



International scientific conference
6th FORUM CARPATICUM –
Linking the Environmental, Political and Societal
Aspects for Carpathian Sustainability

Book of Abstracts

21st June to 25th June, 2021

Brno, Czech Republic

Organizers:

Global Change Research Institute of the Czech Academy of Sciences

and

Forestry and Wood Technology Faculty of MENDELU University

In partnership with:

Science for Carpathians

With the support of the institutions listed below:



Editors: Pavel Cudlín, Radek Plch

The abstracts included in this volume were selected by the Forum Carpaticum Scientific Committee. Final version of the abstracts reflect the work of their authors and published here in as submitted to the committee of the 6th Forum Carpaticum.

Published online at: <https://forumcarpaticum.czechglobe.cz/> by Global Change Research Institute of the Czech Academy of Sciences, Bělidla 986/4a, 603 00 Brno, Czech Republic

Continuing previous meetings: Forum Carpaticum 2010 (Krakow, Poland), Forum Carpaticum 2012 (Stará Lesná, Slovakia), Forum Carpaticum 2014 (Lviv, Ukraine), Forum Carpaticum 2016 (Bucharest, Romania), Forum Carpaticum 2018 (Eger, Hungary). Forum Carpaticum 2021 (Brno, Czech Republic) connects scientists in Central Europe, defines research priorities for the region, provides applicable findings for the politics of the region and enhances international collaboration with partners from outside the Carpathians.

The main conference goals are i) Advance Carpathian research on climate, water, ecological processes, nature conservation, sustainable use of natural resources, human-environment interactions, education for sustainable development, ii) Actively encourage researchers and stakeholders to exchange ideas, knowledge and research results, fostering dialogue between researchers, policy makers, and practitioners and iii) Promote new inter-disciplinary and trans-disciplinary collaborations, establishing links between S4C, local and regional authorities, and stakeholders involved in environmental management.

The most frequent conference themes:

- Assessment of climate change vulnerabilities within forest and agricultural sectors, as well as associated adaptation opportunities
- Carpathian waters – from knowledge to management and sustainable use
- Effects of biodiversity loss on provisioning of ecosystem services in the Carpathians
- Rural-urban relationships, including connectivity of green infrastructure and surrounding landscapes
- Conservation science and practical policy measures to promote sustainability
- Advances in earth observations for sustainable development
- Traditional land management, rural development, smart & sustainable planning, social innovation, and sustainable tourism
- Historical human-environment interactions, including environmental crime, such as illegal logging
- Governance (any legal act or normative rules as well as other formal or informal instruments or tools to manage or steer transition processes)
- Present and future education for the sustainable Carpathians

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Conference Programme

Forum Carpathicum 2021 Program					
Date	Time	Sessions, Workshops, Presentations			
Mon. June 21	9:00 – 10:30	S4C Steering committee Meeting			
	11:00 – 12:30	Workshop: How can FC 2021 contribute to the updated S4C research agenda?			
	14:00 – 15:30	Meeting of S4C Steering Committee and the Scientific Network for the Caucasus Mountain Region (SCN-mt): signing the MOU between the networks, defining concrete cooperation			
	16:00 – 17:30				
Tues. June 22	9:00 – 10:30	<p>Plenary 1 Opening, Information (moderated by Pavel Cudlín)</p> <p><i>Welcome messages:</i></p> <p>Harald Egerer, Secretariat of the Carpathian Convention</p> <p>Ms. Bożena Haczek, Ministry of Climate and Environment of Poland, representing the Polish Presidency of the Carpathian Convention</p> <p><i>Opening Talk:</i> Michal V. Marek, director of the Global Change Institute of CAS: The impact of global change on forests</p> <p><i>Policy presentations:</i></p> <p>Macro-regional strategy as a chance to ensure cohesion and sustainable social and economic development in the Carpathians (Draus E.)</p> <p>Complementarity of the Carpathian Strategy with the EU Strategy for the Danube Region (Wais P.)</p>			
Tues. June 22	11:00 – 12:30	<table border="1"> <tr> <td> <p>S1 Forest ecosystem and resource vulnerabilities to climate change in the Carpathian Mountain Region (Keeton W. et al.)</p> <p>Forest ecosystem and resource vulnerabilities to climate change in the Carpathian Mountain Region (Keeton W. et al.)</p> <p>Model-based potential natural vegetation projections accounting for climate change to assist decisions for forestry and grazing practices (Somodi I. et al.)</p> <p>Saving the timber but not the forest: Post-disturbance management is ineffective in preventing further Norway spruce forest decline in Slovakia (Potterf M. et al.)</p> <p>Soil biological activity changes as a result of windthrow in the Javorová Valley (the High Tatra Range) (Wasak-Sęk K. et al.)</p> <p>Effect of management</p> </td><td> <p>S2 Recent and future changes of agricultural areas of Carpathians (Halada L., Mederly P.)</p> <p>Recent changes and processes of Carpathian agricultural areas with particular focus to Slovakia (Halada L. et al.)</p> <p>Changes in Slovak rural landscape, in the context of globalization (Izakovičová Z., Špulerová J.)</p> <p>The mid-term sustainability evaluation of predicted scenarios in agricultural landscape of the Poloniny NP (Bezák P., Bezáková M.)</p> <p>Chestnut groves as habitats for threatened and rare plant species – case study of Nagymaros (Zeller Z., Pástor M.)</p> <p>Measures to support wild bees and their pollination service (Šlachta M., et al.)</p> <p>Poster: The connection between environmental predictors and regeneration capacity of sandy habitats in Hungary (Csákvári E. et al.)</p> </td><td> <p>S3 Carpathian waters: From knowledge to management 1 (Wyżga B. et al.)</p> <p>Twentieth-century development of floodplain forests in Polish Carpathian valleys: the by-product of transformation of river channels? (Hajdukiewicz H., Wyżga B.)</p> <p>Morphological changes of the Hornád River stream and its management- retrospective view (Labaš P., Kidová A.)</p> <p>The downstream fining trends of two neighbouring rivers; the difference in significance of the disruption factors (Holušová A., Galia T.)</p> <p>Scientific monitoring of immediate and long-term effects of river restoration projects in the Polish Carpathians (Wyżga B. et al.)</p> <p>Patterns of beaver (re)colonization of the Orava-NowyTarg Basin, Polish</p> </td></tr> </table>	<p>S1 Forest ecosystem and resource vulnerabilities to climate change in the Carpathian Mountain Region (Keeton W. et al.)</p> <p>Forest ecosystem and resource vulnerabilities to climate change in the Carpathian Mountain Region (Keeton W. et al.)</p> <p>Model-based potential natural vegetation projections accounting for climate change to assist decisions for forestry and grazing practices (Somodi I. et al.)</p> <p>Saving the timber but not the forest: Post-disturbance management is ineffective in preventing further Norway spruce forest decline in Slovakia (Potterf M. et al.)</p> <p>Soil biological activity changes as a result of windthrow in the Javorová Valley (the High Tatra Range) (Wasak-Sęk K. et al.)</p> <p>Effect of management</p>	<p>S2 Recent and future changes of agricultural areas of Carpathians (Halada L., Mederly P.)</p> <p>Recent changes and processes of Carpathian agricultural areas with particular focus to Slovakia (Halada L. et al.)</p> <p>Changes in Slovak rural landscape, in the context of globalization (Izakovičová Z., Špulerová J.)</p> <p>The mid-term sustainability evaluation of predicted scenarios in agricultural landscape of the Poloniny NP (Bezák P., Bezáková M.)</p> <p>Chestnut groves as habitats for threatened and rare plant species – case study of Nagymaros (Zeller Z., Pástor M.)</p> <p>Measures to support wild bees and their pollination service (Šlachta M., et al.)</p> <p>Poster: The connection between environmental predictors and regeneration capacity of sandy habitats in Hungary (Csákvári E. et al.)</p>	<p>S3 Carpathian waters: From knowledge to management 1 (Wyżga B. et al.)</p> <p>Twentieth-century development of floodplain forests in Polish Carpathian valleys: the by-product of transformation of river channels? (Hajdukiewicz H., Wyżga B.)</p> <p>Morphological changes of the Hornád River stream and its management- retrospective view (Labaš P., Kidová A.)</p> <p>The downstream fining trends of two neighbouring rivers; the difference in significance of the disruption factors (Holušová A., Galia T.)</p> <p>Scientific monitoring of immediate and long-term effects of river restoration projects in the Polish Carpathians (Wyżga B. et al.)</p> <p>Patterns of beaver (re)colonization of the Orava-NowyTarg Basin, Polish</p>
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Tues. June 22		<p>interventions after windstorm on ectomycorrhizal fungal community (Veselá P. et al.)</p> <p>Postdisturbance development of vegetation in the High Tatras (Homolová Z.)</p> <p>Poster: Cost-benefit analysis of spruce monocultures conversion: evidence from the Ukrainian Carpathians (Pelyukh O., Zahvoyska L.)</p>	<p>al)</p> <p>Poster: Changes in the use of agricultural land and soil quality properties in the conditions of the submountain countryside land in the Slovak part of the Carpathians (Petluš P. et al.)</p>	<p>Carpathians (Zawiejska J., Chmielowska D).</p>
	14:00 – 15:30	<p>S4 Carpathian waters: From knowledge to management 2 (Wyźga B et al.)</p> <p>Managed mountain streams as boosters of downstream sediment transport (Galia T., Škarpich V., Ruman S.)</p> <p>Morphological-hydraulic river response to management measures in Natura 2000 (the Belá River case study, Slovakia) (Kidová A. et al.)</p> <p>Large wood and the city: the case study of the Ostravice river, Czechia (Poledníková Z., Galia T.)</p> <p>Long-term monitoring of the recruitment and dynamics of large wood in Kamienica Stream, Polish Carpathians (Mikuš P., Wyźga B.)</p> <p>Poster: The effects of road crossings on stream macroinvertebrate diversity (Gál B. et al.)</p> <p>Poster: Stable isotope variability in precipitation and underground drip water along an orographic transect (South Carpathians, Romania) (Tîrlă L. et al.)</p> <p>Poster: Water resources in small flysch catchments in the Bieszczady Mountains (Mostowik K.)</p> <p>Poster: Water Reservoirs in the Paríž Stream catchment (Borovská J. et al.)</p>	<p>S5 Perspectives through paleoscience for a sustainable future of the Carpathian environments (Florescu G.)</p> <p>Natural archives from the Eastern Carpathians: paleoclimatic insights for climate future projections (Bădăluță C. et al.)</p> <p>Climate change and human impact on the vegetation of the Carpathian foreland (Ukraine) over the last 5,000 years based on pollen studies at archaeological sites (Gerasimenko N. et al.)</p> <p>Equilibrium line altitude (ELA) in the highest mountain massifs of the Eastern Carpathians (Romania, Ukraine) as a proxy for the Last Glacial Maximum palaeoclimate (Kłapyta P. et al.)</p> <p>Signs of glacial activity in the mid-height mountains of Ukrainian Carpathians (Ridush B. et al.)</p>	<p>Workshop 1: Forest ecosystem and resource vulnerabilities to climate change in the Carpathian Mountain Region (Keeton W. et al.)</p>
	16:00 – 17:30	<p>S6 Scientists and humanists working together to propose new (and old) approaches to ecology</p>	<p>S7 The power of social innovation in mountain areas to steer a sustainable governance</p>	<p>Workshop 2: Biodiversity and connectivity of rural-urban forests:</p>

