Carpathians and Roztocze using FORKOME model

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This paper presents a modeling study of the beech (*Fagus sylvatica* L.) forest dynamics in the Carpathians and Roztocze using FORKOME model (Kozak et al., 2003) as a gap type model. In the last decade there were 40 versions of gap models applied to forests from different vegetation-climatic zones (Bugmann, 2001). The study was conducted in the Polish Bieszczady (Stuposiany forestry), Ukrainian Beskidy (Nadsanski Landscape Park) and in Polish Roztocze (Roztoczanski National Park) regions. In each of these locations three research areas were established in beech stands under similar ecological conditions. The aim of this study was to carry out a survey of possible scenarios for beech stand dynamics using computer model. For this purpose, a computer prognostic FORKOME model has been applied, using both general mathematical relationships functioning within a forest ecosystem and empirical ones, characteristic for tree stands in analyzed plots. A control scenario was compared with four other climate change scenarios (warm dry, warm humid, cold dry, cold humid) for a time period covering next 400 years. Using the control scenario, FORKOME model predicted that for the next 400 years beech stands will dominate in terms of biomass and number of trees. The results have confirmed the periodic tendency of changes in stands, consisting of participation exchange between beech and fir. Increase or decrease of temperature and precipitation did not disturb the direction of these changes, although above-mentioned factors had minor impact on alterations and amplitude in the rate of these changes.

The results presented in the paper indicate that the FORKOME model is very useful for prediction of possible alterations of species composition, stem volume and total biomass when investigating different climate changes scenarios in the Carpathians and Roztocze region.

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## Volume growth losses of trees and forest stands in Southern Carpathians LTER Sites (Retezat and Bucegi – Piatra Craiului)

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The health of forest ecosystems is mainly influenced by the negative action of air pollution and climate changes of different biotic and abiotic factors, and other disturbances. Tree growth and stand dynamics were considered as the main synthetic indicators on stability, functionality and productivity of forest ecosystems. Consequently, the results obtained by auxological research in the Southern Carpathians LTER sites, in Romania (Retezat and Bucegi – Piatra Craiului), based on information provided by successive inventories made in 2001 and 2011 (in Retezat LTER site) and in 2006 and 2011 (in Bucegi Natural Park network – part of Bucegi – Piatra Craiului LTER site) showed different average annual growth in volume, among different tree species, due to specific conditions of vegetation, climate and site, and between the groups of defoliation classes (0-1 and 2-3). Evidently, the healthy trees (defoliation classes 0-1 group) recorded higher values than those damaged (group defoliation classes 2-3), differences varying between 0.0 m<sup>3</sup>yr<sup>-1</sup>ha<sup>-1</sup> (Rotunda - spruce) and 3.0 m<sup>3</sup>yr<sup>-1</sup>ha<sup>-1</sup> (Judele - spruce) in Retezat LTER site, and between 0.5 m<sup>3</sup>yr<sup>-1</sup>ha<sup>-1</sup> (Batrana - spruce) and 7.1 m<sup>3</sup>yr<sup>-1</sup>ha<sup>-1</sup> (Salvamont Bran - spruce) in Bucegi Natural Park network, respectively. In determining the loss of annual growth in volume per year and per ha, the processing of information identified cases where the trees migrating in different classes of defoliation and the error estimation during the reporting period were significantly reduced by taking into account the trees communities that had the same damage class, both at the beginning (2001 and 2006, respectively), during the period, and at the end of the period (2011). The mean volume growth losses reached up to 37.5% in Retezat LTER site and 42.1% in Bucegi NP network, for the damaged trees compared to the healthy trees. These results obtained for the first time for this region will contribute to the improvement and development of specific scientific information for forest monitoring system applied in Romania, with special reference to the growth component.

Key words: forest growth losses, crown condition, air pollution, climate changes, forest monitoring, LTER site.

## Inventory of bad lands from Roumanian steppe and forest-steppe afforested between 1980 and 2010

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Romanian steppe and forest steppe areas are affected by the most extensive land degradation processes. At the same time, most of these regions are at risk of droughts and aridity, also having the lowest afforestation rate of the country. Territories where these events are common include the

Dobrogen Plateau, eastern end of the Romanian Plain (Bărăgan Plain), southern Oltenia Plain, Moldavian Plateau and part of Pannonian Plain. In these areas drought is almost continuous even in years when there is an additional rainfall.

In the last 30 years 112 improving perimeters were constituted in the steppe and forest steppe region, covering a surface of 27,380 ha. From this surface, 22,116.64 ha (81%) were afforested, the rest 19% are unproductive lands, lands pending afforestation or reforestation, etc.

Most part of bad lands (70%) are affected by surface erosion of different degrees. A significant part (23%) is represented by lands affected by wind erosion, namely wind deposits (sand dunes and interdunes). Other identified types of degradation (alluvial deposits, gulling, swamps, landslides, salty soils and land degraded by human activities) represents 17% of all these perimeters.

The most widely used species was acacia (*Robinia pseudacacia*), occupying 52.8% of afforested surface, both in pure stands or in mixture with other deciduous and shrubs. Acacia was used on lands with surface erosion of different types, also on sand dunes and interdunes, alluvial lands, even on salted soils.

Other species used in afforestation were:

- oaks (*Q. pubescens*, *Q. pedunculiflora*, *Q. cerris*) used on lands with mild or strong surface erosion, as main species mixed with various deciduous;
- honey locust (*Gleditsia triacanthos* L.) used in pure stands or mixed with other species on various degraded lands;
- ash trees (*F. pennsylvanica*, *F. ornus*) used on various eroded lands and salty soils;
- pines (*P. nigra*, *P. sylvestris*) used on very strongly or excessively eroded land and landslides;
- also, in smaller areas, were used various deciduous, trees as elms, poplars, mahaleb cherry etc., and shrubs (oleander, blackthorn, hawthorn etc.).

Resulted stands have low productivity and the vegetation state is average to poor, according to site conditions. However, plantations succeeded to cover the soil and ensure a significant role in improving environmental conditions. Older acacia stands (over 15 years) manifest intense decline phenomena of trees, which requires their recovery using regeneration felling.

## ORAL PRESENTATIONS

### Land cover change mapping in the Carpathians with MODIS EVI data

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Land use and land cover change (LU&LCC) has powerful influences on e.g. biotic diversity, ecosystem services or local, regional and global climate changes. LU&LCC are often grouped in two types (Lambin et al., 2001, Coppin et al. 2002): conversion (a complete replacement of one land cover/use type by another) and modification (more subtle changes that affect the character of land cover/use without changing its classification).

Central and Eastern Europe experienced drastic changes after fall of the Iron Curtain that have triggered extensive LU&LCC. The Carpathian Mountains, ecologically rather homogenous and the least disturbed range in Europe, are densely cut by political borders what allows to monitor differences in land cover/use change dynamics between particular countries (Kuemmerle et al. 2006).

Provision of homogenous information on LU&LCC and its drivers at the pan-Carpathian level is crucial for policy and research (Kozak et al., 2011), however most of LU&LCC studies were carried out only in a regional scale. Lately, first results of land cover change mapping across the entire Carpathians based on Landsat images have been presented by Griffiths et al. (2012). Moreover, little attention has been paid till now to the use of satellite-derived products characterized by high temporal resolution and medium spatial resolution, provided by e.g. Moderate Resolution Imaging Spectroradiometer (MODIS) sensor. Some of them may be successfully applied to study land cover change (Carraro et al. 2008). Recently, early results based on MODIS NDVI data, for the entire Carpathians, have been presented by Jaśkowiec (2013).

Therefore, the aim of this study is to assess land cover change (taking into account both conversion and modification) in the Carpathian Mountains during the last decade, in large, regional scale, on the basis of MODIS EVI data set.

To map land cover changes 552 MODIS scenes (Vegetation Indices (MOD13Q1) product) from Earth Observing System (EOS) MODIS data set is used. The images are acquired between 2001 and 2012 (2 points of time for each month).

Various approaches from among bi-temporal change detection based on the snap-shot model or trend analysis of time series, can be used to reveal land cover change (Coppin et al., 2002). In this paper trend analysis (temporal trajectory analysis) approach is used. Such studies are not prevailing in digital change detection. They are usually applied for high temporal resolution products (e.g. AVHRR). Change detection based on comparison of development curves (profiles) turned out to be appropriate for studies of variability of the Earth surface attributes in a regional scale (Coppin et al., 2002).

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### **Long-term forest cover changes in the Polish Carpathians: methodological approach**

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Analysis of the long-term land use/land cover change is inseparably related to the uncertainty. Differences in map instructions, geometrical correctness, thematic consistency and many other issues trigger the problems influencing the final results. So far, many methodologies and theoretical models were created to solve that problem (i.e. Petit, Lambin 2002; Plewe 2002; Leyk et al., 2005). The methods proposed were usually tested on relatively small study areas, and therefore it is not always possible to follow them when transferring the models to large area studies.

In our study the entire territory of the Polish Carpathians (nearly 20 000 sq km) is the subject of forest cover change assessment over the last 150 years. Four kinds of data sources were compared: Austrian Second Military Survey from 1850s (1:28 800), Polish military maps from 1930s (1:100 000), Polish topographic maps from 1970s (1:25 000) and contemporary land cover classification based on Landsat imagery (resolution 30 m). Forest masks based on the Second Military Survey and Polish military maps were a result of manual vectorisation, while the forest cover from Polish topographic maps were obtained automatically. All the above-mentioned material, contrary to other maps, gives us a possibility to cover the whole area of the Polish Carpathians in four different time periods.

Our aim was to identify the problems resulting in uncertainty during performance the forest cover change detection in the Polish Carpathians over the last 150 years. The analysis was based on the model proposed by Leyk *et al.* (2005), where all possible problems were considered in the framework of production-oriented, transformation-oriented and application-oriented uncertainty. In each case, a solution is proposed on how to deal with the given aspect of uncertainty in the context of our study area.

The results show that according to the assumptions, production-oriented uncertainty has a biggest impact on the final results. Influence of the transformation-oriented uncertainty on the results is, by contrast, relatively easy to be assessed. We also conclude that scale of the Polish military maps from 1930s (1:100 000), differing from the other material has relatively less impact on the change detection analysis than we previously assumed.

FORECOM project (*Forest cover changes in mountainous regions – drivers, trajectories and implications*, PSRP-008/2010), supported by a grant from Switzerland through the Swiss contribution to the enlarged European Union.

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## **Mapping Forest Fire Susceptibility in Temperate Mountain Areas with Submediterranean Influences with Expert Knowledge. A Case Study from Domogled Ridge - Mehedinți Mountains, Southern Carpathians**

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Forest fires in Romanian Carpathians became a frequent phenomenon during the last decade, although local climate and other environmental features did not create typical conditions. From 2004, forest fires affect in Romania more than 1000 hectares/year of different forest types (deciduous and coniferous). Their magnitude and frequency are not known, since a historical forest fire inventory does not exist (only press papers and local witness for some selected events). Only recent reports from the ISU local bodies (Emergency Situation Inspectorate) provide data about forest fires in the context of fire management missions. Forest fires feature the summer dry periods but there are dry autumns and early winter periods with events of different magnitudes.

The application we propose is based on an empirical modeling of forest fire susceptibility in a typical mountain area with Submediterranean bioclimatic features: Domogled Ridge (1106 m) from Mehedinți Mountains (1466 m). This mountain area superposes on limestones with steep slopes – 800-1000 m (the fault slopes along Cerna Valley above Baile Herculane spa) and sharp ridges.



Temperate beech forest combines with Submediterranean forest patches of black pine (*Pinus nigra ssp. banatica*). The dry season is longer than in other Carpathian areas (May-October) and overlaps with a peak touristic season (June-August). This created favourable conditions for wildland fire triggering because forest litter covering the rendsinic soils are prone to sudden ignition in normal condition.

For mapping and modeling purposes we started from correlating the inventory of fire-affected forest stands with local inventory of fire events from ISU Orsova firemen group and Baile Herculane forestry authorities.

First, fire-affected forest stands are mapped with the help of Pleiades high resolution orthorectified multispectral imagery (2 m) from August 2013. The image was taken two weeks after the wildland fire events from Domogled Mountain Ridge.

Second, we mapped the areas affected by fire according to the ISU Orsova inspectorate.

The analysis combines GIS and remote sensing models (Chuvieco et al., 2012), starting from the ideas that forest fires are featured by the *ignition zones* and then by the *fire propagation zones*.

*The first data layer* (ignition zones) is the result of the crossing between the ignition factors: lightning – points of multitemporal occurrence and anthropogenic activities (grazing, tourism and traffic) and the ignition zones (forest fuel zonation – forest stands and litter typology, soil cover and topoclimatic factor zonation). This data is modelled from different sources: the MODIS imagery fire product (Hantson et al., 2013), detailed topographic maps, multitemporal orthophotos at 0.5 m resolution, Pleiades and Landsat multispectral imagery, forestry cadastre maps, detailed soil maps, meteorological data (the WorldClim digital database) as well as the field survey (mapping using GPS and local observation).

*The second data layer* (fire propagation zones) is the result of the crossing between the forest fuel zonation, obtained with the help of forestry data, the wind regime data and the topographic features of the mountain area (elevation, slope declivity, slope aspect). The analysis also considers the insolation degree of mountain slopes that creates favourable conditions for fire propagation between different canopies.

These data layers are intersected in order to obtain the areas that may be affected by fire. The digital map shows three levels of forest fire susceptibility, assessed on the basis of expert knowledge. They can be validated from the statistical point of view with the polygons of the forest fire affected areas mapped from Landsat TM, ETM+ and Pleiades satellite imagery.

The results could be integrated within the forest management strategies and especially within the forest cadastre and development maps (updated every ten years). The result can confirm that the data gap in terms of forest fire events can be filled with expert knowledge.

(Acknowledgement: The research is financed within the SIAFIM project – Satellite Image Analysis for Fire Monitoring - 2012-2015 by the Romanian Space Agency – ROSA, in the context of ROSA-STAR programme with the contribution of ESA – European Space Agency)

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## Modeling the location of natural cold-limited treeline and alpine meadow habitats in Ukrainian Carpathians

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Alpine zone, covering the top of the highest ridges and mountains in the Ukrainian Carpathians, represents a unique and valuable habitat. As only the highest parts of these mountains rise above treeline, an alpine zone in the Ukrainian Carpathians mostly consists of rather small and isolated patches. As global warming will definitely cause the elevation of cold-limited treeline, the extent of alpine habitats in this part of Carpathians will shrink, probably down to a total disappearance.

The goal of this study is to reveal and determine the extent of the alpine habitats and alpine meadow ecosystems in the Ukrainian Carpathians, and to make predictions about their spatial changes for the middle of the present century, using LANDSAT images, SRTM DEMs, and WorldClim global climate dataset. In order to reach this goal several tasks and some ensuing problems must be solved.

The study area embraces the central part of Ukrainian Carpathians, where all of the highest ridges and peaks are situated. Landsat 7 multispectral imagery has undergone radiometric and topographic correction, and cloud masking. It has then been classified into forest and non-forest classes. As the latter is extensively widespread and only a very small part of it belongs to true alpine meadows (and, respectively, only a small part of the tree/non-tree borderline corresponds to the cold-limited tree line), a research into the true position of this treeline has been carried out. It is based on global climatic data from WorldClim global climate dataset. The WorldClim data layers were generated through interpolation of average monthly climate data from weather stations on a 30 arc-second resolution grid, using ANUSPLIN software (Hijmans et al., 2005). As the spatial resolution of these data (near 1 km) was too coarse for our task, the data have been refined to 70 m resolution using geographically weighted regression approach, with elevation data from SRTM DEM utilized as an independent local predictor.

Several available climatic variables have been explored as possible predictors for treeline location. To determine the critical values of these variables at which a transition from forests to alpine meadows is observed, the histograms for the values of climatic variables have been created, separately for all the area above 1200 m a.s.l. (where tree line is presumably located), and for the part of this area falling inside the tree/non-tree boundary belt. While in the first case the histograms mostly demonstrate a uniform change in values (similar to a regional hypsometric curve), in the case of the tree/non-tree boundary belt they often demonstrate a peak which probably corresponds to a climatically-limited tree line. The value of the climatic variable at this peak is assumed to be the value at which a transition from forest to montane grasslands biomes takes place.

To determine the critical values most closely related to tree boundary location, ANOVA analyses have been run with climatic variables as dependent and forest/non-forest classes as categorical factor, the results of F-tests being interpreted as a measure of relationship. These results, along with visual evidences of the peaks on the above-mentioned histograms, were used to determine the relative significance of climatic variables.

Trees at cold-limited treeline can suffer from a lack of warmth during the growing season, as well as from low temperatures during winter. From the selected variables, information on which is contained in WorldClim dataset, the most significant one turned out to be the mean temperature of the warmest quarter (defined as any 13 consecutive weeks), with natural treelines corresponding to 9.9°C value of this variable. This variable can be treated as an approximation of the mean growing season temperature, proposed by Körner (2012) as the best indicator of the natural climatic treelines

location. Another significant variable is the mean temperature of the warmest month (treeline corresponds to ~10.6 °C). At the same time, the minimal temperature of the coldest month doesn't show a big significance as an indicator of the natural climatic treelines location.

Determining the critical values of the climatic indicators made it possible to map the locations of natural cold-limited treelines and calculate the extent of alpine meadow habitats. The overall area of this type of habitat in the Ukrainian Carpathians is 19.01 km<sup>2</sup> (1901 ha). The largest solid patch is located on top of Chornohora ridge, with much smaller patches found at the highest peaks of Horhany, Svydovets, and Marmarosh massifs.

An attempt has been made to predict the future extent and locations of natural alpine meadow habitats in the Ukrainian Carpathians, based on the climate projections of CCSM4 climate simulation model for representative concentration pathways (greenhouse gas concentration trajectories adopted by the IPCC for its fifth Assessment Report). It has been found that even for the most "optimistic" low emissions scenario (RCP2.6) the lowest value for the mean temperature of the warmest quarter predicted for 2050 is 10.5°C, which is higher than 9.9°C corresponding to the natural treeline locations. This means that, given the assumptions made in the analysis, the natural alpine meadow habitats in the Ukrainian Carpathians will totally have disappeared by 2050 even under the low carbon emissions scenario.

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## Detection of impervious surface changes based on remote sensing data

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The impervious (sealed) surface area is a type of land cover, located mainly in urban areas. These surfaces are most commonly associated with construction (roofs, terraces) and transport (roads, sidewalks, driveways, parking lots) and prevent water infiltration into the soil, disrupt the water cycle and affect the quality and quantity of water resources in a catchment. Studies in many countries showed an increase of impervious surface areas, especially in connection with the development of the settlements and various infrastructure (Arnold, Gibbons, 1996; Weng, 2001). Also in Poland in the last few decades urbanization is steadily increasing. As a result, the area of impervious surfaces has increased, which has led to an increase in surface runoff while reducing infiltration. Consequently, it will undoubtedly increase the frequency and intensity of extreme hydrological events. This applies in particular to mountain areas, which play an important hydrological role both globally and locally (Dec et al., 2009). Determining the level of catchment seal is not easy. It depends mainly on the appropriate classification of the source material (maps, images, laser scanning point clouds). The literature describes numerous methods of classification, using a wide range of image processing technology.

The aim of the present study was to diagnose, basing on the analysis of remote sensing data, the main trends of changes that have occurred in the area of impervious areas over the past thirty five years (1977-2012). A Carpathian catchments within the region of Małopolska, municipality Szczawnica, 87.9 km<sup>2</sup> was selected as a study area. It is a mountain area, with steep and very steep slopes, and important tourist destination with intensive housing and infrastructural development.

The study used two sets of source materials divided into two periods. The first set (A): 1977 and the second set (B): 2012. The first (A) consisted of archival aerial photo images at a scale of 1:20 000, set (B) included high-resolution satellite images WorldView-2 taken in 2012, characterized by a 0.5 m spatial resolution panchromatic channel and 1.8 m multispectral channels. To increase the accuracy of satellite imagery interpretation, LiDAR data from airborne laser scanning acquired in 2012 were also used.

Archival aerial photos have been subjected to manual on-screen vectorization in order to delineate impervious surface areas. Object-Based Image Analysis (OBIA) method was used to extract impervious surface areas at high-resolution satellite images WorldView-2. OBIA revolutionized processing of remote sensing data, offering an effective technique of automatic classification, with quality similar to human visual interpretation, but faster, cheaper and easier to reproduce. In comparison to classical methods of classification, OBIA is not based on individual pixels, but their coherent groups, which are able to better reflect the real world objects. Through the integration of spectral features, semantic or contextual data, this method allows to fully exploit the value of high resolution satellite images (Blaschke, 2010; Blaschke, Strobl, 2001).

The quality of results will be controlled (accuracy assessment) based on aerial orthophotos. The final step will be to conduct spatial analyzes on geodata derived from manual vectorization and OBIA analysis to determine the changes that have occurred in the area and distribution of impervious areas within the municipality Szczawnica.

The project is currently in the implementation phase (completion of the project date - June 2014). The project is implemented within a scholarship of Anna Pasek Foundation and Doctus Scholarship program.

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## POSTER PRESENTATIONS

**Data classification of multisensoral remote sensing images  
in forest type evaluation**

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Evaluation of the earth's surface objects can be done by different algorithms and methods, but it is most expedient to use remote sensing data, as they allow prompt assessment of significant land areas with minimal labor and economic costs.

The main objectives of our research are:

1. The feasibility assessment of using 'Random Forest' algorithm for the classification of coniferous and deciduous stands and decryption capabilities previously segmented images to improve the accuracy of selection of conifers and deciduous stands.
2. To establish the ways of improving the accuracy of classification covered with forest vegetation images, together with a combination of multispectral and radar remote sensing data taken during one growing season.

Our study area is located in Volynska and Lvivska Oblasts in Western Ukraine and covers about 7,500 km<sup>2</sup>. The study was previously completed by a joint Ukrainian-German research team using a special methodology (LUCAS 2009). Additionally, 71 circular sample plots, forest inventory materials, and photo-interpretation of images with ultra-high resolution ability were used. These data served as the basis for creating the class characteristics of each vegetation cover class, where 70% of data served for the formation of signatures, and 30% – for the validation of the data.

To map the land use systems, multispectral Landsat TM data (30 m resolution) and ERS-2 SAR data (20 m resolution) were acquired. A total of two Landsat scenes (June and November 2010) and nine ERS-2 scenes (each month in 2010 except for January, May and August) were used. The Landsat images were preprocessed to level L1T and thus a sufficient geometric and radiometric accuracy for our analysis was ensured (USGS, 2013). The Superpixel Contour (SPc) segmentation algorithm was used for image segmentation in combination with a semi-automatized parameter selection (Stefanski et al., in press). We chose the Random Forest (RF) classifier due to its advantages of being fast, efficient with large data sets, robust to outliers and overfitting as well as user-friendly with regard to its parameter selection (Breiman, 2001). In this study, the classification model was generated with 1000 training samples per class. The training samples were selected by an equalized random sampling.

A preliminary results of the accuracy assessment showed that the highest accuracy was achieved for the pre-segmented images (over 94%), including a combination of multispectral (from June and November 2010 with segmented) and radar (multispectral from June and November 2010 with segmented and radar). The most accurate classification was used then to classify diverse satellite images of the entire research area.

Classification of the remote sensing data using the Random Forest algorithm can quickly get a new reliable mapping and statistical information. Overall, the image classification accuracy is over 80%, indicating the decent possibility of using 'Random Forest' algorithm for the classification.

The use of complex images that includes multispectral and radar data, improves the classification accuracy comparing to the classification of one type of the images. We received even better classification results when included the pre-segmented image in a classification process.

Derived digital image classification results of satellite images can be used to estimate the forest area, forest cover and the forest type. These thematic maps could serve as material for the study of dynamic changes in the forest cover. Methodology of forest cover research could be used not only for flat area, but and for mountain's territory, like Ukrainian's Carpathians.



## Land use trends in the Poloniny National Park

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The paper presents results of the survey on land use development and its changes in the Poloniny National Park between 1773 and present time. Land use was identified from historical military maps and aerial orthophotographs. Poloniny National Park is located in NE corner of the Slovakia, in Slovak part of the Eastern Carpathians Biosphere Reserve. However this area has a marginal position within Slovakia and is placed on the periphery of economic interest, so many interests are presented in the territory. Region can be classified as forestry-agricultural mountain landscape, with domination of forests, therefore production of timber and other forest goods represents the main function of this landscape. The area has been settled and therefore housing function is also important, however, currently majority of villages exhibit lowest number of inhabitants during last 200 years. The housing function was significantly influenced by construction of water reservoir Starina in 80-ies, what resulted into evacuation of 7 villages and establishment of relatively large settlement-free area. By this political decision, another important function in the region arose – water management. In non-forest part of landscape, grasslands dominate, arable land covers only small portion of agricultural land. The total area of agricultural land is continuously decreasing during last 50 years, especially remote grasslands and areas in displaced part of the region are gradually abandoned. Function of nature conservation has been improved during last 50 years. It can be documented by growing number and the area of protected areas. Also recreational function of the landscape is more important during last decades, although facilities and services do not correspond with potential of the region. Change of land use for last about 50 years, was directly caused by factors such as were changes in legislation, the agricultural regime change in population age structure and overall marginalization and underdevelopment of the region. Currently the landscape from last years to the desert, overgrown meadows are neglected, number of buildings and service buildings rabble, roads and sidewalks are overgrown. But nevertheless, and perhaps due to the fact of belonging to the Poloniny National Park, it is the best preserved and most stable parts of Slovakia.