Forum Carpaticum 2021 Program				
Date	Time	Sessions, Workshops, Presentations		
		<p>in the Carpathians (Cooley T.J. et al.)</p> <p>Using traditional ecological knowledge, science, and music to imagine new relationships with mountain ecosystems (Cooley T.)</p> <p>Unfolding the Potential of Cultural Heritage: a Case Study from Val Venosta (South Tyrol, Italy) (Schmidt R., Agosti E.)</p> <p>In the woods – In the wild. An artistic research project of speculative ecology in Transcarpathia (Alam B. et al.)</p> <p>Between space and view: Inhabiting a landscape in the Bieszczady Mountains (Trzuszczńska P.)</p> <p>“Is it still our land?” Between traditional and modern ways of using the land. Example of the Tatra mountain region called Podhale (Trebusia-Staszal S.)</p>	<p>of nature (Nijnik M. et al.)</p> <p>How to turn stakeholder evaluation of multi-functional forestry into innovative forest governance practices to enhance sustainability transformation in the Carpathian Mountains? (Nijnik M. et al.)</p> <p>Citizen Science in the Carpathians – adopting Living Lab approach (Adam M. et al.)</p> <p>Impacts of social innovation on spatiality in mountain–lowland relationships: Trajectories of two Swiss regional initiatives in the context of new policy regimes (Perlik M. et al.)</p> <p>Can social innovation offer transformative opportunities to forestry in Ukraine? (Nijnik M. et al.)</p> <p>The power of social innovations to tackle challenges in forestry: Switzerland and Ukraine in the focus (Melnykovych M. et al.)</p> <p>Poster: Social innovation and Biodiversity Conservation through Participatory Management of protected areas in Eastern Slovakia: Reconciling nature conservation with local development (Meessen H. et al.)</p> <p>Poster: Green for Care - Stakeholder Analysis (Florea S. et al.)</p>	<p>planning and sustainable land management at the peripheral edges (Diaz-Maroto I.J.)</p>
Wed. June 23	9:00 – 10:30	<p>Plenary 2 (moderated by Tamara Mitrofanenko, Joanna Zawiejska)</p> <p>Keynote 1, Katter-Wettstädt L.: ESD and regional development</p> <p>Enhancing societal impact of S4C - inputs & recommendations from conference participants</p>		

Forum Carpathicum 2021 Program				
Date	Time	Sessions, Workshops, Presentations		
Wed. June 23	11:00 – 12:30	S8 Carpathian waters: From knowledge to management 3 (Wyżga B. et al.) Endosymbionts of threatened thick shelled river mussel <i>Unio crassus</i> Philipsson, 1788 in Carpathians (Zajac K., Zajac T.) Role of vegetation cover in water and soil retention modeling in the Dřevnice River basin, Czech Republic (Jakubínský J. et al.) Where do fine sediments come from? A study of natural and anthropogenic processes, connectivity and flood efficiency in a southwestern Carpathian basin (Moroşanu G.A et al.) Exploring and quantifying the impact of climate change on Carpathian rivers (Kędra M.) Climate data over the Carpathian Region - challenges for environmental applications (Micu D.M. et al.)	S9: Education for Sustainable Development -best practices of education for sustainable development in the Carpathians and other mountainous regions (Mitrofanenko T. et al.) Recommendations for Stronger Integration of Education for Sustainable Development into the Carpathian Convention: results of a participatory process (Mitrofanenko T. et al.) Bringing primary school pupils closer to environmental education. Proposal for a field itinerary in Romanian Carpathian Mountains (Drăgan T., Moroşanu G.A.) BioLearn – project about how to use biomimicry in education for sustainability (Neumayer É. et al.) Respect Nature in the Carpathians (Shchoka I. et al.)	Workshop 3: Becoming better science writers and science communicators for the Carpathians (Munteanu C.)
	14:00 – 15:30	S10 Cross sectoral issues- the Carpathians valued as a living place (Hoffmann C.) Conservation and valorisation of the Carpathians landscape from the environment legislation point of view. Case study (Verga M.) Integration and reconciliation of biodiversity protection with local socio-economic development in Carpathian protected areas (Bisconti S. et al.) Enhancement of green infrastructure in Polish Carpathians for ecological benefits and sustainable local development (Mikołajczyk P.) Sustainability measured by annual statistical reports – Đerdap National Park (Serbia) (Pantić M., Milijić S.) Gifts of the forest - contemporary use of wild mushrooms: Cases from the Carpathians in Romania and Ukraine (Stryamets N. et al.) Poster: Green infrastructure as	S11 Applications of historical data in geography, land use, ecology and conservation (Kaim D, et al.) Stone mounds and walls as a current manifestation of past human-environmental interactions in vine regions of Little Carpathian Mountains (case study of Modrá, Slovakia) (Hanušin J. et al.) High resolution 19th century buildings, railway and road network database for the Galicia and Austrian Silesia, Habsburg Empire (Kaim D. et al.) A century of population dynamics in the Romanian Carpathians (1910– 2020). Factors, spatial patterns and regional disparities (Muntele I. et al.) Changes in selected land cover forms in Galicia in the 20th century and the diversification of socio-economic development in Poland and Ukraine. The study based on cartographic and statistical materials - preliminary results. (Quirini-Popławski Ł. et al.) Historical remote sensing for	S12 Tree and forest growth across Carpathians – from past to future (Pokorný R.) What is possible future of the European beech in the Carpathians? (Pokorný R.) Response of beech and fir along the Carpathian gradient (Čater M.) Patterns and drivers of tree longevity across primary mountain forests of Europe (Pavlin J.) Transition from even aged spruce to uneven-aged close-to-nature mixed forest stands - a challenge for economical optimisation and planning (Roessiger J. et al.) European beech as a main edicator of the vegetation tiers in the Carpathians Mts. – in what time horizon will the changes be noticeable? (Holuša O., Holušová K.)
Wed. June 23				

Forum Carpaticum 2021 Program			
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Wed. June 23		<p>an active tool of support to spatial stability and biodiversity of landscape (Moyzeová M. et al.)</p> <p>Poster: Online environment as tool to push forward the recherche: an example for landscape disservices (Stupariu I. et al.)</p> <p>Poster: Negative effects of road traffic on vertebrate species – A literature review from Hungary (Borza S. et al.)</p>	<p>ecology and conservation in the Carpathians Ecoregion (Nita M.D. et al.)</p> <p>Poster: The great landed property in Galicia in the middle of 19th century: its legacy and influence on contemporary forest areas (Miklar A. et al.)</p> <p>Poster: Countertrending local knowledge erosion: persistence of traditional cattle healing practices in the Bukovinian Carpathians (Mattalia G. et al.)</p> <p>Poster: Long-Term Development Trend of the Historical Cultural landscape of the UNESCO Monument: Vlkolínec (Slovakia) (Boltižiar M. et al.)</p> <p>Poster: Factors of Norway spruce (<i>Picea abies</i>) survival during severe bark beetle (<i>Ips typographus</i>) outbreak in Central Europe: Non-linear tree resistance responses (Korolyova N. et al.)</p>
	16:00 – 17:30	<p>S13 Study of the temporal and spatial variability primary production and carbon allocation in Carpathian forests (Nezval O.)</p> <p>A new approach of phenological observations: using digital repeat photography to estimation of phenophases of European beech forest in the White Carpathian (Nezval O.)</p> <p>Carbon modelling of primary forests: an example from the Carpathians (Keith H. et al.)</p> <p>Primary forest biomass dynamics across scales driven by natural disturbances (Rahhan D. et al.)</p> <p>BEECH POWER: World Heritage BEECH Forests: emPOWERing and catalyzing an ecosystem-based Sustainable Development (Waldherr M., Öllös H.)</p> <p>Natural dynamics of temperate mountain beech-dominated primary forests in the Western Carpathians (Frankovič M. et al.)</p>	<p>S14 Global changes and local responses: Resilience, adaptations, innovations for the sustainable development of Carpathians tourist destinations (Matei E., Mika M.)</p> <p>Tourism, ecology, and the roles of musicking in the Polish Tatras Mountains (Cooley T.)</p> <p>Exploring tourism in Tatra National Park and Low Tatras National Park by using social big data (Rusňák T. et al.)</p> <p>Skiing area development and sustainability issues in Romanian Carpathians (Mihai B.A. et al.)</p> <p>Exploring visitors' spatial behaviour as a basis for protected areas management – a case study from the Tatra Mountains (Hibner J., Taczanowska K.)</p> <p>Cooperation for the digital promotion of destinations in the Polish Carpathians: DMOs' perspective on the use of ICT (Pawłowska-Legwand A.)</p> <p>Poster: Lessons learned for resilience of tourism industry in the Romanian Carpathians during Sars-Cov-2 Pandemic (Matei E.)</p> <p>Poster: Sentiment analysis as feedback for improving sustainable management in Northern Subcarpathians of Oltenia Destination (Trutescu M.N.)</p> <p>Workshop 4: Inter- and transdisciplinary mountain data in the Carpathians: Identifying user requirements and access preferences (Adler C. et al.)</p>