## Political and economic drivers of land cover changes in mountain regions: an example from low Ukrainian Carpathians

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Mountain regions are much more vulnerable to fast economic, cultural and environmental impacts, that is why dynamic of landscape, both natural and cultural have to be one of the main issues in scientific agenda in Carpathian region.

Twentieth century and, especially, its ending has been marked by significant socio-economic transformations in the Carpathian countries, including Ukraine. Especially drastic changes have



happened in land use, land cover and, as a consequence, in a structure of cultural landscapes. Such dynamic is caused mainly by political and economic drivers. The goal of this study is to detect land cover structure and dynamic during 20<sup>th</sup> century, and analyze the drivers of these changes in landscapes.

As a study area, one rural municipality was selected in northwestern part of Ukrainian Carpathians in the low mountains. Boberka municipality has an area of 6,819 ha, population of 1,654 inhabitants in 2011. The traditional economies of the study area were and still are forestry and agriculture. Boberka has a long history of agricultural development – low elevation and gentle slopes afforded vast expansion of grasslands and cultivated fields around the villages.

Two significant events in the history of Europe forced to drastic changes in structure cultural landscapes of study area. The first one is World War II and, as one of its results, changes of state borders and economy system. After 1945 local population of Boberka was partly re-settled and collective system in agriculture was established. The second event was a Soviet Union collapse and following large socio-economic changes in the region. The disintegration of agricultural enterprises took place in 1990-ies and former state lands were divided between its workers. As the consequence, some lands become abandoned and the processes of secondary succession have started in landscapes.

In our study the spatial data for three periods were used – 1937 (Poland before WW II), 1983 (Soviet Union) and 2008 (Ukraine). Our results show that between 1937 and 2008 the share of forest landscapes increase in Boberka from 26.5 to 50%, open landscapes – decreases from 66.2 to 48.2% and the share of settlements decreased from 7.3 to 1.8% of overall area. Recent land cover changes (from 1983 to 2008) is equal 718 ha (10.6% overall area) and about 90% of them indicate the replacement of arable land and pasture with shrubland or young forest. Among shrub species juniper dominates, among trees – spruce. Important remark is that 21 % of study area is situated in a buffer zone near the state border, established after 1945, which is under control of Ukrainian border guard and could not be used by local people for their purposes.

In 1997 the municipality was included into the Nadsianskyi Regional Landscape Park, a part of the East Carpathian Biosphere Reserve. In addition, it was planed to construct border crossing “Boberka-Zhuravyn” before the European football championship in 2012. On one hand, decreasing of anthropogenic impact on the landscapes within last three decades and creation of nature protection institution could help in preservation of the nature and cultural heritage of the territory. However, the significant challenge for this is possibility of fast building of tourist and border infrastructure accompanying with intense migration of people in the case of border crossing creation.

## **Criteria for Assessing Landscape Dynamics in the Central Part of the Eastern Carpathians. Case-Study: Bicz River Basin**

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The extent and the aspect of the landscapes in the Eastern Carpathians are extremely varied, therefore requiring well defined boundaries and hierarchization based on analysis criteria and

parameters according to the landscape specific of each typological category.

We used as analysis unit the Bicaz River basin because it covers the most representative mountain units in the central part of the Eastern Carpathians, but also for the precise delimitation by cutwaters, which allows exact quantitative measurements for certain indices representative related to dynamics of the mountain landscape.

Considering the deployment and connection between geographical components of the Bicaz basin, several criteria were identified, based on which the assessment of the landscape dynamics has been established. These criteria, which are the base for differentiating and classifying the mountain landscapes, are as follows: the spatial extent and the timeline for the landscape's representation and analysis, the dominance of elements, criteria for the evaluation of the landscape's functionality and the natural potential of the landscape. The results of the multicriteria analysis and statistical processing of the data resulted from direct calculation lead to the identification and establishing of boundaries for the current types and subtypes of landscapes.

The delimitation of the basic units of the landscape has been achieved through the direct relationship between the morphological structure and land use. The result of this analysis, outlined on the map of the basic units of landscape, shows a large number of categories, some of them being dominant on the scale of the whole basin of Bicaz, while others are included in the spatial structure of certain characteristic sectors. Therefore, the landscape in the Bicaz River basin is widely varied as image, with a regressive evolution of the diversity of the basic units, from complex and heterogeneous in the west to simple and increasingly uniform to east, due to the intense fragmentation of the areas.

## ORAL PRESENTATIONS

### Forest ecosystem services in Bucegi-Piatra Craiului LTER Site, Southern Carpathians

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Different pressures (soil formation, photosynthesis, energy cycle) as supporting ecosystem services for the benefits humans receive, directly or indirectly from ecosystems (provisioning, regulation and cultural services) are key components for description of ecosystem functioning (Costanza et al., 1997; MA, 2005). The controlling pressure of natural and anthropogenic factors on forest ecosystems status in Bucegi – Piatra Craiului LTER Site have a negative impact on ecological complexes by reducing their structural and specific diversity, functionality of different ecosystem components, including a reduction in provided goods and services, recording economic losses and endanger of human health (Vadineanu, 2001). Analyzing the social-ecological systems response to the cumulated effects of natural and anthropogenic control factors and also to their pressures, especially global changes and land use. The describing of structure, functions and processes that take place at ecosystem level requires a specific approach (multi- and interdisciplinary) and methodologies for integrated analysis, leading to the development of support systems for assuring stakeholder decision in a social and ecological management.

The long term research developed in Bucegi-Piatra Craiului LTER site is related to climate dynamics, air chemical parameters, forest ecosystems components and effects of proper natural resources management, based on ecological processes and their productive and support capacity. The spatial and temporal organization of Natural Capital components in ecological and socio-economical research is essential for integration and analysis of information combined with adoption of appropriate mechanisms for knowledge to users (Popa and Bann, 2013).

The services provided by forest ecosystems placed in Bucegi and Piatra Craiului protected areas (components of Bucegi - Piatra Craiului LTER site) refers to the supply of wood and non-wood products, game etc. Irrational use of these products may lead, on long-term (30-35 years), to a reduction in the economic capacity of these protected areas, but the contribution to economy will be over 2.5 Mil. Euros. In the same time, significant losses will be recorded in respect to other forest ecosystem services (carbon sequestration, water regulation and control of soil erosion, landscape and touristic activities). Through a sustainable ecosystems management, low values for these products on short term due to their exemption from harvesting in certain situations will return in the long term (over 25 years), their net present value becoming higher. Also, other ecosystem services generated/maintained through a sustainable forestry will be provided at the same time. The social and ecological inter - and transdisciplinary research conducted in the Bucegi - Piatra Craiului LTER site provide the possibility for scientifically knowledge on forest ecosystem services and their role in human well-being, and also on forest biodiversity as final ecosystem service and good for valuation.

At present, in this LTER site, as a couple of two protected areas, the non-woody product potential is incompletely quantified. Bucegi and Piatra Craiului parks have a substantially potential in this way. Carbon sequestration forest function can provide over 33 Mil. Euros in the following 25 years. Only by adopting a legal framework at national level related to monitoring and guarantee

of sequestrated quantities, voluntary markets of carbon certificates can be accessed.

We acknowledge the financial support of European commission through FP7 Programme (OpenNESS project) and of Romanian Ministry of National Education through “GEDEFOR” Programme (PN09460101 project).

Key words: forest ecosystems, biodiversity, ecosystem services, human wellbeing.

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### **Ecosystem modelling tools for assessing land use change and climate change impact on ecosystem services of The Carpathians**

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Land use change and climate change are undoubtedly the greatest challenges of the 21st century. Huge amounts of carbon dioxide have been released to the atmosphere via burning of fossil fuels, cement manufacturing, land use conversion and other processes, which unbalance the energy budget of the Earth-atmosphere system and trigger global warming. At present terrestrial biosphere (and also the oceans) mitigate climate change as biosphere and oceans together sequester about half of the CO<sub>2</sub> that is emitted to the atmosphere annually by human activity. But lack of appropriate knowledge about the *future evolution* of terrestrial ecosystem functioning is a major problem which causes the main uncertainty in the climate projections and ecosystem studies. However improved ecosystem modelling would not be possible without appropriate data. Data plays a central role in model development, testing, optimization, validation and in simulation studies, that shaped up the Model–Data–Fusion concept (Williams et al. 2009). Fortunately, due to considerable progress in the availability of input and experimental data sets in the past few decades (e.g. FORESEE climate database, FLUXNET data, biomass measurements, plant trait databases, remote sensing, etc.) new possibilities opened in biogeochemical model development.

Biodiversity informatics (or ecoinformatics) plays a central role in the research community’s efforts to address the urgent questions around land-use, environmental change and ecosystem services that are facing governments and regions worldwide. It can provide ultimate IT tools, but

it is clear that some barriers to progress are also sociological, basically persuading people to use the technological solutions that are already available. This is best addressed by developing more effective coordinated coupled modelling systems that deliver immediate benefit to the user, hiding the majority of the technology behind simple user interfaces relating to our use of the natural environment (Hardisty et al. 2013). Our emphasized aim is to address Biome-BGC ecosystem model developments and new IT tools based on the model according to the main components of the Model–Data–Fusion framework.

Biome-BGC – developed by the Numerical Terradynamic Simulation Group, University of Montana – is a widely used, biogeochemical model that simulates the storage and flux of water, carbon, and nitrogen between the ecosystem and the atmosphere, and within the components of the terrestrial ecosystems (Thornton, 2000). Several researchers used and modified the original Biome-BGC model in the past (Churkina et al. 2003; Vetter et al. 2008; Trusilova et al. 2009). Most recently our research group developed Biome-BGC to improve the ability of the model to simulate carbon and water cycle in various ecosystems (Hidy et al. 2012). The modifications include structural improvements of the model (e.g. the simple, outdated, one-layer soil module was replaced by a multilayer soil module; drought related plant senescence was implemented; model phenology was improved). Recent developments and implementation of the model can help to simulate annually varying cropland or forest management options (i.e. ploughing, planting, harvesting, application of fertilizers, forest thinning, clearcutting), dynamic whole plant mortality due to disturbances, and groundwater depth control for lowland ecosystems. Our improved model is called Biome-BGC MuSo.

The key informatics technologies applied to development of the new integrated IT tools are i) scientific workflow management system (Taverna) embedded to a virtual laboratory portal (<http://portal.biovel.eu>), ii) Drupal content management platform for handling input and parameter data sets related to ecosystem modelling (Biome-BGC Projects database), iii) rest style web service technology (Biome-BGC specific new services), iv) BOINC desktop grid technology and 3G Bridge services for parallel distribution of computation demanding simulations, finally v) PostgreSQL/PostGIS technology for spatially extended simulations. Although the model is embedded in web services and deployed on rather different computing infrastructures, workflows can easily orchestrate the web services to fulfil the ultimate scientific goals: effective, flexible and fully reproducible ecosystem modelling investigations.

The Biome-BGC MuSo was tested in a case study of grasslands in the Carpathians taking into account diverse environmental and anthropogenic drivers. In this approach calibrated and validated biogeochemical model (MuSo v1.2) was coupled with a number of climate projections to estimate present day and future trends of grassland productivity and uncertainties of carbon sequestration. The simulations were driven by 10 climate change scenarios retrieved from the so-called FORESEE database (Open Database FOR Climate Change-Related Impact Studies in Central Europe; <http://nimbus.elte.hu/FORESEE>; Dobor et al. 2013). We defined representative natural and semi-natural grassland types according to NATURA 2000 habitat type classification, combined with obvious management regimes (no management, grazing, mowing) as functional 'end-members' of the grasslands of the region. Finally, end-members have been combined to get spatially explicit simulation results. Net Primary Production (NPP) and different carbon cycle components (Gross Primary Production, Total Ecosystem Respiration, Net Biome Production) have been simulated for the entire Carpathians. Analysis of simulation results for the end-members revealed that future changes strongly depend on site conditions and management associated to grassland types.