Forum Carpathicum 2021 Program				
Date	Time	Sessions, Workshops, Presentations		
Thur. June 24	8:45 – 10:30	Plenary 3 (moderated by Joanna Zawiejska) Keynote 2, Miko L.: Green Deal and EU Recovery plan - opportunity or challenge for environment in Carpathians? Keynote 3, Bussetini M.: Linking science to policy for an aware system management. Lessons learned and perspectives		
	10:30 – 11:00	Official Signing of the Memorandum of Understanding between the Science of the Carpathians Network (S4C) and the Scientific Network for the Caucasus Mountain Region (SNC-mt) <i>Welcome words:</i> Carolina Adler (MRI), representatives of S4C and SNC-mt		
	11:00 – 12:30	S15 Large carnivores in the Carpathians: Challenges for effective conservation and management (Kutal M., Duľa M.) Large carnivores in the Carpathians: Challenges for effective conservation and management (Kutal M., Duľa M.) Brown bear predation on sheep and cows in the Carpathian landscapes (Pop I.M. et al.) The project LIFEstockProtect. Livestock protection from farmers for farmers (Stauder J., Favilli F.) Attitudes toward large carnivores in Serbia (Lavadinović V. et al.)	S16 Advances in earth observations for sustainable development in mountainous regions (Ostapowicz K.) Remote sensing for monitoring the fulfilment of vegetation functions (Vytlečka P., Pechanec V.) Land use intensity trajectories on forest-rural-urban areas obtained from dense Landsat time series (Ostapowicz K., Butsic V.) Forest aboveground biomass mapping from satellite optical and radar data (Navratilová B. et al.) LiDAR as a tool for detection of historical anthropogenic landforms: examples from Slovakia (Lieskovský J. et al.)	S17 Getting it done right: Mediation for sustainable use and reuse of the Carpathians resources (Kubal Czerwinska M., Krzesiwo K.) How does Forest Stewardship Certification address the legality issues in the context of European national frameworks? (Buliga B., Nichiforel L.) Use of renewable energy resources and management of waste recycling projects in the Romanian plain. Case study: Giurgiu county, Romania (Ducman A. et al.) Policies for integration of ecosystem services into local bioenergy strategies: challenges and opportunities for the Ukrainian Carpathians (Soloviy I. et al.) The route of riverine macroplastic: a transdisciplinary perspective (Liro M. et al.)
	14:00 – 15:30	S18 Social economic, and environmental impacts of illegal logging in the forests of the Carpathian Ecological region (Bihun Y. et al.) WorldForestID: Addressing the need for standardized wood reference collections to support authentication analysis technologies; a way forward for checking the origin and identity of traded timber (Gasson P. et al.)	S19 Modelling of the biodiversity and ecosystem functions/services for nature protection and sustainable use of natural resources in the Carpathians (Pechanec V., Cudlín P.) Risk assessment of biodiversity loss in the Beskydy Protected Landscape Area (Pechanec V. et al.) Scaling effect on the aboveground carbon stock assessment (Purkyt J.)	Workshop 5: Towards the Carpathian ESD Expert Network: Integrating Education for Sustainable Development into the activities of the Carpathian Convention (Mitrofanenko T., et al.)

Forum Carpaticum 2021 Program		
Date	Time	Sessions, Workshops, Presentations
		<p>NGO capacity building in Ukraine to fight illegal timber harvesting (Karabchuk D., Bihun Y.)</p> <p>Near real-time monitoring of forest stands to combat illegal timber harvesting in Ukrainian Carpathians (Chaskovskyy O., Karabchuk D.)</p> <p>Tools for risk mitigation in sustainable forest management of Ukraine (Kravets P. et al.)</p> <p>Wildlife crime in Eastern Europe – case study of Serbia (Lavadinović V., Islas C.)</p> <p>et al.)</p> <p>Estimated impacts of climate change to selected ecosystem services of forests under different management – a case study from the West Carpathians (Murgaš V. et al.)</p> <p>Climate regulating ecosystem services of old-growth forests: case study from Ukrainian Carpathians (Smaliychuk A. et al.)</p> <p>Poster: Mapping and assessment of recreation as a cultural ecosystem service (Csákvári E. et al.)</p> <p>Poster: Ecosystem services provided by wild plants as a basis for sustainable livelihood (Nowak-Olejnik A.)</p> <p>Poster: Modeling present and prospective distribution of <i>Phyteuma</i> genus in Carpathian region with machine learning techniques using open climatic and soil data (Mkrtchian A.)</p>
	16:00 – 17:30	Informal discussion (with a drink): What can S4C do for us - enhancing impact for Carpathian scientists
	17:00-17:30	Virtual Tour (30 min)
Fri. June 25	9:00 – 10:30	Workshop on FC 2021 Results: <ul style="list-style-type: none"> formulating the message to the Carpathian Convention Secretariat inputs into the S4C research agenda
	11:00 - 12:00	Final Plenary - Closing of the Conference Follow-up meeting of the S4C Steering Committee

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Invited lectures

ESD in sustainable regional development – approaches to implementation

Kater-Wettstädt L.¹

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We are in a critical phase of human development, as climate change, diversity loss or water management are pressing issues in more and more places of the world. Against this background the world community agreed 2015 on sustainable development goals (SDGs) to be reached by 2030, which mark important activity areas, one of which makes special mention of inclusive quality education for all and the promotion of lifelong learning (Unterhalter, 2019). This goal No.4 underlines the importance to equip all people with necessary knowledge, skills and attitudes to promote sustainable development (UN 2015).

Education for sustainable development (ESD) is a relevant education concept in this regard. ESD addresses all pedagogical activities in formal and informal education to promote and support a fair societal development that respects human needs on the one and the planetary boundaries on the other hand. There are different models for ESD which key competences learners should develop (de Haan 2006; Rieckmann 2018; Wiek et al. 2011,). Central goals, same across the models, are to empower people and help them develop relevant competences to actively participate in change processes. This includes e.g. system thinking, empathy or action competence. ESD provides orientation to design learning environments in a participatory, activating, reflective and interdisciplinary way (Redman et al. 2021). The formats themselves can vary as they need to be context sensitive.

Implementation strategies for ESD activities can be initiated on different levels, e.g. individual, institutional, structural, community or system level. Collaborative, multiprofessional efforts to combine the different levels promise to be successful for a wide implementation. Universities are showcased as possible hubs for network building and drivers for change. Three examples from Leuphana University and the broader German context are introduced and critically reflected in view of their scalability.

De Haan, Gerhard (2006): 'The BLK '21' programme in Germany: A 'Gestaltungskompetenz'-based model for Education for Sustainable development. In: *Environmental Education Research* 12, 1, p. 19–32.

United Nations. „General Assembly. Resolution adopted by the General Assembly on 25 September 2015. Transforming our world: the 2030 Agenda for Sustainable Development“.
http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E.

Unterhalter, E. (2019). The many meanings of quality education: politics of targets and indicators in SDG 4. *Global Policy*, 10, 39–51.

Redman, Erin/Murphy, Cliona/Mancilla Mendez, Yasmany/Mallon, Ben/Kater-Wettstaedt, Lydia/Barth, Matthias/Ortiz-Martínez, Gabriela/Smith, Greg/Kelly, Orla (2021): International Scaling of Sustainability Continuing Professional Development for In-Service Teachers. In: *Interdisciplinary Journal of Environmental and Science Education* 17, 3 –

Rieckmann, Marco (2018): Learning to transform the world: key competencies in ESD. In: Leicht, A./Heiss, J./Byun, W. J. (Eds.): *Issues and Trends in Education for Sustainable Development. Education on the move*. Paris: UNESCO Publishing. p. 39–60.

Wiek, Arnim/Withycombe, Lauren/Redman, Charles L. (2011): Key competencies in sustainability: a reference framework for academic program development. In: *Sustainability Science*, 6, p. 203–218.

Thematic Sessions

Citizen Science in the Carpathians – adopting Living Lab approach

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Empowering local communities' appreciation and pride in the Carpathians' unique local nature is vital for their efficient nature conservation, sustainable regional development, and more in-depth cooperation with protected areas management. Thus, protected areas adopt tools to strengthen systematic communication approaches. Citizen science as an emerging topic has a high potential to empower this communication. It has become a powerful tool to stimulate public input and engagement in natural resources, environmental management, and policymaking [1]. Within the project Citizen Science in the Carpathians we aim to strengthen protected areas managers' capacities in adopting citizen science on their daily basis and, in consequence, to deepen their relationships with the local stakeholders. Besides organizing workshops and BioBlitzes and creating digital information sources, the project aims to establish the Living Lab approach in Hungary. As a multi-stakeholder organization set-up, a Living Lab carries out innovation activities in real-life settings and includes the public and private sector, academia, and citizens [2]. The project Living Lab approach will be based on observing selected citizen science projects in a delimited territory in protected areas in Hungarian Carpathians, dealing with biodiversity monitoring and communication between protected areas managers and local communities. Thus, Living Lab ought to serve as a source of experience and knowledge that can be transferred to protected area managers in particular countries.

Keywords: Citizen Science, Protected Areas, Living Lab, Local Stakeholders

We would like to thank the Visegrad Fund for support to the project on Citizen Science in the Carpathians, no. 22020458.

[1] McKinley, D.C., Miller-Rushing, A.J., Ballard, H.L., Bonney, R., Brown, H., Cook-Patton, S.C., Evans, D.M., French, R.A., Parrish, J.K., Phillips, T.B. and Ryan, S.F. (2017). Citizen science can improve conservation science, natural resource management, and environmental protection. *Biological Conservation*, 208, pp.15-28.

[2] Dell'Era, C. and Landoni, P. (2014). Living Lab: A methodology between user-centred design and participatory design. *Creativity and Innovation Management*, 23(2), pp.137-154.

In the woods – In the wild. An artistic research project of speculative ecology in Transcarpathia

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We want to present our experiences and findings from an artistic research project that students and teachers of the Art & Science master's programme at the University of Applied Arts Vienna have been working on from 2016 to 2019. The project started with entering a contemporary academic discourse that aims at reframing our understanding of 'nature' (De Castro, 2014; Latour, 2014), and what it means to be 'in woods' or 'in the wild'. Artistic imaginations concerning nature become markedly influenced by new insights of various scientific disciplines. In order to narrow down this rather broad topic, the research focused on the question of 'what is a forest?'. We were exposed to a multidisciplinary scientific discourse inspired by many new theoretical and practical silvicultural insights. These theoretical discussions regarding our relationship with nature were complemented by an experiential and experimental component where we could deepen our understanding on forests through practical on-site research. For this purpose, we stayed in the forests of Transcarpathia (Ukraine) for ten days in July 2017. Together with local stakeholders, visions and versions of what a forest 'is' were debated. In a second phase, we returned to the Ukrainian forests in September 2018 to assemble its research findings, allies and questions around a plot of land in Nyzhnje Selyshche in search for a latent commons. The 48-hour happening, 'The Landing is on Friday', was an event of 'speculative ecology'. It took place between trees and ruins and welcomed aliens that had emerged beyond our (knowledge)horizons. The publication produced, 'Catastrophic Animals on Terra: A Guidebook to Life Elsewhere' (Alam et al., 2019), results from the collective experience in speculative research.

Keywords: Artistic Research, Speculative Ecology, Multinaturalism

Thanks to the other participants of the project G. Aldrete, G. Bashiri, M. Busch, J. Folkmann, M. Gallo, A. Gramosis, M. Igual Capdevila, R. Lippuner, M. Marković, F. Neuts; and to the cooperation partners Molotok/Khust rayon public organization, B. Popov/Eco Solutions Forge & R. Seidl/University of Natural Resources & Life Sciences Vienna.

Alam, B., Aldrete, G., Bashiri, G., Benn, R., Busch, M., Deifel, V., ... Rebhandl, M. (2019). Catastrophic animals on terra: A guidebook to life elsewhere (B. Alam, V. Deifel, & B. Kräftner, Eds.) University of Applied Arts Vienna.

De Castro, E. V. (2014). Perspectivisme et multinaturalisme en Amérique indigène. *Journal des anthropologues*. Association française des anthropologues, 138–139, 161–81 <<https://doi.org/10.4000/jda.4512>>.

Latour, B. (2014). On Selves, Forms, and Forces. *HAU: Journal of Ethnographic Theory*, 4.2, 261–66 <<https://doi.org/10.14318/hau4.2.014>>.

Natural archives from the Eastern Carpathians: paleoclimatic insights for climate future projections

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The Carpathian Mountains are home to some of the most sensitive natural archives of climate and hydroclimatic changes from Eastern Europe. Ice caves, lacustrine and fluvial sediments, tree rings, speleothems, peat bogs and/or guano deposits are all hosting important proxy records of past climate and environmental changes. In this study we will present climatic (e.g., winter and summer temperatures, moisture sources) and hydroclimatic (e.g., rainfall events, floods) changes during the Late Holocene, which appear to be linked with the complex interplay between the large-scale atmospheric patterns across Eastern Europe. Also, the comparison with the solar irradiance shows synchronously with data from ice core, tree rings, lake sediments and peat bog records. These results offer the possibility to predict general trends and major changes in climate and hydroclimate and at the same time highlight the complexity of the past climatic dynamics in Eastern Europe.

Keywords: natural archives, climatic and hydroclimatic changes, Eastern Carpathians, climate projections

This research has been supported by UEFISCDI Romania (grant PN-III-P4-ID-PCE-2020-2723) and IAEA Austria (grant CRP F33025 - Isotope Techniques for the Evaluation of Water Sources in Irrigation Systems, contract 22895). GB is funded by the the project entitled "DECIDE-Development through entrepreneurial education and innovative doctoral and postdoctoral research", project code POCU/380/6/13/125031, project co-financed from the European Social Fund through the 2014–2020 Operational Program Human Capital.

The mid-term sustainability evaluation of predicted scenarios in agricultural landscape of the Poloniny NP

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Poloniny National Park represents forest-grassland dominated ecosystem, with peripheral location on the Slovakian border with Ukraine and Poland and with low population density. Based on sustainability appraisal of Poloniny in 2005 under BioScene project, three scenarios of agricultural landscape development were outlined. Our current research aims to assess trajectories of these scenarios after 15 years, considering socio-ecological context and achievement of selected sustainable objectives. The study also analyses tourism that assumed to be the recent key factor in Poloniny's rural development. For the assessment we employed data on demography, changes in agricultural area, changes based on geo-tagged photos and two questionnaire surveys with local stakeholders. The first survey included feedback on achieving the 2005's sustainability objectives and perceived changes in land management and the second aimed to find out the number of accommodated visitors in the last years. We conclude a mixed impact for biodiversity and natural resources and negative or stagnating trend for most of social and economic aspects. Improvements are expected primarily in avoiding depopulation and maintaining young generation, support to social infrastructure and local job creation. A key factor in stimulating multi-functional and sustainable landscape management is surely ecotourism, which has significantly expanded in the last few years, especially due to local initiatives. However, its long-term maintenance should be linked with greater contribution to well-being of local community. Achieving this target requires better design of future agricultural policy, which counts with peripheral mountain regions, provides better conditions for small farming and value intangible benefits from agriculture. At the same time, launched bottom-up activities need to be strengthened by more powerful local planning that would steer coming support to multifaceted and targeted sustainable actions.

Keywords: sustainability, scenarios, agricultural landscape, ecotourism, Poloniny

This research was funded by Scientific Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic and the Slovak Academy of Sciences, grant number VEGA 2/0018/19, project "Ecological analyses of landscape acculturation in Slovakia since early prehistory until today" and by the Integrated Infrastructure Operational Programme funded by the ERDF, project ITMS2014+ 313011W580, "Scientific support of climate change adaptation in agriculture and mitigation of soil degradation."

Integration and reconciliation of biodiversity protection with local socio-economic development in Carpathian protected areas

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Protected areas in the Carpathians cover almost 36,000 km², which is about 18% of the Carpathian ecoregion. They host a unique variety of plants and animals and provide important services for the benefit of the local population and the sustainable development of society, especially about the conservation of the region's exceptional biodiversity². Unfortunately, the serious global problem of biodiversity loss also affects these areas. Main threats come from changes in social and economic conditions, included infrastructure development and tourism pressure, habitat fragmentation, poaching and illegal logging, over-harvesting and inappropriate natural resource utilization. Moreover, traditional approaches to resource management and nature conservation are no longer sufficient to guarantee long-lasting economic benefits and ecosystem services provision. This explains the need to implement an innovative transnational approach, reconciling both biological and landscape conservation policies and measures for local socio-economic development, thus increasing the support and involvement of local communities in the PAs management. This approach is based on the development, testing and implementation of new tools in the Carpathians, such as an Ecosystem Services Toolkit adapted to the conditions of the target area, a laser scan survey method, LiDAR (Light Detection and Ranging), useful for planning the PAs management, and a series of supporting policy documents (e.g. thematic strategies, guidelines), with the approval of the Carpathian Convention.

The main achieved results, which will be presented, are the elaboration of the ESS Toolkit as a support tool for PAs environmental management decisions and the strategies on PAs biodiversity conservation, sustainable nature and cultural-based tourism development, and communication with local communities aimed to facilitate the integration of biodiversity conservation and sustainable local socio-economic development in the Carpathians.

Keywords: Biodiversity, Protected Areas, Sustainable Development, Management, ESS Toolkit

Appleton M. R. and Meyer, H. Editors, (2014). Development of Common Integrated Management Measures for Key Natural Assets in the Carpathians.

Dovers, S., Feary, S., Martin, A., McMillan, L., Morgan, D. and Tollefson M., (2015) Engagement and Participation in Protected Area Management : Who , why, how and when?, IUCN

INTERREG CENTRAL EUROPE, Treasures of the Carpathians, 2020. <https://www.interreg-central.eu/Content.Node/Centralparks/Treasures-of-the-Carpathians.html>

Ionita, A. and Stanciu, E., (2012) Participatory management of protected areas in the Carpathian region, Brasov.

IUCN, Best Practice Protected Area Guidelines Series No. 30, (2020), Guidelines for conserving connectivity through ecological networks and corridors.

UNEP/CC/COP4/DOC14, (2014) Strategy for Sustainable Tourism Development of the Carpathians.

How does Forest Stewardship Certification address the legality issues in the context of European national frameworks?

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At the European level, there is a very diverse setting of the national regulatory frameworks regarding forest management (Nichiforel et al, 2018). In some countries, the policy instruments are focused on command and control instruments which mainly impose the obligation that forest owners implement a forest management plan. Other countries emphasize more the use of economic instruments (such as subsidies) or voluntary instruments to motivate the responsible use of forest resources. Forest certification is a voluntary tool used as a market instrument to provide a guarantee to the consumers that the timber production is done in agreement with an international standard (Cashore et al, 2005).

The aim of this research is to make a comparative analysis of the identified non-conformities in different countries by using a classification system. Non-conformities are used under the FSC® certification and represent a deviation from the standard that needs to be improved in a timeframe. Reports from 14 countries were checked for 5 years. By using a qualitative content analysis, the non-conformities were coded based on four domains (Forest management issues, Environmental issues, Social issues and Administrative issues). Under each domain specific categories were created to allow for a better comparison (Buliga and Nichiforel, 2019). Moreover, the qualitative categorisation distinguished between: non-conformities referring to an infringement of a legal requirement, non-conformities referring to a voluntary requirement and non-conformities that are not clear in their description on the relation with the legal or voluntary requirements.

The results of this analysis show that clear patterns of non-conformities can be identified between “western” countries and former socialist countries. The analysis shows the potential use of FSC® public reports, for assessing the main problems that the implementation of forest management brings in practice, in a cross-country comparative perspective.

Keywords: Regulatory frameworks, Non-conformities analysis

Buliga, Bogdan, and Liviu Nichiforel. "Voluntary forest certification vs. stringent legal frameworks: Romania as a case study." *Journal of cleaner production* 207 (2019): 329-342.