In a broader context the new model version and Biome-BGC specific set of IT tools are enable a wider array of scientists to perform ecosystem scale simulations and to perform analyses not previously possible due to high complexity and computational demand.

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## Concept of silvicultural management in the Western Carpathians

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In last decade, forest owners and managers are faced with a new situation in forest stands in the Czech part of the Western Carpathians (the Moravsko-Slezské Beskydy Mts.). Traditional silviculture management focusing on spruce monocultures fails in current stands, since they exhibit decline symptoms such as drying and yellowing due to lack of nutrients (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.

On the basis of long-term observations and other studies, new silviculture concept is proposed for use within the area of interest. Firstly, thinning programs to be applied in spruce stands on nutrient-rich and nutrient-poor sites were formulated (Slodičák et al., 2013). Analyses of possible soil-improving function of some tree species, which may be used to restore nutrient supply, were presented subsequently (Novák et al., 2012).

Nowadays, conversion and regeneration techniques (incl. target species compositions) are added and introduced in this contribution.

### Methods

New silviculture concept is based: (1) on analyses which were realised in model Jablunkov region, the Beskydy Mts. (Šrámek et al., 2008) and (2) on knowledge from other regions with comparable conditions. Study about climate development (Bagár, 2007) and forest management (Plíva, 2000) were also included. Main interest is focused on two forest vegetation zones, where beech or beech + fir naturally dominate.

The term „Target tree species composition“ (TTSC) was used in our study. TTSC is



composition at the end of rotation optimized from the viewpoint of economy, biology and ability to fulfil all requested forest functions and services with respect to particular natural conditions. As for above mentioned process of forest conversion, TTSC was proposed in two variants: Basic TTSC and Transient (Ameliorative) TTSC.

Basic TTSC proceeds from the present information on spruce decline and increased drought stress on the sites unsuitable for spruce. It can be achieved over a longer time span (one or two rotations).

Transient Ameliorative TTSC is based on ability of some mostly broadleaved species to ameliorate the site, to take the nutrients from deeper horizons and to mitigate the throughfall acid deposition. The main aim of this composition is to ameliorate the site and to prepare it to gradual implementation of Basic TTSC.

## Results and recommendations

### Species composition

The basic strategy for new silviculture concept is based on following principles (for detailed example of proposal see table 1):

1. To omit Norway spruce in lower (naturally dominated by beech) vegetation zone. On the other hand, to maintain an admixture of Norway spruce for future natural regeneration in higher vegetation zone dominated by beech with fir
2. Share of beech would not be increased because beech is not the best species from the viewpoint of amelioration and production.
3. Proposed species composition should include the species, which exhibit experimentally documented positive soil-improving and production effects (wild cherry, elm, aspen, birch, lime and introduced Douglas-fir).

**Table 1:** Species composition on fertile sites in vegetation zone naturally dominated by beech and fir. Comparison of common practice to new silviculture concept.

| Source                  |                    | Species composition |     |     |     |     |     |     |     |     |     |     |     |
|-------------------------|--------------------|---------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                         |                    | NS                  | EB  | SF  | La  | Li  | Ma  | A   | Dg  | WCH | Asp | E   | BR  |
| Present management plan | NS dominated sites | 6-7                 | 2-1 | 1-2 |     |     | 0-1 |     | +   |     |     |     |     |
|                         | EB dominated sites | 0-2                 | 7-5 | 2-1 | +   |     | 0-1 |     | +   | +   | +   |     | +   |
| Natural (Plíva, 2000)   |                    | +                   | 5-7 | 3-5 |     |     | +   |     |     |     |     |     |     |
| New concept             | Basic TTSC         | 1-3                 | 2   | 2   | 1-2 | 0-+ | +2  | 0-1 | 0-1 | +   | +   | 0-+ |     |
|                         | Ameliorative TTSC  | 0-1                 | 1-2 | 2-3 | 0-+ |     | 1-3 |     | +   | 0-1 | 1   | 0-+ | 0-2 |

NS – Norway spruce, EB – European beech, SF – silver fir, La – larch, Li – linden, Ma – sycamore maple, A – ash, Dg – Douglas-fir, WCH – wild cherry, Asp – aspen, E – elm, BR – birch, numerals denote decimal proportion of individual species sharing the management unit, + means proportion less than 10%.

### Techniques of conversion

Under-planting and inter-planting are the most common conversion techniques in forests. Main reason for planting seedlings into the existing stands (remnants of stands) is to take advantage of their ability to soften the climate extremes, to protect the forest soil from erosion and drought or from risen water table during the conversion.

Under-planting is used in older stands. This technique is recommended in broken-canopy stands (canopy 40 – 60% due to mortality or deliberate preparatory cut). Regeneration should be managed using relatively small (0.03 - 0.08 ha) canopy gaps, which are (1) not shadowed by crowns and (2) not in drip zones of the shelter trees.

In younger stands (to the top height of ca 4 m), inter-planting should be used for integrating the present stand into the newly created structures. We can use regeneration elements such as strips or round openings (with or without shelter) according to inter-planted tree species or local conditions.

This study was funded by Czech Ministry of Agriculture in the frame of MZE0002070203 research plan “Stabilisation of forest functions in anthropically disturbed and changing environmental conditions”.

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## Regulating ecosystem services assessment for sustainable spatial planning on local level

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Taking into consideration the development strategy of the European Union, sustainable development, so the development adjusted to the environmental conditions, should account for the basis in spatial planning. Hence, spatial planning process should always begin with the assessment of environmental conditions and on the basis of this proper zoning could be conducted. At the same time, however, such assessment is a difficult issue for a comprehensive approach. One of the approach applied for environmental management is the concept of ecosystem services. Ecosystem services are defined as the benefits provided by ecosystems to society (Costanza et al.,

1997; MEA, 2005) and they are divided in four categories: provisioning, regulating, supporting and cultural services. Regulating services, understood as the benefits obtained from the regulation of environmental processes (MEA, 2005), may be used for spatial development planning as they account for proper indicators of environmental resilience to human pressure. However, the assessment of the regulating services involves numerous problems. Apart from those related to assessment of ecosystem services in general (e.g. quantifying the benefits), there are some specifically related to regulating services. One of them is that there is no final product, whose value could be measured. In the consequence, the environmental quality is often used as an indicator of service flow and the state of the ecosystem. Unfortunately, the environmental quality does not result directly from the amount of work that is needed to achieve the desired state of the environment because the magnitude of human pressure is also of great importance (Villamagna et al., 2013). According to the procedure proposed by A. M. Villamagna et al. (2013), assessment should be based on the regulation work required to diminish the negative effects of pressures affecting on the quality of the environment. On the other hand M. Gutierrez and M. Alonso (2013) stated that some regulatory services can be assessed only on the basis of the negative consequences of their lack. What is more, estimating the demand for services is difficult because it requires not only the knowledge of the pressures, but also information on the legal standards related to maximum permissible values of pollutants. Therefore, often the need for regulating services is measured in relation to the population (Burkhard et al., 2012), which does not reflect exactly the size of regulating services provided.

The aim of the presentation is to show the results of the assessment of regulating ecosystem services in the three villages of different environmental conditions located in the Polish part of Carpathians. Regulating services such as: immobilization and filtration of pollutants, drainage of contaminants, groundwater protection as well as self-purification of surface water were considered. The assessment was based on the potential environmental capacities, environmental quality and the magnitude of human impact. In the assessment procedure thematic maps (numerical terrain models, hydrographic maps, geoenvironmental maps, soil and agriculture maps, orthophotos, etc.) and data from the environmental quality monitoring stations were used. The assessment was conducted in non-monetary way in the relation to point system assessment of potential environmental capacities, environmental conditions and the magnitude of human impact. Firstly, the potential environmental capacities were assessed on the basis of environmental properties such as: type of rock, soil pH, clay and humus content in the soil, slope, functional type of surface, depth to groundwater table, land cover type, etc. Secondly, environmental quality was analysed in the relation to maximum permissible values of pollutants and the size of human impact was assessed. Comparison of these three values made it possible to assess the size of regulating services. The selection of test areas of various environmental properties allows to show the differences in spatial distribution of specific environmental capacities, environmental quality, human impact and consequently differences in the regulating services intensity distribution.

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## POSTER PRESENTATIONS

**Bats and ecosystem services**

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Ecosystem services are natural processes that benefit and increase human well-being. As a member of ecosystems, because of different dietary preferences, foraging behaviors and adaptations of different bat species, they may play many roles and contribute several types of services. Globally they realize important function in arthropod suppression, seed dispersal and pollination as well as forest regeneration (Kunz et al., 2011). Humans receive direct benefits from bats as guano for fertilizer, and through contributions to medicine and culture in some continents. European bats provided mainly one of the noted types of ecosystem services, arthropod depression. However, evaluation of such activity is rather very complicated. Bats as night animals can respond to irruptive or pulsed resources in ways generally not possible for majority of other vertebrata. Migrating bat species link ecosystem processes and fluxes that are separated by great distance and times. There is insufficient data and publications concerning economic valuation of ecosystem services provided by bats. Additional research regarding the topic of the ecosystem services and bats would be extremely useful.

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**The Central Western Carpathians - as an example of the degradation of a public space with a valuable landscape for outdoor advertising**

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The outdoor advertising has been started to develop from the year 1835 when in New York City. That form of advertising meaningfully took on importance in USA at the turn of the 19th and 20th century. In East-Central Europe, a dynamic development of advertising occurred in the 90s years of 20th century (Anioł 2004; Gruszczyński 2005).

The author's purpose was to identify an influence of advertising on a degradation of the areas of high landscape values. The Research was made on both sides of The Central Western Carpathians: Polish and Slovakian. The observations were made on 280 kilometers of roads making a circle around the Tatra Mountains and 170 kilometers of a regional and local roads covering the area among them.

The results of the cataloguing clearly showed the diversity in an arrangement of advertisements

on the area of the research. A greater number appear in the "belt road" in Poland than in Slovakia. On the Polish side 1 824 advertising carriers were catalogued while on the Slovakia – 483. Along the roads in the Polish, 1 km there are an average of 24 outdoor advertising, while in Slovakia – 6. In Slovakia, outdoor advertising is arranged regularly, in Poland there are big differences. The accumulation of advertisements exist on the busiest road between Nowy Targ and Zakopane. On every of 3 marked sections with elements for measurement 923 advertisements were catalogued (61 adverts/1kilometer of the road). The greatest number of them were inventoried between Poronin and Zakopane – 413 (82 adverts/1kilometer of the road). In Slovakia, the largest number of outdoor advertising were inventoried in the section in Ružomberok (78 adverts; 15 adverts/1kilometer of the road). The lowest number exist in the wooded area (Spišská Belá - 3 adverts) and in small villages (Liptovský Hrádok - 4 advert and Dzianisz - 10 advert).

In both countries, the number of the adverts grow in the suburbs. What is more, the greater accumulation exists in the vicinity of shopping centers, gas stations and driveways. In Slovakia the greater number of adverts exists in a mountain passes. The lowest number exist in the wooded area and in small villages.

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## Close to nature forest management in Hungary, based on Pro Silva principles

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Pro Silva Europe, founded in Slovenia in 1989, is a federation of foresters who advocate forest management based on natural processes. Objective of the "movement" is to support a paradigm shift in forest management. Pro Silva recommends maintenance of continuous forest cover – and full use of natural dynamic forest processes, which is an alternative to the conventional silvicultural methods.

Pro Silva Hungaria started its advocacy work in 1999, supported by foresters, forest ecologists and green NGO's as well. In the last 15 years, both state forest companies and private owners are taking part in the development of the new method, and forest authorities also support the process. Based on the new Forest Code of Hungary (2009) it is now partly obligatory to use continuous cover forest management in state forests, replacing clearcut and uniform shelterwood systems.

Applicability of Pro Silva principles on a large scale is still disputed. Its economic viability is questioned by most foresters, just like its applicability in certain forest types, such as mesic oak-hornbeam forests, or floodplain forests. However advantages of continuous cover forest management from nature conservation and touristic point of view is clear, and makes it an accepted alternative of conventional silviculture methods especially in protected or recreational areas. Continuous cover forest management is an appropriate response to the challenges of climate change, since it results

uneven aged mixed stands which are more resilient against different effects of climate change – such as stronger winds, drought, floods, etc. Local forest climate can also be maintained better, if forests are not interrupted by felled areas.

### **Ecosystem services, current utilization activities and their impacts on the alpine environment of the Belianske Tatry Mts.**

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The common problem in majority of national parks is to find the optimal balance between recreational use and nature preservation as well as an optimal and sustainable management. In Slovakia, there are research activities dealing with this actual topic in the Belianske Tatry Mts, a part of the Tatry National Park.

High mountain area of the Belianske Tatry Mts offers mainly recreational use. But alpine ecosystems provide for people also other broad range of benefits known as ecosystem goods and services. Goods provided by ecosystems include, e.g. non-timber forest products, water; services include e.g. water supply and retention, pollution control, soil formation and various regulatory mechanisms of climatic conditions, populations of animals and plants. The main scientific aim is to recognize all natural resources of the alpine area of the Belianske Tatry Mts in order to assign the value of ecosystem services with respect to the establishment and management of protected areas.

The recreation and sport potential of the objective area is high. According to the mountain shape and unstable bedrocks, there are no many other possibilities for other activities like e.g. skiing. Annually, the alpine zone is under the pressure of excessive tourism. In consequence of nature destruction, the ridge path has been closed since 1978. During 1993 – 2009, the path leading from the Tatranská Javorina to the Ždiar village was available only in one-way direction. Since 2009 it is available in both directions. Actually, paths, saddlebacks and their surrounding are increasingly destructed and deformed.

Significant changes in alpine environment caused by the human society can lead to its overexploitation, distribution of a non-native species, vegetation and soil destruction and finally to complex damage of native ecosystems and consequent reduction of biodiversity. Conservation of ecosystems is a moral imperative and a practical necessity for current and future generations.

(Acknowledgement: The contribution was prepared within the grant project of the Ministry of Education of the Slovak Republic and the SAS Nr. 2/0025/13 “Current utilization of high mountain landscape, its impacts on change of environment and assessment of carrying capacity of selected national parks of Slovakia” and within the grant project of Slovak Research and Development Agency Nr. APVV-0866-12 „Evaluation of ecosystem functions and services of the cultural landscape“).



## Current utilization of high mountain landscape, its impacts on change of environment and assessment of carrying capacity of selected national parks of Slovakia

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The main aim of the project Current utilization of high mountain landscape, its impacts on change of environment and assessment of carrying capacity of selected national parks of Slovakia is to evaluate consequences and effects of actual utilization of the high mountain landscape by man on selected sites and to assess carrying capacity of selected areas for given activities. The idea is to bring new data for science and praxis related to evaluation of implications of actual utilization of high mountain areas and on carrying capacity assessment of area for particular activities. Special attention will be given to selected affected sites in subalpine and alpine vegetation belt, with various degrees of destruction. Research is made on selected model areas.

High mountain landscape represents mosaic of valuable habitats demanding favourable conditions for conservation of specific ecosystems with a substantial insular effect, glacial relicts, endemic species, threatened and protected taxa of flora and fauna. Ecosystems are characterized by the high ecological, socio-cultural and economic value. Results of experimental research, mapping of landscape changes, various interpretations and proposals can reflect to monitoring of real state of nature in National parks, its protection and legislation.

(Acknowledgement: The contribution was prepared within the grant project of the Ministry of Education of the Slovak Republic and the Slovak Academy of Sciences No. 2/0025/13 "Current utilization of high mountain landscape, its impacts on change of environment and assessment of carrying capacity of selected national parks of Slovakia" and within the grant project of Slovak Research and Development Agency Nr. APVV-0866-12 „Evaluation of ecosystem functions and services of the cultural landscape“).

## Non-wood forest products: provisioning or cultural ecosystem services of forest landscapes?

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Forest landscapes provide huge variety of goods and services for human wellbeing for ages. After Millennium Ecosystem Assessment 2005 there is growing interest to identify, assess, use and maintain ecosystem services. Number of scientific papers concerning ecosystem services is rapidly increasing. However, managing forest ecosystem services in certain landscape in a sustainable way is still a big challenge for decision-makers, landscape planners and managers. The aim of this study was to analyse the use and governance of non-wood forest products as provisioning and cultural ecosystem services of forest landscape in selected rural areas in Småland (Sweden), Kortkeross (Russia) and Roztochya (Ukraine). These areas were selected because of the similar historical use of forest resources, predominating rural residency, a high percentage of forest coverage and free accesses to forest products collection. Non-wood forest products belong to both provisioning (food, wild plant and animal products etc.) and cultural (spiritual and religious values, inspiration, traditional knowledge, recreation and tourism, etc.) ecosystem services.

For this study in-depth semi structured qualitative interviews with local rural residents in forested region were done in 2011-2013 (n=234). We interviewed people how they used forest resources and what benefits they got from the forest landscapes.

Results show that among provisioning ecosystem services vital for rural livelihoods were food (berries, mushrooms and birch sap) and livestock, natural medicines (plants, mushrooms) and fibre (fire wood). Among cultural ecosystem services tourism and recreation, religious values inspiration, and traditional knowledge were mentioned as important. Provisioning forest ecosystem services were more important for local people in the Ukrainian and Russian case studies. Berries, mushrooms, medicinal herbs, cattle grazing were used for personal consumption and for additional income. Many of respondents state that non-wood forest products were the only source of income. For respondents with high income, the cultural services were important. In the Swedish case study the provisioning forest ecosystem services were out of minor importance. Game meat, berries, mushrooms were used for personal consumption; at the same time cultural ecosystem services were the most important. The practice of collecting non-wood forest products have been declining due to lifestyle changes, urbanization and general changes in land-use patterns and a decreased contact with nature. Finally, we discussed how forest ecosystem services might increase the welfare of rural residents.

Acknowledgement. To Marine Elbakidze for advising.

### ORAL PRESENTATIONS

#### **The conditions for the sustainable development of the Ukrainian Carpathians**

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The current Ukrainian legislation recognized that anthropogenic and human impacts on the environment in Ukraine are several times higher than the corresponding rates in developed countries. The root causes of environmental problems in Ukraine are: inherited economic structure, depreciation of fixed assets, the current system of state administration in the field of environmental protection, the lack of clear division of environmental and economic functions, the lack of formation of civil society, the lack of understanding in the community priorities for preserving the environment and benefits sustainable development and environmental non-compliance with the law. All of the common processes of land degradation, the most ambitious is the erosion (about 57.5 percent of the territory), pollution (20% of the territory), flooding (about 12 % of the territory). Nutrient content of the soil reduces and annual losses of humus make up 0.65 tons per 1 hectare. Forests cover more than 15.7 % of Ukraine (9.58 million hectares), located mainly in the north (Polissia) and west (the Carpathians). To achieve the optimal rate of forest cover (20 %) is necessary to create more than 2 million hectares of new forests (Law of Ukraine).

Occupying less than 6% of Europe, Ukraine has about 35% of its biodiversity (Biosphere Ukraine has over 70,000 species of flora and fauna, including flora – more than 27 thousand species of fauna – more than 45 thousand species. Prior to the nature reserve fund of Ukraine includes more than 7608 areas and sites with a total area of 3.2 million hectares (5.4% of the total area of the country) and 402.5 hectares within the Black sea. Much of the biodiversity in Ukraine concentrated in the Carpathians. Nevertheless, the proportion of protected areas in Ukraine is insufficient and remains much lower than in most European countries (Law of Ukraine).

Therefore, to ensure the sustainable development of mountain regions of the Carpathians in Ukraine is important to develop new approaches to address the socio-economic and environmental problems. However, the problems of mountain areas in the Carpathians are not only in Ukraine but also in other countries.

Until recently, the significance of the Carpathian mountain research to the global mountain research community has not been adequately reflected. Even though this eco-region offers perfect conditions for a “natural laboratory” for global change research and has a rich mountain research history of its own with a wealth of local expertise and data, publishing in international journals was relatively low (Körner 2009).

The idea of the Science for the Carpathians initiative goes back to the negotiation process of the Framework Convention on the Protection and Sustainable Development of the Carpathians (Carpathian Convention) in 2001. The Ukrainian Government requested the United Nations Environment Programme – Regional Office for Europe (UNEP/ROE) to facilitate an intergovernmental consultation process among the Carpathian countries with the aim of drafting an international convention on the Carpathian mountains to be adopted at the Fifth Ministerial Conference “Environment for Europe” in 2003 (Bjørnsen Gurung 2013).

The Carpathians are one of the most environmentally sensitive areas of Europe. In many places here goes an excessive exploitation of natural resources, particularly deforestation.

Especially threatening situation in this context observed in Ukrainian and Slovak part of the mountain array. For example, in northern slopes highest Ukrainian top of the mountain Goverla annually cut down about 40 thousand m<sup>3</sup> of wood. Only in recent years on the lands projected to generate protected areas are completely cut down more than 300 hectares of forest water regulation. This leads to disruption of the natural balance, leading to the degradation of scenic landscapes, habitats decrease, and sometimes to the extinction of many rare species of plants and animals, a significant gap in socio-economic development of this region and rise to catastrophic natural disasters (Hamor 2010).

The highest mountain region of Ukraine is the Ukrainian Carpathians. The territory of the region requires special attention for him, given his role in the recreational industry and the need to maintain the diversity of flora and fauna, as it is here preserved some unique forms of plant and animal life.

The potential of tourism and recreation in Ukraine is not enough using. However, this area has some significant advantages in relation to its effective development opportunities as well as the cost of creating jobs is much less than the industry, and the reversibility of investment capital several times higher than in other areas.

The socio-economic model of the Carpathians must be economically profitable for Ukraine and neighbouring countries (Poland, Slovakia, Hungary and Romania). For this it is important to establish closer cooperation with the EU through participation in a number of applications including, Horizon 2020 and the development of relationships within the Carpathian Euroregion (Dovbenko 2013).

International experience shows that the effective area of the development of mountain regions is the development of various forms of recreation management. The natural base of the resort complex Ukrainian Carpathians are more than 800 springs and wells curative mineral waters, curative mud resources. Area recreational landscapes is 616.7 hectares, and their one-time capacity in an environmentally acceptable load is estimated at 1434.7 thousand people. At the same time, the Alpine region with 3.5 times smaller recreational areas annually receives 40 million tourists and 60 million tourists and travellers (Kravtsiv et al., 1993).

Environmental protection has become an important task of the business. New modern business policy in Carpathian should include investment in programs for renewable energy, which creates the possibility of reducing production costs, energy efficiency and environmental protection, which is a response to rising energy prices.

#### Acknowledgement

Questions of creation the conditions for formation the sustainable development the Ukrainian Carpathian are considered. It is analyzed the opportunities of increasing the potential of recreation industry and minimization of negative influence the human activity on the environment.

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## Factors affecting the persistence of traditional agricultural landscapes in Slovakia during the collectivization of agriculture

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Collectivization of agriculture (1950s - 1970s) was one of the most important periods in landscape development in Slovakia. Traditionally managed agricultural landscapes, that covered more than half of the Slovak territory, were transformed into large-scale fields by a process of land consolidation, and only fragments of traditional agricultural landscapes survived.

The current area of traditional agricultural landscapes is about 44,455 ha, which is less than 1% of Slovakia (Špulerová et al. 2011). The purpose of this contribution is to identify the main geographic factors and determine their potential role in the transformation or persistence of traditional agricultural landscapes in Slovakia during times of agriculture collectivization. Specifically, our aims were to (1) identify the geographic factors that played a key role in the process of land consolidation, (2) compare the geographical factors of the collectivized and uncollectivized fields and (3) find the set of decision rules used for keeping the fields traditionally managed or for collectivizing them.

We mapped the preserved TAL using a combined method comprising visual interpretation of aerial photos and field surveys in 2009 - 2011 according to method proposed by Dobrovodská et al. (2010) and (Špulerová et al. 2011). We analyzed four types of agricultural field: arable fields, grasslands, vineyards and orchards. The mapped TAL polygons were assigned to these four types according to the dominant land-cover type within the mosaic. To obtain land-cover information from the time of collectivization, we used historical military topographical maps from 1950-1956. The boundaries of collectivized fields were taken from the current Land Parcel Identification System (LPIS) which is the database of individual agricultural fields that are eligible for Common Agricultural Policy subsidies. We then statistically analyzed the various geographical factors and their influence on the transformation process of traditional and collectivized fields, i.e., slope steepness, soil fertility, distance from settlements and isolation from regional capital cities. For each polygon, we calculated the average value of the independent predictor variables and compared collectivized (48,849 polygons) versus non-collectivized polygons (2,871 in total) as the response variables. To do so, we used a classification tree analysis.