Nichiforel, L., Keary, K., Deuffic, P., Weiss, G., Thorsen, B.J., Winkel, G., Avdibegović, M., Dobšinská, Z., Feliciano, D., Gatto, P., Gorriz Mifsud, E., Hoogstra-Klein, M., Hrib, M., Hujala, T., Jager, L., Jarský, V., Jodłowski, K., Lawrence, A., Lukmine, D., Pezdevšek Malovrh, Š., Nedeljković, J., Nonić, D., Krajter Ostoić, S., Pukall, K., Rondeux, J., Samara, T., Sarvašová, Z., Scriban, R.E., Šilingienė, R., Sinko, M., Stojanovska, M., Stojanovski, V., Stoyanov, N., Teder, M., Vennesland, B., Vilkriste, L., Wilhelmsson, E., Wilkes-Allemand, J., Bouriaud, L., 2018. How private are Europe's private forests? A comparative property rights analysis. *Land use policy* 76, 535–552. <https://doi.org/10.1016/j.landusepol.2018.02.034>

Cashore, B., Cornelis van Kooten, G., Vertinsky, I., Auld, G., Affolderbach, J., 2005. Private or self-regulation? A comparative study of forest certification choices in Canada, the United States and Germany. *For. Policy Econ.* 7, 53–69. [https://doi.org/10.1016/S1389-9341\(03\)00011-X](https://doi.org/10.1016/S1389-9341(03)00011-X)

Tourism, ecology, and the roles of musicking in the Polish Tatras Mountains

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This presentation considers how tourism in the Tatra Mountains has historically played a role in forming conceptions of mountains themselves and of the human societies that develop within mountain regions. While preindustrial village social structures in the Tatras, like much of the Carpathians, tended to be ecologically sustainable (Angelstam, P. et al. 2013: 394), tourism to the Polish Tatra region known as Podhale began to change relationships to mountain ecologies by facilitating casual temporary interactions that did not require mutual sustainability for survival. A watershed moment was the 1873 founding of the *Towarzystwo Tatrzańskie* (Tatra Society). The founders were urban elites, not *Górale* (mountain people or highlanders) from the Tatra Mountains. Mountain guides engaged by the Tatra Society were almost invariably leading *Górale* musicians, possibly because much of their musicking expressed relationships with mountain ecosystems, including a large pitch-rhythmic tune group called *wierchowa* (mountain peak), and a singing style called *pasterska* (pastoral) (Cooley, 2005). Song texts and performance contexts also reference living with and in high mountain ecologies: seasonal movement of sheep up into the mountains for the summer months, other seasonal and place-specific labor and social/courtship rituals, the naming and use of trees and herbs, and so forth. *Górale* performance genres, therefore, performatively maintain Traditional Ecological Knowledge. The Tatra Society's early reliance on *Górale* musicians as mountain guides and holders of local knowledge set a precedence that continues today, even while some aspects of *Górale* musicking has responded to influences of globalization. However, we now must ask if the continued growth of tourism in Podhale risks overwhelming the legacy of intimate engagements between *Górale* and the mountain ecology.

Keywords: tourism, musicking, Górale, Traditional Ecological Knowledge (TEK), Towarzystwo Tatrzańskie (Tatra Society)

Angelstam, P., M. Elbakidze, R. Axelsson, P. Čupa, L. Halada, Z. Molnar, I. Pătru-Stupariul. (2013). "Maintaining Cultural and Natural Biodiversity in the Carpathian Mountain Ecoregion: Need for an Integrated Landscape Approach." In *The Carpathians: Integrating Nature and Society Towards Sustainability*. Edited by Jacek Kozak, Katarzyna Ostapowicz, Andrzej Bytnerowicz, and Bartłomiej Wyżga. Pp 393-424. Berlin, Heidelberg: Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-12725-0_28.

Cooley, T. (2005). *Making Music in the Polish Tatras: Tourists, Ethnographers, and Mountain Musicians*. (Bloomington: Indiana University Press).

Using traditional ecological knowledge, science, and music to imagine new relationships with mountain ecosystems

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Sustainable cultural processes, like sustainable ecosystems, require change (Allen 2019). All life needs to adapt—even innovate—to survive. This presentation shows some of the ways that musical practices have adapted over the past 150 years in the Polish Tatra Mountain region (Podhale) to accommodate a rapidly developing tourism industry (Cooley 2005). The practices continue to change in order to remain “traditional,” thus modeling a social system that values Traditional Ecological Knowledge as a flexible way of being. This has allowed many regional *Górale* (mountaineers) to continue living thoroughly within the beautiful but unforgiving high Tatras, and fully in the modern world. But is this sustainable as climate change threatens to devastate traditional lifeways in some mountain areas (e.g. Post 2019)? In this paper, I join others in calling for humanists and scientists to collaborate (e. g. Guyette & Post 2015; Post & Pijanowski 2018; Hoelle & Kawa 2021) as we first imagine and then work to develop adaptive human-cultural practices and policies that are equitable and sustainable for all biological beings in the Carpathian ecosystems.

Keywords: Tourism, Tatra Mountains, Traditional Ecological Knowledge (TEK), music, imagination

Allen, A. (2019). Sounding Sustainable; or, The Challenge of Sustainability. In: Cooley, T. (ed.), *Cultural Sustainabilities*. University of Illinois Press, Urbana, pp. 43-59.

Cooley, T. (2005). *Making Music in the Polish Tatras: Tourists, Ethnographers, and Mountain Musicians*. Indiana University Press, Bloomington.

Guyette, M., & J. Post. (2016). Ecomusicology, Ethnomusicology, and Soundscape Ecology. In Allen, A. & K. Dawe, (eds.) *Current Directions in Ecomusicology: Music, Culture, Nature*. New York: Routledge. 40-56.

Hoelle, J & N. Kawa. (2020). Placing the Anthropos in Anthropocene, *Annals of the American Association of Geographers* 0(0):1-8.

Post, J. (2019). Climate Change, Mobile Pastoralism, and Cultural Heritage in Western Mongolia. In: Cooley, T. (ed.), *Cultural Sustainabilities*. University of Illinois Press, Urbana, pp. 75-86.

Post, J. & B. Pijanowski. (2018). Coupling Scientific and Humanistic Approaches to Address Wicked Environmental Problems of the Twenty-first Century: Collaborating in an Acoustic Community Nexus. *MUSICultures* 45 (1-2): 71-91.

Response of beech and fir along the Carpathian gradientns

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In predicting the effect of climate change on the future performance of tree species, a geographic, namely latitudinal gradient can serve as a useful space-time proxy (Čater and Levanič, 2019). To predict species responses to climate change, physiological boundaries should be evaluated with morphological responses to different light intensities to obtain a complete representation of a species' fundamental niche. The research focused on European beech (*Fagus sylvatica* L.) and silver fir (*Abies alba* Mill.), which are very likely to be the two key-future tree species for much of Europe's mid- and high-altitude forests.

On eight permanent plots positioned in uneven-aged beech and fir forests above 800 m a.s.l. along the geographic gradient of Carpathian mountains, physiological and morphological response to light intensity was measured in predefined light categories based on analysis of hemispherical photos (ISF%) during three consecutive growing seasons (2017- 2019). Plots were located in managed and old-growth forests.

On each plot, quantum yield (Φ) was measured during the main growing season in the shelter below mature canopy category (ISF<15%), in the forest edge category (15%<ISF<25%) and in the open, without shelter or shading (ISF>25%) under controlled and comparable environmental conditions. Morphological response to light was evaluated as response to shading, separating light conditions where orthotropic growth transitioned to plagiotropic. Measured responses were matched to local weather/climate conditions from the KNMI database.

Keywords: Keywords 1, Keywords 2, Keywords 3, Keywords 4, Keywords 5

Holeksa, J., Jaloviar, P., Kucbel, S., Saniga, M., Svoboda, M., Szewczyk, J., ... Żywiec, M. (2017). Models of disturbance driven dynamics in the West Carpathian spruce forests. *Forest Ecology and Management*, 388, 79-89.

Bringing primary school pupils closer to environmental education. Proposal for a field itinerary in Romanian Carpathian Mountains

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In teaching the environmental sciences, the professor has the role to ensure the bond between students' previous and new knowledge about the processes and

phenomena that govern the smooth running of the nature, without resorting to "by heart" memory. In like manner, bringing students closer to nature may help strengthen their ability to cope with various situations of anthropogenic impact on the environment. In light of these understandings, education for environmental sustainability is of particular importance for the development of the youth pro-nature awareness.

In the quest for those cognitive abilities aiding second-grade target pupils fathom the societal environmental issues, the current research aims to propose and test an exploratory teaching approach upholding their comprehension of abstract notions currently used in earth sciences. The joint "Mathematics and environmental exploration" curriculum for the second-grade level in Romanian elementary schools outlines a logical framework for teachers to instill in their students an ecological behavior in favor of nature. The vast majority of notions in the curriculum can be taught via thematic trips, prioritizing game-type activities, observation and understanding by the pupils of different phenomena and geographical realities, with the teacher acting as a shadow moderator of the discussion.

For this case study, the proposed itinerary covers the southern Romanian Carpathians, with the following points of interest: Bucharest – Ploiești – Câmpina - Sinaia- Brașov - Bixad - Sfânta Ana Lake - Brașov – Buzău - Bucharest. This itinerary can be covered in 3 days, preferably between April and May, and it is intended for pupils in Bucharest. The evaluation of the achievement of the objectives can be done all along the trip. The teaching methods and experimental activities are defined in accordance with the specificity of the natural factors (geology, relief, climate, water, soil, vegetation floors from forests to alpine pastures) and anthropic pressures observed on the field. The results are expected after the Covid-19 pandemic, when field applications will be possible. We envisage to improve students' ability to respond to environmental issues and to encourage a proactive attitude in full understanding of human influence on nature in the Carpathian context.

Keywords: environmental education, Carpathian Mountains, empirical learning, sustainability, field trip

Use of renewable energy resources and management of waste recycling projects in the Romanian plain. Case study: Giurgiu county, Romania

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The introduction of renewable energy sources in the energy circuit is one of the challenges of the 21st century for all communities on the planet, and the promotion of benefits is completely necessary in an era decimated by climate changes, extremely urban pollution and mismanagement of resources. Pollution from energy and heat sources is not the only problem of urban or rural communities in Romania, identifying a different nature pollution, by introducing into the ecosystem non-degradable waste,

chemical pollutants or natural changes imposed on man, which will become destructive with the lack of recycling projects. The objective of the study is to identify the level of renewable energy potential in the Romanian Plain, through a case study focused on Giurgiu County, but also to analyze the current capacity of renewable energy and how they can help or replace traditional forms of energy. The secondary objective of the study is to analyze the projects aimed at reducing pollution in the analyzed territory, as well as how they are viewed by the local administration. The aim of the study is to raise awareness of the need to use renewable energy sources and the principles of sustainability in waste management.