From our findings, we have strong evidence that collectivization particularly affected those land patches that had the potential to increase production. Traditional agricultural landscapes remained on steep slopes, less fertile soils, and on sites close to the settlements, but that were more isolated from regional capital cities. Steepness is the major discriminant variable for collectivization of arable fields and vineyards. The small-scale fields that were located on steep areas were not accessible for heavy machinery, and therefore remained untouched by collectivization. Since soil fertility is statistically highly correlated with slope steepness ( $R = -0.80$  for all polygons), it is difficult to determine pure relationship between those two factors and TAL persistence. Our result identified soil fertility as an important driver. According to land consolidation rules the private parcels that were barriers for collective farming were taken away from owners and exchanged with parcels with the same or 20% lower fertility. Practically, the private farmers, which did not join the cooperative farm, often got the least fertile soils in the cadastral area (Demo 2001). Accessibility (distance from settlements) played an ambiguous role in TAL persistence. On the one hand, the farmers that entered the cooperative farms were allowed to keep 0.5 ha of arable land and additional 0.5 ha of pastures in submountaneous areas for family farming.

This land was usually located close to settlements. On the other hand, the land of private farmers, that did not join the cooperative farm, was re-located to remote areas during the land consolidation process (Demo 2001). Since the number of private farmers was successively reduced most of the traditionally managed fields observed today remained closer to settlements. This ambiguous role of accessibility described above is responsible for the low explanatory power of this variable. The accessibility is the main discriminant in the case of grassland only, but the overall importance of geographical factors is low. Isolation (distance from regional capital city) did not play such an important role.

We analyzed only four geographical factors, which we hypothesized to be the most significant for TAL persistence in a process of agriculture collectivization. It appears that the four predictor variables explain the persistence of traditional orchards and arable fields sufficiently, since the misclassification rates (ratio of misclassified area to the total classified area) were low. In the case of grasslands, the total misclassification rates were low as well, but this was mainly caused by an unequal number of collectivized and non-collectivized fields. Only 38% of traditional grasslands were classified correctly. Since the management of collectivized and uncollectivized grasslands is relatively similar and is not as intensive as in the case of arable land, we may, therefore, conclude that geographic conditions did not play an important role in collectivization. In the case of vineyards, the role of analyzed geographical factors was influential, but there were other factors that may have played significant roles as well. These include economic factors, changes in population density and age structure, historical land use, cultural differences, education level and willingness for innovation, as well as other factors that played a role on a local scale.

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- This contribution is the result of project funding from the Slovak Research and Development Agency (No. APVV-0866-12, “Evaluation of ecosystem functions and services of the cultural landscape”).



## Improving Rural Tourism Training – an approach based on understanding local communities' needs

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Many communities in rural and mountainous areas are facing challenges and difficulties including – among others – unemployment, depopulation, environmental degradation or social problems (Sharpley, 2002). According to the World Tourism Organization (WTO, 1996), rural tourism is an important aspect in the facilitation of rural development as it offers an opportunity for income generation, job creation and diversification (Brandth & Haugen, 2011). The 'EU Strategic Guidelines for Rural Development' (European Commission, 2006), defines as third priority: "Improving the quality of life in rural areas and encouraging diversification of the rural economy" (European Commission, 2006, p. 26) and emphasizes the diffusion of ICT as an important factor for the diversification of rural livelihoods, which is a fundamental aspect also recognized by (Galloway, Sanders, & Deakins, 2011).

Already in 1997, Getz and Page highlighted the fact that rural tourism managers, who often lack in previous experience and formal business education, might need formal management training (Page & Getz, 1997) in order to drive their business to success. As evidenced by research, projects and publications (Campbell, 1999; Gannon, 1994; Simpson, 2008) the mainstream rural tourism development frequently does not empower rural mountain communities, as they are often excluded from the development processes. Sproule (1996) highlighted the need to involve communities effectively in the development of activities, empowering people to mobilize their own capacities. In this context, the lack of knowledge about valorization, entrepreneurship, management and promotion of tourism resources as well as the lack of knowledge in new media technologies in each and every aspect of the tourism goods creation, management and promotion represent crucial challenges (Inversini & Cantoni, 2011; Inversini, Cantoni, & Bolchini, 2010; Inversini, Cantoni, & Buhalis, 2009; Marchiori, Inversini, Cantoni, & Dedekind, 2010).

The goal of this research strives to understand current shortcomings among the local population of five rural mountain regions (Austria, Italy, Poland, Ukraine and Romania) regarding tourism knowledge, skills and attitude, putting a focus also on information and communication technologies. Based on the identification of these needs as well as on a structured literature review regarding necessary competencies in rural tourism, the authors aim to outline a pedagogical training model for successfully empowering communities in the establishment of rural tourism activities. Additionally these core competencies can impact on the creation of learning material targeted to rural tourism managers (Page & Getz, 1997).

The paper is based on a multi-method approach. There was carried out an extensive literature review, conducted on different academic databases (Annals of Tourism Research, Journal of Rural Studies, Journal of Travel Research and Tourism Management) and on Google scholar. In order

to query databases a series of keywords have been selected. This selection was not only able to provide a general overview about the rural tourism competencies but also to add value to the modern rural tourism managers, providing directions for future research and improving on the field of the rural tourism training. Insights regarding the needs of the local stakeholders are drawn from the community consultations as well as a quantitative survey that both have been implemented in the course of the *InRuTou* project.

Results show that rural communities face distinct challenges and thus, need to gain capacities in specific competence fields. Integrating these competences into a training approach could contribute to successfully empowering communities to establish rural tourism activities. Finally, the paper outlines practice and policy recommendations, including incorporation of the project results in the activities related to the implementation of the Carpathian convention.

As an example of their practical use, the applicability of the results to the pilot areas in Ukraine is briefly described.

The paper is written in the framework of the project Innovation in Rural Tourism (InRuTou), funded by the Lifelong Learning Programme of the Education, Audiovisual and Culture Executive Agency of the European Union. The InRuTou project was launched in January 2012 with the objective of providing new skills and competencies for the development of six eLearning modules to rural tourism business managers, in five pilot areas in the Carpathians, the Alps and the Apennine (Austria, Italy, Poland, Ukraine and Romania). The project has been funded with the support from the European Commission and was supported by *IMC University of Applied Sciences Krems, Associazione Seed, Romontana, Ecopsychology Society and Information Center Green Dossier*.

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## **The use of the Carpathian landscape for educational purposes on the example of secondary schools in Krakow and Tarnow cities**

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Nowadays, the need for outdoor environmental education is increasing due to growing awareness of both authorities and society. Self-actualization and life-long learning in connection in various forms of educational tourism acquire growing regard in modern society. In schools, environmental education (usually within biology and geography lessons) is obligatory as teaching young people about environment is especially beneficial for the future environmental attitude. Additionally, It have already been admitted that outdoor environmental education is more effective than indoor one. Thus, outdoor environmental education is an important ecosystem service; however, most often it is omitted in the ecosystem services literature. Therefore, the extent of usage of landscape for educational purposes is poorly known. In this respect, the aim of the study is to investigate how the landscape of the Carpathian Mountains is used for educational purposes by secondary schools teachers.

As the biggest demand for environmental education is in the big cites, the cities of Krakow and Tarnow were chosen for the study. The cities the greatest number of secondary schools in Malopolska Province. Both of them are located on the foothills of the Carpathian Mountains and in the basins neighbouring them. Principally, they have good transport accessibility with most of the Polish Carpathians.

In order to obtain information how the landscape of the surroundings of Krakow is used for educational purposes, the questionnaires with geography teachers and students from Krakow and Tarnow secondary schools were conducted. The research included visiting nine secondary schools both in Krakow and Tarnow. In Tarnow, surveys were conducted with the group of 12 geography teachers and 180 students, and in Krakow – with the group of 9 geography teachers and 180 students.

The questionnaire included the following questions for geography teachers: (1) Do field classes give an advantage to teach students about natural environment? (2) What hinders the organisation of outdoor geography lessons? (3) What places would you recommend to visit for an educational purposes and what problems are appropriate to discuss there? (4) Did you conduct outdoor lessons with secondary schools students during the last three years (how many times)? (5) Which places did you visit with students in order to conduct a geography lesson? (6) What problems were discussed during field classes? (7) How long did the outdoor lessons last approximately? (8) Which students participated in outdoor lessons (students with expanded program of geography, students without

expanded program of geography, members of special interests groups)? The surveyed teachers were also asked about the duration of their work as a teacher.

The secondary schools students were asked the following questions: (1) Did you participate in outdoor geography lessons during secondary school education (how many times)? (2) Which places did you visit with teacher for a geography lesson? (3) What problems were discussed during field classes? (4) How long did the outdoor lessons last approximately? (5) Which classes were conducted in the field (geography lesson, special interests group meeting)? (6) Do, in your opinion, outdoor classes give an advantage to learn about natural environment (justify your answer)? (7) Which places would you like to visit during your school classes? (8) What problems should be discussed there?

The survey reflected the actual use of education as an ecosystem services. In this case, it was the usage of the Carpathian landscape environment for the purpose of outdoor environmental education at secondary schools. Regrettably, the interviews revealed that the usage of landscape for educational purposes during school lessons is poor. Also, the students' knowledge about the variety of landscapes in the surroundings is limited. However, students' and teachers' opinions show that there is a big potential demand for outdoor education as an ecosystem service.

## **Carpathian Informatorium: Facilitating Access to Information on the Carpathian Convention and to Carpathian Data Resources**

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One of the major challenges in effective management of the "Carpathian Space" in line with the provisions set forth in the Framework Convention on the Protection and Sustainable Development of the Carpathians (Carpathian Convention) is insufficient access to credible and up-to-date data that need be considered by a wide range of stakeholder institutions in planning and decision-making procedures at the regional and local level. To address this challenge, a special information tool, the Carpathian Informatorium, has been developed in the frame of the project entitled *Carpathians Unite – mechanism of consultation and cooperation for implementation of the Carpathian Convention* supported by a grant from Switzerland in the years 2012-2015 through the Swiss Contribution to the enlarged European Union.

The Carpathian Informatorium is a web portal presenting data resources on the Polish Carpathians: their natural and cultural heritage, tourist infrastructure and actions undertaken towards the implementation of the Carpathian Convention, its thematic protocols, and other relevant strategic documents. The Informatorium also plays a role of a "working space": communication and participation platform for stakeholders involved in implementation of the Carpathian Convention in Poland such as local and regional self-governments, NGOs, local communities, tourists, the scientists, national institutions, as well as the Carpathian Convention National Focal Point and Carp. Convention Steering Committee.

The content of the portal has been divided into three distinct areas, tailored to the needs of three major target groups:

- 1) experts and other stakeholders involved in Carpathian Convention's national and international thematic working groups;

- 2) local communities and local self-government authorities: supporting sustainable planning and management of space and natural resources, fostering public participation in local issues, building the “Carpathian identity”;
- 3) the general public, most notably visitors and tourists – Carpathian nature lovers: presenting information on Carpathian biodiversity and means of its conservation through traditional sheep grazing which helps restore valuable semi-natural mountain meadow habitats.

Besides standard, common web tools, the portal makes wide use of use of geovisualisation techniques and geoinformation tools (incl. a comprehensive metadata catalogue) capable of significantly improving practical usability and applicability of presented resources. The Carpathian Informatorium will provide geo-tools through which, for example, the decision-makers and planners will be able to display biodiversity-related spatial data and incorporate them in the planning and decision-making procedures. Also, tools for communication and participation will enable sharing feedback, knowledge, and foster active involvement of various groups of stakeholders in the implementation of the Carpathian Convention.

## Nature and business conservation opportunities in the Carpathians

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WWF Hungary has initiated an innovative pilot project on the skirt of the Carpathians, next to the upstream of the Tisza River in north-eastern Hungary. Its goal was to restore the area's natural floodplains and produce local renewable energy while increasing and diversifying local income streams.

WWF together with local communities set up a pilot project in Tiszatarjan village and removed wild bushes of the highly invasive *Amorpha* species, which first had been shipped to, and burnt, at a large nearby energy plant to produce “green energy” and now it is being used for heating the local public buildings. *Amorpha fruticosa* is an invasive plant which is bad for biodiversity and reduces flood capacity, and it has colonised large areas of floodplain alongside the river Tisza in Hungary.

Large areas of land formerly covered by the *Amorpha*, together with less productive arable lands, are now being given back to nature, to restore the floodplain's former glory. Some of the area is being replanted with native, energy useful willow trees, which will serve as a long-term, sustainable supply of “biomass”. An important element is to set some lands aside for wetland and grassland conservation, the management of which will be paid for by revenues from biomass sales. Additional project “mechanisms” include the introduction of grazing animals such as grey cattle and water buffalo to prevent the return of invasive species, and to assist with grassland management. Finally, these changes provide an attractive landscape for eco-tourism, which will bring in additional revenues to economically diversify and better sustain this rural community.