Keywords: pollution, environment, sustainability, ecology, green

(I would like to thank the local administration in Giurgiu County for the opportunity to provide us with conclusive data on the recycling projects carried out in the county, as well as on the data on renewable energy sources.)

Managed mountain streams as boosters of downstream sediment transport

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Understanding bedload transport rates and virtual velocity of transported sediments in stream channels can inform catchment-based management plans and efforts based on the frameworks of sediment (dis)connectivity. We assessed the potential alteration of coarse sediment (dis)connectivity (i.e., gravel and cobble-size fractions) in two small streams as a response to the presence of complex torrent-control works. These two neighbouring foothill streams (managed and control untreated; channel width <5 m, bed slope ~2 %) were located in the north slopes of the Moravskoslezské Beskydy Mts. (Czech Republic) and they notably differ in channel morphology (plane beds separated by subsequent check dams vs. natural pool-riffle). Our 30-months-long monitoring including four bankfull events documented very long transport distances (up to 500 m) of tagged particles in the managed stream as the response to channelization works, strong bed armouring processes and a lack of depositional bedforms. In the opposite to the boosted downstream sediment flushing, the lateral sediment supply and vertical exchange of bed material were notably reduced by the presence of artificial bank stabilisations and forced bed armour layer. In contrast, a lot of tagged particles remained quite close to the place of their initial installation in the untreated pool-riffle stream despite the similar peak discharges observed during the monitoring period. The frequent presence of bank failures in the outer banks of bends and the negligible difference between grain sizes of the surface and subsurface bed layers suggested strong interactions in the vertical and lateral dimensions of sediment (dis)connectivity. From a long-term perspective, climate and land use changes since the 19th century together with the construction of torrential works since the 20th century notably affected sediment production and its downstream fluxes at the catchment scale (see discussion in Galia et al., 2021).

Keywords: river management, bedload transport, sediment (dis)connectivity, check dams,

The research was supported by SGS10/PřF/2021

Galia, T., Škarpich, V., Ruman, S. (2021). Impact of check dam series on coarse sediment connectivity. *Geomorphology*, 377, 107595.

WorldForestID: Addressing the need for standardized wood reference collections to support authentication analysis technologies; a way forward for checking the origin and identity of traded timber

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We describe a program called WorldForestID which is being developed to monitor and support authentication and compliance in international trade of timber products. The program is being run by a consortium of government and non-government organizations: US Forest Service International Programs (USFS IP), Royal Botanic Gardens, Kew, Forest Stewardship Council (FSC), Agroisolab, and World Resources Institute (WRI). Initial funding has come from the US Department of State, USFS IP, US Department of Agriculture Animal and Plant Health Inspection Service, Forest Stewardship Council, and the UK Department for Environment, Food and Rural Affairs (Defra). The aim is to build a comprehensive collection of internationally traded timber species. The collection is used as reference material to validate forest products. Although there are a large number of xylaria (wood collections, Index Xylariorum IV) around the world, many of the specimens do not provide geo-locations suitable as reference material for pinpointing provenance, many lack-associated herbarium vouchers and some are misidentified. The samples being collected in this program address these issues and include bark, sapwood, and heartwood, ensuring that the material collected is suitable for current and future scientific analysis. We describe the process of collection and validation from field to laboratory and the advantages and disadvantages of the main techniques used to ascertain/verify identity and provenance. Ultimately, we envisage the day that scientific methods will be used routinely and successfully by timber traders, manufacturers, retailers, and law enforcement to accept or reject identity and provenance claims on internationally traded timber and forest products and, where necessary, to support prosecutions when laws such as EU Timber Regulations, Lacey Act and CITES are infringed.

Keywords: *DART-TOFMS, illegal logging, international trade, provenance, SIRA (stable isotope ratio analysis), wood anatomy, wood identification, xylarium*

US Department of State, US Forest Service; International Programs, US Department of Agriculture, Animal and Plant Health; Inspection Service; Defra, FSC.

Abe, H., Watanabe, U., Yoshida, K., Kuroda, K., & Zhang, C. (2011). Changes in organelle and DNA quality, quantity, and distribution in the wood of *Cryptomeria japonica* over long-term storage. *IAWA Journal*, 32(2), 263–272. <https://doi.org/10.1163/22941932-90000056>

- Bergo, M. C. J., Pastore, T. C. M., Coradin, V. T. R., Wiedenhoeft, A. C., & Braga, J. W. B. (2016). NIRS identification of *Swietenia macrophylla* is robust across specimens from 27 countries. *IAWA Journal*, 37(3), 420–430. <https://doi.org/10.1163/22941932-20160144>
- Blanc-Jolivet, C., Yanbaev, Y., Kersten, B., & Degen, B. (2018). A set of SNP markers for timber tracking of *Larix* spp. in Europe and Russia. *Forestry: An International Journal of Forest Research*, 91(5), 614–628.
- Boner, M., Somner, T. H., Erven, C., & Forstel, H. (2007). Stable isotopes as a tool to trace back the origin of wood. Proceedings of the international workshop “Fingerprinting methods for the identification of timber origins”, October 8–9 2007, Bonn/Germany.
- Braga, J. W. B., Pastore, T. C. M., Coradin, V. T. R., Camargos, J. A. A., & Silva, A. R. (2011). The use of near infrared spectroscopy to identify solid wood specimens of *Swietenia macrophylla* (CITES Appendix II). *IAWA Journal*, 32(2), 285–296.
- Deklerck, V., Finch, K., Gasson, P., Van den Bulcke, J., Van Acker, J., Beeckman, H., & Espinoza, E. (2017). Comparison of species classification models of mass spectrometry data: Kernel Discriminant Analysis vs. Random Forest; a case study of *Afrormosia* (*Pericopsis elata* Harms (Meeuwen)). *Rapid Communications in Mass Spectrometry*, 31, 1582–1588. <https://doi.org/10.1002/rcm.7939>
- Gasson, P. (1999). Wood anatomy of the tribe Dipterygeae with comments on related Papilionoid and Caesalpinoid Leguminosae. *IAWA Journal*, 20, 361–375.
- Gasson, P. (2011). How precise can wood identification be? Wood anatomy's role in support of the legal timber trade, especially CITES. *IAWA Journal*, 32(2), 137–154.
- Index Xylariorum IV. Compiled by Anna H. Lynch and Peter E. Gasson (version March 2010), and updated by IAWA under supervision of Frederic Lens (March 2016). Retrieved from <https://www.iawa-website.org/uploads/soft/Abstracts/Index%20Xylariorum%204.1.pdf>
- Koch, G., Haag, V., Heinz, I., Richter, H. G., & Schmitt, U. (2015). Control of internationally traded timber – The role of macroscopic and microscopic wood identification against illegal logging. *Journal of Forensic Research*, 6, 317. 4172/2157-7145.1000317
- Lancaster, C., & Espinoza, E. (2012). Analysis of select *Dalbergia* and trade timber using direct analysis in real time and time-of-flight mass spectrometry for CITES Enforcement. *Rapid Communications in Mass Spectrometry*, 26(9), 1147–1156. <https://doi.org/10.1002/rcm.6215>
- McClure, P. J., Chavarria, G. D., & Espinoza, E. (2015). Metabolic chemotypes of CITES protected *Dalbergia* timbers from Africa, Madagascar, and Asia. *Rapid Communications in Mass Spectrometry*, 29, 783–788. <https://doi.org/10.1002/rcm.7163>
- Rees, G. O. (2015). Verifying the declared origin of timber using stable isotope ratio and multi-element analyses. Thesis, University of York, UK. Retrieved from <http://etheses.whiterose.ac.uk/9522/>
- Watkinson, C. J., Gasson, P., Rees, G. O., & Boner, M. (2020). The development and use of isoscapes to determine the geographical origin of *Quercus* spp. in the United States. *Forests*, 11(8), 862. <https://doi.org/10.3390/f11080862>

Climate change and human impact on the vegetation of the Carpathian foreland (Ukraine) over the last 5,000 years based on pollen studies at archaeological sites

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The studied area is a highland with broad-leaved woods (oak, hornbeam and beech). At present, the woods have been largely replaced by agricultural land. Pollen studies of six archaeological sites in the Chernivtsi region demonstrate that cultivation had started here in the Late Neolithic, but it strongly increased since the Bronze Age. The climate change also affected the vegetation. The Trypillya culture (IV millennium BCE, 5400±30 - 5285±35 BP, Chernovol, Radetskyi, 2015) appeared under a warm and wet climate: hornbeam-lime-oak woods spread, and thermophilic *Juglans* occurred. During the existence of the Ozhevo settlement, wooded areas were reduced, and hazel spread (a sign of clearing). Human impact is seen in the presence of *Cerealia*, *Centaurea cyanis* and *Plantago major*. Broad-leaved woods did not recover after the settlement disappeared, and that indicates a cooling at the end of the Atlantic which could have caused the settlement's abandonment. A significant aridification (with an increase in xerophytes) marked the Middle Subboreal (the Northgrippian-Meghalayan transition). The humid phase, with the spread of nemoral woods, occurred during the Late Subboreal. Woodland was replaced by meadow-steppe after 1000 years BCE – the “xerothermal depression” (Zolotun, 1975; Gerasimenko, 1997). Early Iron Age settlements appeared in the VI century BC under humid climate mixed forest, but clearings were started for construction of defensive walls (against nomadic raids) and cultivation. The spread of secondary meadows became more marked during the IV-VI centuries CE (the Ridkivtsi site, 1740±50 BP) and in Early Slavic times (VIII cent.). Woods and meadow-steppes co-existed, *Cerealia*, *Fabaceae*, *Fagopyrum*, *Juglans*, *Vitis* grew, and diverse weeds were common. The warm and wet climate of the Medieval Optimum (1190±50 BP, 1040±90 BP) caused the extensive spread of nemoral woods (oak, beech and hornbeam), which had started to diminish during the Little Ice Age.