The municipality and some landowners began clearing, transporting, and selling the biomass. Key for WWF was what would happen to the cleared land. A contract was jointly developed which included stipulations concerning natural areas and which specified that a certain proportion of cleared land had to be set aside for nature, whilst a certain proportion could be planted with indigenous tree species for future burning, to ensure the mechanism was not just a “one-off”.

The contract was based on a number of nature conservation criteria written by WWF, such as the requirement for biomass to be certified by WWF. In the beginning the municipality company



contracted with local unemployed workers to cut and remove invasive *Amorpha fruticosa* from the floodplains. So the pilot project began to work. Since 2012 the local *Amorpha* and the willow trees have been being used as biomass source and burnt in local solid biofuel boilers to heat up the public buildings of the village.

One hundred fifty years ago, the area was a beautiful mosaic of sparsely forested floodplain grasslands (similar to savannah or steppe), wetlands (e.g. oxbows, old riverbeds, clay pits), and floodplain softwood forests. In 1989, a large part of the area was protected as a national park and internationally protected as a Ramsar wetland site. The area is home to globally significant species such as the black stork, white-tailed eagle and countless water birds that migrate to the area in the spring, including herons and geese. The area is especially noted for its "Tisza Flowering," the mating dances of a mayfly (*Palingenia longicauda*) species, which create a breathtaking immense cloud of swarming winged insects for only three to four days each end of May or beginning of June.

Historically, the area's habitats and landscapes were maintained and enhanced through traditional practices such as extensive grazing (of local breeds of Hungarian Grey cattle and Mangalica pigs), hay harvesting, sustainable forest management, floodplain orchards (cherry, pear, apple, and plum production), reed harvesting, sustainable fishing, and handicraft production (e.g. willow branch baskets).

Previously the Hungarian agriculture was characterized by drastic increases in energy intensive inputs (e.g. artificial fertilizers). Yields doubled over 25 years, while the diversity of yields decreased. As a result, traditional land-use practices declined even more.

Grazing almost completely stopped within the dykes as many former farmers gave up farming and many lands were left unmanaged and abandoned.

The net result of these changes was that environmental degradation proceeded, especially in former wetlands and floodplain areas. Most wetlands disappeared, both inside and outside the dykes. The risk of floods increased (five floods in the last 10 years), because the riverbed deepened, and the floodwater retention capacity of the floodplains decreased. A major problem resulting from the decreased grazing and scything was widespread colonization by invasive species such as wild *Amorpha fruticosa* ("running acacia") in the floodplain grasslands and wetlands.

The subregion where our pilot project exists, is currently economically depressed. Average incomes are low, the level of unemployment is higher than the national average; and education and training are below the national average.

With the project not only a conservation issue is being done, but also gives benefits to the local economy and the model can be multiplied all over the river.

Now Tiszatarjan municipality together with WWF has developed a the local biomass supply chain which produces biomass for new small-scale heating systems that can provide the public buildings of the village with heating energy. Biomass from floodplain is economically competitive with the natural gas, and the Tisza floodplains around Tiszatarjan have hundreds of hectares of *Amorpha* which could be cleared.

The municipality, with the help of WWF-Hungary, has reintroduced water buffalo in wetland areas and Hungarian long-horned Grey Cattle in woody grassland areas to help restore the grasslands to their former species-rich glory. Semi-managed grazing also attracts new biodiversity, especially water birds around wetlands. Beavers have been reintroduced in the floodplains' project area as the former native ecological engineers are supposed to diversify the wetland's landscape and restructure floodplain habitats. Yet this mechanism has led to the restoration of "new" nature – wetlands and grasslands. The landscape – and the economy – of this area have been completely transformed. The resultant improvements to the landscapes and biodiversity make the area more attractive to tourists

Opportunities exist for expansion not only along the Tisza, but also around other wetlands and floodplain areas. Already other municipalities and local communities from abroad have expressed interest to start work. Eventually much of the entire river length could be transformed. This would mean more green energy, more income, more profit, more jobs, and more nature.



## Protected area as an important actor of sustainable development? Examples from Polish and Ukrainian Carpathians

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As we face today a paradigm shift in the field of nature protection – from a segregation an integration (Mose, Weixlbaumer, 2007) - there is a growing agreement that protected areas can play an important role in regional development. This seems to be especially important when we consider mountain areas, that are usually rich in biodiversity, but also often subjected to a considerable recreational pressure. Both mass tourism and conservationist approach excluding traditional land use can be dangerous for fragile semi-natural environments, such as (former) pasturelands, that often represent high biological and cultural values. The author claims that they can both be also harmful for fragile, peripheral mountain communities. By contrast, an integration-oriented protected area can widely contribute to a sustainable land use and, through zoning, to a balance between strict protection, recreation and traditional usage. In Polish and Ukrainian Carpathians we can encounter various approaches to nature protection and role the protected areas should play in local social and institutional environments. This variety will be shown through several examples of national parks and biosphere reserves from both countries.

The two investigated Ukrainian cases – the Carpathian Biosphere Reserve and the Carpathian National Nature Park – are characteristic for the fact that several traditional activities such as summer animal farming, were not prohibited there outside the strict protection zone, mostly because of a strong position of state/communal animal farms. Thanks to this, the continuity of sheep and cattle grazing was not interrupted in many places. As a result, we can still observe there a living cultural landscape of semi-natural high mountain meadows in the neighbourhood of strictly protected territories, where natural processes such as reforestation, are going on (Sitko, Troll, 2008). In contrary, summer farming and other forms of traditional land use were prohibited in many Polish mountain national parks following their establishment/re-establishment after the WW2. For these reasons, as well as due to decreasing profitability of animal husbandry, summer animal farming almost disappeared from most mountain ranges of the Polish Carpathians. Despite that the paradigm changed and extensive seasonal grazing is nowadays desired to maintain biodiversity of many protected sites, except for the Tatra National Park it has been re-introduced with a moderate success.

The role of protected area as an important actor of local and regional development has obviously many more aspects, such as promotion of the area itself and its traditional products, enhancement of 'nature friendly' forms of tourism, as well as protected areas' involvement in the field of education and infrastructure. As this form of protected areas' activity is being intensively developed in both countries, an analysis and comparison of various types of projects will also be presented. Preliminary studies show that although Polish protected areas can benefit from the EU support, the investigated Ukrainian ones are also active in applying for the external funding and do participate in international projects. Sometimes, like in the case of the Carpathian Biosphere Reserve, they even try to become a local leader and coordinator of green tourism, or, like in the case of Pieniński National Park, cooperate with local health business in order to protect endangered species typical for the area.

The data gathered for this paper covers mainly: statistical data obtained through queries as well as qualitative information obtained through interviews and queries of various materials such as websites, local newspapers, official documents and strategies, etc.

In order to sum up the variety of cases, examples and practices connected with protected areas' impact on local and regional development, a model of these interactions will be proposed.

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## POSTER PRESENTATIONS

**Development and functioning of Galician spa resorts  
in Western Carpathians in 2<sup>nd</sup> half of 19<sup>th</sup> century**

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The intention behind this speech is to present the West Galicia spa resorts: Krynica and Szczawnica as the popular centres of the Central Europe's spa culture in the second half of the 19th century. Through the dynamic development of the spa facilities and infrastructure embracing the curation buildings, bathrooms, baths and hotel facilities, suitable conditions were created, hospitable to hydrotherapy and leisure. Thus, Krynica and Szczawnica started to compete effectively with other renowned European spa resorts of the time: Ems, Freiwald, Gastein, Karlsbad, Marienbad and others. The indicated West Galicia spa resorts constituted places, where the cultural interaction occurred between the spa guests originating from various partitions of Poland and from abroad. The arriving spa patients were separated by the social status, religious denomination, education level, but were united by the willingness to recover and enjoy cultural entertainments. What did Krynica and Szczawnica look like in those times? What did the Galician spa culture phenomenon of the third and fourth quarter of the 19th century consist in?

The answer to the above formulated questions will be given on the basis of the research conducted by the authors, comprising the reference literature, press of the époque, and archivist materials.

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**Evaluation of social development on Natura 2000 sites in Poland  
with the use of Local Human Development Index (LHDI)**

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Challenges of local development at the European Ecological Network Natura 2000 sites and the actual effect of the program on real development opportunities and barriers are issues of current interest to various groups: scientific community, policy makers and public institution. Majority of the research in this topic has so far covered only selected regions, voivodships or particular sites, frequently providing only qualitative evidence focused on chosen social groups and institutions engaged in

designation of the network. This poster presents results of a country-wide analysis of administrative units (powiat) with and without Natura 2000 designated sites, using Local Human Development Index data for comparing development levels. Comparison of chosen administrative units (powiat) allows to describe a state and changes in time for the whole country, comparisons between the regions and voivodships and verification of available results from other analysis of smaller scope. A special attention is given to mountain regions and administrative units with designated Natura 2000 sites of alpine bio-geographical region. The results confirm the role of Natura 2000 primarily for development in rural areas, challenges of development in periphery regions, as well as it justifies a need for further studies and assessments in longer time perspective. The presented analysis is to be continued in the future with the use of available public data. Its' application enriches knowledge-based management of mountain regions and social development near and within protected areas.

## Along the beautiful, blue Orava River – project of geotouristic road trip

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Geotourism is a new branch of tourism related to inanimate nature, geology, geomorphology, natural resources of landscape, landforms, rocks and minerals, fossils, with an emphasis on appreciating the processes that are creating and created such features (Dowling, Newsome, 2010). Geotourism belongs to the qualified tourism group that means, that it is prepared for the people who like adventure and they have enough skills to make this kind of tourism.

The main reason of this presentation is to propose the geotouristic road, as an alternative form of geotourism for the Tatra Mountains. This road focuses on the geology and geomorphology of the Orava region, located west of the Tatra Basin, in the area providing the possibility of visiting especially interesting localities, related to numerous geological and geomorphological units in the Inner Carpathians.

The author presents here the geotourist road track which contains nine geosites along the mountain valley, the Orava River. It flows from the Orava artificial lake through the Magura Orawska Ridge, Skoruszynske Foothills, Mala Fatra Range and Choč Mountains into the Váh River. The river creates a picturesque gorges crossing the various rock complexes with complicated tectonic structures in the Inner Carpathians. Among them, the most significant geosite is the Medieval Orava Castle (*Oravský hrad*), built of limestones, that create the "castle cliffs" rising 112 m above the valley floor. Other geosites are related to Orava artificial lake, the largest lake in Slovakia. A dam of this lake is built on the anticline formed by thick-bedded sandstones with intercalations of shales belonging to the Magura Nappe (Misik, 1976). There is a beautiful view on the Magura Orawska Ridge and Beskid Żywiecki Range from the dam crest. Other interesting geosite lies close to village of Podbiel, named "Červený kameň pri Podbieli". The red limestones in this locality, that is a part of the Klippen Belt, contain numerous Jurassic macrofossils, like ammonites and belemnites (Misik, 1976).

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## **Ski tourism in the Kasprowy Wierch Mountain Area (Poland) – experience, motivations, opinions – preliminary results**

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Skiing developed about four thousand years ago on the Scandinavian Peninsula, where skis were used for travel. Currently skiing is a sport and a form of recreation. There exist several forms of skiing – alpine skiing, cross-country skiing, and ski touring (combination of both forms of skiing). In addition, snowboarding has become a very popular winter sport. The main ski regions of Europe are the Alps, Carpathians, and mountains in Scandinavia (Kurek, 2011).

Kasprowy Wierch Mountain is the highest situated ski resort in Poland. A cableway was built to the resort in 1936. The cableway can transport 360 persons per hour in the winter. There are also two chair lifts leading to the resort via the nearby Gąsienicowy and Goryczkowy carries. The resort possesses two ski runs – Goryczkowa and Gąsienicowa. Both have an extension in the form of a ski trail that leads to the village of Kuźnice at the base of the Tatra mountain range ([www.pkl.pl](http://www.pkl.pl)).

The main objective of this study is to generate a profile of the users of ski runs in the Kasprowy Wierch area, which includes their opinions about the resort and their reasons for choosing this area for skiing. Surveys were conducted among users of ski runs in the area of Kasprowy Wierch. The research was carried out on 22 to 23 of March in the Kasprowy Wierch area (Malopolska Province, Poland). Research are preliminary due to unfavorable winter conditions in this year and they will be complemented in the next winter season. More research will also be carried out in April during the weekends. The survey is divided into four distinct sections – general information about the trip, motivations, opinions, experience and safety. Respondents were asked mainly about the type of winter sports they chose, choice of ski routes, and frequency of arrivals in the winter. In addition, respondents provided a reason for choosing this particular ski resort and their reasons for skiing in general. Other key questions in the survey cover opinions on the cableway and the resort. The section on safety include questions about previous experience in skiing, preparation for the trip, and equipment. This research study is part of a larger project whose aim is the monitoring of tourist movement in the area of Kasprowy Wierch Mountain over the course of the year.