Keywords: woodland composition and extention, Bukovyna, palynology, Middle and Late Holocene

Chernovol, D.K., Radomskyi, I.S. (2015). Kamyani vistrya z tripil'skogo poselennya Ozeve-ostrov. Kulturny kompleks Kukuten'-Trypillya ts yogo susidy. Astrolyabia, Kyiv, 367-384 (in Ukrainian).

Gerasimenko, N. (1997). Third Millennium BC Climate Change and Old World Collapse. NATO ASI Series. Series I: Global Environmental Change, 49, 371-399.

Zolotun, I.I. (1974). Razvitie pochv yuga Ukrainy za poslednie 50-45 stoletiy. Ukrainian Agricultural Academy Press, Kiev (in Russian).

Twentieth-century development of floodplain forests in Polish Carpathian valleys: the by-product of transformation of river channels?

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In the second half of the 20th century, valley floors of Polish Carpathian rivers lacked forest. During the 20th century forest developed on higher parts of former river channels that were no longer disturbed by channel processes as a result of river channelization and/or channel incision (Hajdukiewicz and Wyżga, 2019). Abandonment of the pastoral and agricultural use of riparian areas additionally stimulated forest expansion. The 20th-century development of floodplain forests is illustrated by the study of four rivers: Czarny Dunajec, Koszarawa, Biała and Raba. Between the 1870s and 2009 all these rivers significantly narrowed but they differed in the timing and scale of the process. The width of the Czarny Dunajec and Raba rivers decreased progressively in the first and second halves of the 20th century, the Biała experienced a narrowing primarily in the first half of the century, whereas the narrowing of the Koszarawa took place in its second half. A scale of the narrowing ranged from 35% in the Koszarawa to 78% in the Raba. The channel narrowing increased the proportion of floodplains in the river corridors; in the Biała valley, it doubled, increasing from 42% to 84%. Forest expansion on the floodplains significantly increased the proportion of forested areas in the river corridors, which in 2009 ranged from 28.5% in the Czarny Dunajec valley to 46.5% on the Koszarawa. The largest increase in forested area over the last 130 years, from 2.4% to 45.3%, was recorded in the river corridor of the Biała. The development of floodplain forest was accompanied by establishing of islands in the rivers; however, these features survived only in unchannelized river sections. The occurrence of floodplain forests and overgrowing river banks with trees exert positive effects on the functioning and diversity of riverine and floodplain ecosystems in Polish Carpathian valleys. However, a delivery of fallen trees to the channels is the source of hazard during floods.

Keywords: floodplain forest expansion, channel narrowing, river corridor, biodiversity

This study was performed within the scope of the Research Project 2015/19/N/ST10/01505 financed by the National Science Centre of Poland.

Hajdukiewicz, H., Wyżga, B. (2019). Aerial photo-based analysis of the hydromorphological changes of a mountain river over the last six decades: The Czarny Dunajec, Polish Carpathians. *Science of the Total Environment*, 648, 1598-1613.

Recent changes and processes of Carpathian agricultural areas with particular focus to Slovakia

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Humans have altered landscape for centuries, but recent rates of change are exceptionally high. Institutional and economic factors were most influential drivers in shaping deforestation and agricultural expansion in Carpathians, while socio-demographics and institutional shifts were found the key drivers of land abandonment by Munteanu et al. (2014). The collectivization of agriculture after 1950, change to market oriented economy after 1990, and accession to EU in 2004 are the main milestones of agricultural landscape development in Slovakia (Bezák et Mitchley, 2014) and they are shared by other Carpathian countries.

From the long-term perspective, the agricultural land abandonment and afforestation were the most intensive processes in Slovakia. The abandonment was most intensive after the transition to open market economy and even its rates were twice higher in mountains, the majority of abandoned land was located in plains. The likelihood of abandonment increased with distance from the national capital (Bratislava), decreased with an increase of annual mean temperatures and was higher in proximity to forest and on steeper slopes. The recultivation of agriculture happens at the same time as abandonment, but in lower rates (Pazúr et al. 2020). Intensity of urbanization is increasing over the time. It seems that agriculture abandonment significantly decreased in last decade.

In order to find out how these processes take place and differ at the local level, we established case studies in the project Demetra in different landscape types. In Pannonian lowland we observed maintenance of relatively intensive agricultural use, part of arable land was recently transformed to orchard or vineyards. In mid-mountains of Carpathians we registered conversion of arable land to grasslands (hay meadows and pastures), otherwise the land use is stabilised. The abandonment of agricultural land that was remarkable especially in 1990-ties does not play an important role currently.

Keywords: agricultural landscape, land use change, drivers, rural areas

This research was supported by the grant agency APVV, project No. APVV-17_0377 Demetra.

Bezák et Mitchley, (2014). Drivers of change in mountain farming in Slovakia: from socialist collectivisation to the Common Agricultural Policy. *Regional Environmental Change* 14, 1343–1356.

Munteanu, C., Kuemmerle, T., Boltziar, M., Butsic, V., Gimmi, U., Halada, Ľ., Kaim, D., Király, G., Konkoly-Gyuró, É., Kozak, J., Lieskovský, J., Mojses, M., Müller, D., Ostafin, K., Ostapowicz, K., Shandra, O., Štych, P., Walker, S., Radeloff, V.C. (2014). Forest and agricultural land change in the Carpathian region - A meta-analysis of long-term patterns and drivers of change. *Land Use Policy* 38, 685–697.

Stone mounds and walls as a current manifestation of past human-environmental interactions in vine regions of Little Carpathian mountains (case study of Modra, Slovakia)

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Stone mounds and walls are defined as the man-made accumulations of the unnecessary skeletal material accumulated over centuries as by-products of vineyards cultivation usually at the borders of plots. They are among the relatively durable remnants of traditional farming; we still find them in the landscape even when other visible traces of past winegrowing have disappeared. We analysed their distribution, position, shapes and volume; also, we defined the basic types and causes of their disappearance and transformation, relying on the comparison of situations in 1894 and 2018. A combination of the historical maps, aerial images and Lidar data study and field research as well were used for the identification and analysis of stone mounds and walls. The volumes of stone mounds and walls in 2018 were computed from the digital terrain model derived from the Lidar data. Dependencies between the individual characteristics in individual years were quantified by correlation coefficient (r) and that of determination (r^2). Compared to 1894, the number of stone mounds in 2018 decreased by 38%, their overall area diminished by 62%. The main driving force of the disappearance or transformation of stone mounds and walls has been the transition to modern, large-area vineyards in socialism period. Stone mounds and walls though remain a noticeable testimony to the traditional viticultural landscape with undeniable biocultural value.

Key words: stone mounds and walls, traditional viticultural landscape, Lidar data, Modra, Slovakia

This work was supported by the project No. 2/0078/18 Research of biocultural values of landscape.

Exploring visitors' spatial behaviour as a basis for protected areas management – a case study from the Tatra Mountains

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Mountain protected areas (PAs), due to attractiveness of its natural resources, belong to important tourist destinations. Especially, carpathian national parks often face a challenge to fulfill both: nature conservation objectives and societal functions, such as recreation or education (Eagles i in. 2002). Therefore, reliable information on visitor load and their spatio-temporal distribution along with detailed nature monitoring is needed, in order to successfully manage PAs (Cessford, Muhar 2003). This study focuses on a heavily used tourist destinations in two Tatra National Parks (TPN & TANAP). The main aim of this research was to determine the relationship between visitors' spatial behavior and the trip characteristics in the vicinity of cable cars Kasprowy Wierch (Poland) and Łomnicki Staw (Slovakia) as well as to conduct a comparative analysis. On-site interviews were conducted in two cable car areas: 2014 in Kasprowy Wierch area (Taczanowska, et al., 2016) and 2014 as well as 2015 in Łomnicki Staw (Hibner, 2018). A total sample of interviews was 3167. Survey include information on visitors' routes in research areas, trip characteristics (use of cable car / type of purchased cable car ticket) and general information about respondents. The spatial and statistical analyses were done using ArcGis as well as SPSS software. The presentation will include results and some practical recommendations for PA's management.

Keywords: cable cars, protected areas, spatial behavior

Cessford G., Muhar A. (2003): Monitoring options for visitor numbers in national parks and natural areas. *Journal for Nature Conservation* vol. 11, 4, 240–250.

Eagles P.F.J., McCool S.F., & Haynes C.D.A., (2002) *Sustainable Tourism in Protected Areas: Guidelines for planning and management*. IUCN xv: 1-183. Gland Switzerland, Cambridge UK.

Hibner, J (2018) *Wpływ kolei linowych na structure ruchu turystycznego w Tatrach* PhD Thesis. Jagiellonian University, Cracow, Poland.

Taczanowska K., Zięba A., Brandenburg C., Muhar A., Preisel H, Zięba S., Krzeptowski J., Krajewska A., Kamińska K., Latosińska B., Hibner J., Makaruk W., Hat-Pawlikowska K., Sostmann H., Graf C., Benitez R., Bolos V., Gonzalez L.M., Garcia X., Toca-Herrera J.L, Zmrzlikar S., Ziobrowski S. (2016): Visitor Monitoring in the Tatra National Park – a Pilot Study – Kasprowy Wierch [Monitorig ruchu turystycznego W Tatrzańskim Parku Narodowym – studium pilotażowe – Kasprowy Wierch 2014]. Project Report. Institute of Landscape Development, Recreation and Conservation Planning, University of Natural Resources and Life Sciences (BOKU), Vienna, Austria. P. 201.

European beech as a main edificator of the vegetation tiers in the Carpathians Mts. – in what time horizon will the changes be noticeable?