The poster will include also an information about the size of tourist flow based on the number of tickets sold in the entry to the Tatra National Park in the winter and on the number of tickets sold for the cableway to Kasprowy Wierch.

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## Forestry legislation and conservation of the forests from the Romanian Carpathians over time

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The paper aims at analysing the effect of the forestry laws and regulations on the preservation of forests within the Romanian Carpathians, by evaluating their territorial integrity over time and the preservation status of the forest genetic resources.

There were identified several distinct phases in the evolution of the forest cover within the Romanian Carpathians influenced by the regime of the forest property (before 1863, 1864-1918, 1918-1947, 1948-1989, 1990 – in the present) and by the application of the provisions of the forestry laws (1852, 1879 in Transylvania, and 1881, 1898, 1910, 1930 in the Kingdom of Romania, and 1962, 1996, 2008 in Romania) (Ivănescu, 1972; Giurgiu 2010; Marinescu et al., 2013).

The important changes into the forest took place after the *Land Law* was issued in 1921, which allowed to create a pasture by forest expropriation.

The forests property was strongly affected in 1945 when the big forest owners guested that the forests will be nationalized and quickly sold to the peasants small surfaces of forest.

In 1948, the forests owned by all natural and legal persons had been nationalized without granting any compensation to the owners. It followed a period with intense forest exploitations with two intervals of maximum exploitation (1951-1955 and 1962-1975).

After 1989, the Romanian political class oscillated between leaving the forests in the property of the state and the in integrum restitution of the forests. Thus, in 1991, it is reconstituted the right to property regarding the appropriation of maximum 1 ha of forest only for natural persons, but in 2000, 2001 and 2005 there are issued new laws that reconstituted the right to property for all the owners of forest that had been nationalized in 1948 on the old locations (restitution in integrum) or where the forests was deforested, the appropriation with equivalent surfaces taken from the property of the state. With the help of an ambiguous law and due to an inefficient control in the field that should had been made by the forest administrators, there had been returned important surfaces of forests located in other places than the ones that were initially owned. To the volume of wood legally exploited, it was added the illegal cuts which increased even more the pressure upon the stability of forest ecosystems.

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## **Romanian Carpathians protected areas as ecotourism destinations between certification process and smart functioning**

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Ecotourism has become a priority for tourism politics in Romania. National authorities, NGOs have established, for the first time, a set of criteria for the certification of ecotourism destinations. Carpathian Mountains, which concentrate most of the protected areas in Romania are the main pool to attract ecotourists. This study aims to analyze the perception of young people on the development of ecotourism in the national parks and natural parks in the Romanian Carpathians. In this study used the survey method, questionnaire tool, applied on 200 respondents. The results of the survey were analyzed by SPSS v.17. The results show that the ecotourism is consumed mainly by young people, whose revenue are not high, equally as genders, graduated of higher education. In the same time the study reveals that Romania has the natural and anthropogenic potential for ecotourism, but it is necessary, in addition to certification proposed by the ministry a national and international promotion of ecotourism destination profile.

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## **The development of the tourism infrastructure as a factor of the environmental change in the mountain areas. Case study of the Prut Valley tourist region (Eastern Beskidy Mts., Ukraine)**

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Key words: natural environment, tourism, conflicts, spatial planning, Eastern Beskidy Mts., Ukraine.

Natural and especially landscape qualities constitute a major factor creating the touristic attractiveness of the Eastern Beskidy Mountains. The traditions of tourism in the area date back to the early 19<sup>th</sup> century, but it has been last ten years only, when the touristic function developed

extremely dynamic. It concerns especially regions like Truskavets and the Pruth Valley, which have gained its renown as the tourism receptors already before.

Ukraine (Poland alike) had signed the Framework Convention on the Protection and Sustainable Development of the Carpathians in 2003, which subsequently was ratified in 2009. The territory examined in the article is majorly located within the boundaries of the Carpathian National Park. The Protection Law on the Nature and Reserves' Resources of Ukraine (1992) has defined a national park as an area of national importance holding a unique qualities of its natul and cultural environment. Human activity should be then subordinated to the aim of the preservation of the natural resources.

Several environmental conflicts have been identified in article, basing on the results of the field researches (conducted in the years 2005-2010):

- between intensive development and existence of tourist settlements and the condition of the natural environment (A),
- between intensive traffic and the condition of the natural environment (B),
- between functioning of the widely understood ski infrastructure and the condition of the natural environment, related to the changes of the traditional use of land (C),
- between tourist infrastructure and the qualities of landscape (D).

The changes of the natural environment in the Pruth Valley, because of the different forms of tourism performed there, has point, surface and linear character at the moment. A winter sports' center Polyanytsya (Bukovel), located nearby the Carpathian National Park is clear example of the excessive use of the environmental resources. The ski resort in Polyanytsya (according to data from 2010) had 14 ski lifts with the capacity of 30 500 persons per hour and more than 50 km of slopes. At that time there was no comparatively prepared ski resort both in the Ukrainian and Polish Carpathians. It is due to its functioning that a process of the expansion of the tourist infrastructure proceeds in the neighboroung villages of the Pruth Valley like Yaremche, Mykulychyn and Tatariv, located on the territory of the National Park already.

In general, the transformation of the natural environment caused by tourism, is focused on the traditional tourist regions (Pruth Valley). In most parts of the Pruth Valley region one can notice several conflicts of major and medium intensity. The least visible changes appeared in the areas with the smallest infrastructure (eastern and southern parts of the region).

The identification of the present, as well as the indications of the potential conflicts occuring on the territories of the tourist reception should be used by formulation and implementation of the idea of sustainable development, taking into account the protection of the natural environment resources.

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### **The structure of map use among Chornohora visitors – tourist assessment of maps, its availability and potential implications for tourism development**

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Although knowledge about a structure of map use within a certain region should be perceived as vital from the spatial managers' perspective, the research which incorporates collecting opinions about particular consumer goods are often associated with fulfilling marketing needs only. However, the maps' quality and availability can both strengthen tourist interest of the region and help in structuring the visitor flows, so, in turn, preserving the most vulnerable ecosystems from the human impact.

The aim of this exploratory study was to identify the structure of map use among Chornohora visitors and to provide insight to the methodological aspects of this kind of research. Chornohora was chosen for a study area as one of the most popular hiking destinations in Ukraine but still peripheral from the perspective of foreign tourists. The authors intended to find out if the role of a specific map differs depending on the place of residence and the visitor familiarity with the range. The fieldworks were carried out 14-18 August 2013 in three sections of the range – *Vysokohirnyi* (with Pop Ivan peak); *Chornohirskyi* (with Nesamovyte Lake) and *Bystretskyi* (with Hoverla summit). Questionnaire survey method was used. The questionnaires (in four language versions – Ukrainian, English, Polish and Russian) were divided into two parts each. The first one included general questions like: the number of past visits to Chornohora, respondents' place of residence and on the fact of using the map during the trip. On separate sheets, the covers of all available Chornohora maps were presented and respondents were asked to point the ones which they were familiar with. Several questions on advantages, disadvantages and availability of the owned maps were also provided. The sample of 91 tourists were questioned which seems acceptable regarding the exploratory character of the research.

The results show that the most popular map among Chornohora visitors (23% of respondents) is still a *Turystychnyi stezky* series one. However, the answers suggest that it was chosen mostly (66,7%) because of its wide availability, not – perceived high quality (24%). On the contrary, the map most often selected because of its good quality was the last ACCA publication (in cooperation with „Carpathian Trails“ foundation) but it is known only to 13% of the respondents. The study confirmed that Polish and Czech tourists mostly chose maps published in their origin country but the availability of the maps did not significantly influence these visitors' decision on coming to Chornohora. Surprisingly, only one respondent was taking use of a Polish Military Institute of Geography map (released during 'interwar period') which are still recognised as useful in more remote Carpathian places.

The most frequent perceived advantage among the whole group of owned maps was their scale but accuracy of the object's distribution and maps' readability were also appreciated. On the other hand, tourists mostly complained about outdateness of certain maps or their poor detail—small number of objects. Meanwhile, it was noticed that tourists tend to bring more than one map with complementary features. The growing role of GPS system for hikers was also confirmed. The authors believe that there is a need to continue this kind of research, especially in more peripheral regions where local development can be more dependent on the inflow of tourist supplied by the proper spatial information.

## **Biosphere reserves for nature conservation and preserving cultural heritage**

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At the end of the 20<sup>th</sup> century the active creation of biosphere reserves began. First biosphere reserves were just protected areas and after the adoption of Seville Strategy in 1995, they intended to become learning sites for sustainable development. At the beginning of 2014 in a worldwide network of biosphere reserves was 621 BR in 117 countries. In 2011 the Roztochya Biosphere Reserve was included into the World Network of Biosphere Reserves. It represents the Ukrainian part of projected area of Ukrainian-Polish transboundary biosphere reserve. Preservation of cultural values for future generation is one the main tasks of biosphere reserves.

The aim of this study is to identify the natural and cultural values in the Roztochya region and use of the Biosphere Reserve as a tool for the preservation of this heritage.

The region Roztochya is situated in the Western Ukraine and Eastern Poland. It is characterized by high species richness, diversity of landscapes, and as part of the main European watershed it has global conservation value. To preserve biodiversity paramount importance of formation of transboundary biosphere reserve that will cover guard physiographic regions belonging to different states. Roztochya Biosphere Reserve belongs to the natural core of the national ecological network within Galicia-Slobodzhanskoho, and the Dniester corridors. Roztochya bordered by Prykarpattia region, so the flora and fauna have mountain species.

Ancient tragic history of the region retains Jewish, Polish, German and Ukrainian cultures. On the territory of the Roztochya Biosphere Reserve are important cultural values: Christian holy places such as churches, a monastery in the village Krekhiv, cave monastery in village Stradch. There are monuments of Jewish culture – synagogues, cemetery in the village Nemiriv. Especially valuable is the wooden church of the Holy Spirit (1502) at village Potelych, which is the oldest church in the region. There are the burial places of soldiers who died in the First World War (Austrian cemetery) in the village Ivano-Frankove. In village Potelych is the largest in Western Ukraine burial of German soldiers killed in World War II.

High percentage of forest cover, hilly terrain, springs and streams, mountain elements of flora and fauna, possible migration of people from the mountains in the distant past are reflected in traditional crafts, culture and folk customs. Only Roztochya wood carving, embroidery and manufacturing wooden furniture, toys, and ceramics retains flavour of mountains.

Roztochya Biosphere Reserve promotes traditional crafts, organizing exhibitions of folk

products, workshops for the manufacture of wooden toys, egg-painting and ceramics. A number of tour itineraries that illustrate the cultural heritage of the region and shows natural values. Excursions help to preserve the values of culture.

Keywords: sustainable development, biodiversity, Roztochya, cultural values.

### **Some aspects of natural and cultural heritage preservation in Yasinia Valley (Rakhiv Raion of Zakarpattia Oblast, Ukraine)**

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There are some places and objects in Yasinia valley connecting with natural and cultural heritage in Ukrainian Carpathians. Yasinia valley is located in Rakhiv district of Zakarpatska oblast and included such modern villages as Yasinia, Lazeshchyna and Chorna Tysa. The river Tysa starts here and Svydovets and Chornohirskyi mountain ranges are surrounded the valley. Some terrains of Carpathians next to Yasinia valley are the part of *Carpathian Biosphere Reserve*.

The well-known church in Yasinia valley that is called as Strukivska Tserkva was included to World Heritage of UNESCO last year being of a part of Ukrainian-Polish joint order "Wooden Tserkvas of Carpathian Region of Poland and Ukraine".

The fact is a great challenge for society of the region not only due to necessity to set appropriate accommodations for tourists and specialists but organization of preservation system of natural and cultural heritage of the Carpathians including both Strukivska Tserkva and other objects of Yasinia valley and Svydovets and Chornohirskyi mountain ranges.

The potential threats are following:

- ignoring the reconstruction works which are necessary (or were decided on the stage of agreement of the mentioned order) for Strukivska Tserkva and its furniture preservation;
- forcing of influence on ecological system in the region without monitoring and protecting system organizing;
- noneffective government support for traditional economy in a region.

These and other threats are characterized in the poster and the ways of politics in Yasinia valley are discussed.



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