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European beech (*Fagus sylvatica*) is one of the main edificators of forest ecosystems in the Central Europe and is one of the holders of the altitudinal vegetation zonation. The species occurs in Carpathians Mts. In the Czech Republic from cca 260 m a.s.l. up to 1320 m a.s.l. – i.e. 2nd vegetation tiers (*Fageto-querceta* s.lat.) to 8th vegetation tier (*Piceeta* s.lat.) (classification of vegetation tiers (VT) according to the forest site classification system, which is used as a base for forest management in the Czech Republic). For the differentiation of individual vegetation tiers we use the life manifestations of tree edificators, therefore also the manifestations of beech individuals. Individual vegetation tiers differ significantly in the average height of the crown level (average height of the main crown level in the 2nd VT was found 29 m (the maximum height 35 m), in 3rd VT the average height of the main crown level was 38.9 m (maximum height 46.5 m), in 4th VT average height 43, 2 m (max height 51 m), in 5th VT average height 38.8 m (max height 45 m), in 6th VT average height 27.1 m (max height 35 m), in 7th VT average height of 17.2 m (maximum height 23 m) and an average height of 8.4 m (maximum height of 5 m) in 8th VT), so the shape of the crown, forkiness of trunk, etc. Each vegetation tier has its own features. With a theoretical change in the "shift" of vegetation tiers to higher altitudes due to climate changes, individual trees will also regulate by changing their growth. However, changes such as height, crown shape, etc. they will be recognizable only in the horizon of 150-250 years, i.e. in the next generation of forest stands. Therefore, it is understandable that the vegetation stages have a permanent position for the next 50-70 years.

Keywords: *Fagus sylvatica*, dendrometric characteristics, life manifestations, ecological limits, vegetation tiers, forest site classification system, the Western Carpathians Mts., Czech Republic

The downstream fining trends of two neighbouring rivers; the difference in significance of the disruption factors

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The downstream fining is a process of gradual decrease of sediment size caused by abrasion and selective sorting. This process is often disrupted either by blocking of sediment transport e.g., by grade control structures, or by sediment input throughout

the river course, such as tributary sediment fluxes, local incision, bank erosion, or lateral sediment inputs from adjacent hillslopes. We assessed downstream grain-size trends on gravel bars in two neighbouring regulated rivers: the Lubina and the Ondřejnice, which are draining the Czech part of the Outer Western Carpathians. The aim was to evaluate the effects of grade control structures as well as significant tributaries and possible lateral sediment inputs as the disrupting elements in the process of downstream fining. We also assessed the relationship between channel width and grain-size variations of sediment and the depositional trends within the planar area of the gravel bars. The outcome of this research showed larger sediment grain sizes (from the gravel bars surfaces) in the Ondřejnice as well as a higher downstream reduction coefficient ($D50 = 0.033 \text{ mm km}^{-1}$; $D84 = 0.036 \text{ mm km}^{-1}$) than in the Lubina ($D50 = 0.026 \text{ mm km}^{-1}$; $D84 = 0.032 \text{ mm km}^{-1}$). These intense reduction trends were observed in the sediment grain-size on single- or multi-thread rivers in the Western Carpathians. Grade control structures were associated with the disruption of the downstream fining only in few cases. As for the tributaries and lateral inputs, they can be in some cases linked to the disruption in the Ondřejnice. However, no significant tributary or any lateral input areas were associated with the disruption in the Lubina. Both rivers showed the coarsest sediments deposited mostly within the centre area of the gravel bars. In the Lubina, the wider channels were often linked with a presence of finer sediment deposition and coarser in narrower channels, but only a weak relationship was found out in the Ondřejnice.

Keywords: downstream fining, gravel bar, tributary, sediment grain-size

Postdisturbance development of vegetation in the high tatras

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Large scale windstorms disturbed forest ecosystem in the Tatra Mts. in 2004, and were followed by a severe fire in 2005. The main objective of long term postdisturbance development of vegetation study were determination of succession pathways unposition, where the directionder different management. The hypothesis of convergence in vegetation succession is based on the „climax“ theory, according to which all successional series in an area with the same climate will eventually converge towards a unique final community. (Feldemeyer – Christe et al. 2011) in our case group of forest type Lariceto – Picetum, respectively allianceVaccinio-Piceion. A long-term study on the vegetation successional dynamics of the area was launched immediately after the 2005 event. The classical issue in succession is change in species com of change includes alternative pathways towards one or several equilibrium stages. The succession pattern of vegetation was quite different according management. Sussessional pathway of non-extracted plot (NEX) approaching extracted site (EXT) and after fire (FIR) since 2011ecological site conditions with different processing have been balanced since 2010. The highest diversity of species of herbs and plants is an area of fire. The species *Rubus idaeus*

became dominant at all research plots. The highest abundance we registered at NEX, where carbon source may be decayed stumps.

Key words: The Tatra Mts, calamity, permanent research plots, succession

Feldmeyer-Christe E., Küchler M. & Wildi O. (2011) Patterns of early succession on bare peat in a Swiss mire after a bog burst. – *Journal of Vegetation Science* 22(5): 943-954.

Near real-time monitoring of forest stands to combat illegal timber harvesting in Ukrainian Carpathians

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Based on spectral analysis of satellite images, the authors assessed changes in the forest cover of designated areas of the Ukrainian Carpathians. Identification of the rapid changes is carried out by comparing individual images for the beginning and end of specified periods with application of the normalized difference vegetation index (NDVI) method. This classical approach is used because disturbances to forest cover, such as timber harvesting, lead to a decrease in NDVI values.

Analytical and field research of clearcuts conducted within the ForestCom illegal timber harvesting program supported by the US Forest Service resulted in following conclusions:

- The characteristics of modern satellite images (spatial and spectral resolutions) such as of Sentinel-2 are suitable for identification of rapid changes in forest cover. Their availability (free access) facilitates the increase in their use for inventory and monitoring the loss of forest cover and the legitimacy of clearcuts.
- The identification method disturbance of forest cover based on the automatic creation of rapid change maps is most objective and fast. It is, therefore, the best method for implementation of remote sensing in a variety of timber harvesting monitoring systems.
- Use of Sentinel-2 images for monitoring of clearcuts is still the most applicable solution, as it, combined with the modern automatic methodology for detecting rapid changes, makes it possible to obtain data on the structure and size of clearcuts over large territories in a short period of time.
- Such maps of changes in combination with forest owners' electronic maps and, if available, with schemes of officially conducted timber harvests, could play a crucial role in detection of illegally logged places and monitoring of other disturbances.

The implications of using NDVI technologies for forest communities in terms of the cessation of illegal timber harvesting as well as law enforcement and the criminal prosecution of perpetrators are discussed.

Keywords: Ukrainian Carpathians, normalized difference vegetation index (NDVI), illegal timber harvesting, forest disturbance

Changes in Slovak rural landscape, in the context of globalization

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Slovakia, despite the fact that 56% of the population lives in cities, can be considered a rural country. This is evidenced by the landscape character and the structure of the settlement. The agricultural landscape of Slovakia is subject to permanent changes. There are a number of factors that change not only the structure and scenery of the agricultural landscape, but also significantly endanger and degrade its natural resources. Transformational changes can be considered as the main factors. The agricultural landscape is also significantly affected by the process of globalization. Structural changes in the territory of Slovakia brought several changes, which significantly affected the character of the agricultural landscape of Slovakia and caused a number of not only socio-economic but also environmental problems. It includes all scale of newly arising actual and till now not solved problems. The particular problems are often mutually connected. For example the change in land utilization influences in a considerable extent the biodiversity and landscape stability, the abandonment of agricultural land causes the spread of invasive species, the destruction of which requires certain economic resources, the restructuring of agriculture has conditioned increased unemployment and another social problem. Their solution requires the application of a holistic approach to the assessment and solution of agricultural land problems.

The paper will present analyses of the current problems of Slovak rural landscape and analyses of the basic drivers of these changes and their impacts.

Key words: Slovakia, agricultural landscape, transition, global megatrends, problems of rural landscape

This work was supported by the Projects: APVV-17-0377: DEMETRA

Role of vegetation cover in water and soil retention modeling in the Dřevnice River basin, Czech Republic

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This contribution presents the results of water and soil retention modeling carried out in the Dřevnice River basin, in the eastern part of the Czech Republic. The Dřevnice River is a left-hand tributary of the Morava River with a length of 42 km and a basin area of 435 km², located in flysch zone of Outer Western Carpathians.

Soil water retention is determined using the LOREP model, serving as a tool for spatial localization of sites with low water capacity and associated with a structured catalogue of non-technical measures to increase and support the water retention function of the landscape. Sediment retention is captured by the InVEST/SDR model, combining the soil loss calculation using the (R)USLE method and the calculation of the sediment delivery ratio (SDR), based on the connectivity index.

The modeling process captures both the current ecological state of the landscape, including its dynamics, and also the theoretical state after vegetation removal for comparison purposes. Then the water and sediment retention are calculated by comparing the real values for the current vegetation cover with a hypothetical state, where the entire catchment area is covered only with bare soils. The results clearly capture the significant influence of vegetation cover on the performance of the water retention function and soil erosion control of the landscape.

The analysis revealed that there are several types of natural or semi-natural habitats able to retain a significant amount of rainwater, even in soils with limited retention capacity. A possible increase in the area of these habitats may indirectly contribute to the mitigation of hydrological extremes and the increase of surface water quality. The location of surface runoff source areas and proposals for appropriate measures to mitigate it are one of the most important information for the conservation of water resources, their sustainable management as well as mitigation of the frequency of extreme hydrological phenomena.

Keywords: water retention, environmental modeling, LOREP model, surface runoff

High resolution 19th century buildings, railway and road network database for the Galicia and Austrian Silesia, Habsburg Empire

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High-quality historical data are crucial for any long-term environmental or socio-economic analysis. However, since their acquisition is a time-consuming process, their usage is limited to relatively small areas. Here we present a set of mid-19th century historical datasets covering Galicia and Austrian Silesia (80 000 km²) – historical provinces of the Habsburg Empire, currently located in Czechia, Poland, and Ukraine. Data contains road and railway network and exact locations of the buildings. All of the data are available in GIS .shp format and freely available to the scientific community (Kaim et al., 2021). In the paper, we critically present the datasets in relation to original data sources – the maps of the second military survey (1:28,800) and assess their quality. The data captures the situation just before rapid industrialization (Frank, 2005), massive inter-continental migration, and profound land use changes, being a result of societal and political changes in Central Europe, covering also substantial parts of the Carpathians (Munteanu et al., 2014).

Keywords: HGIS, Historical GIS, data sources, Central Europe, historical data, historical maps

This research was funded by the Ministry of Science and Higher Education, Republic of Poland under the frame of 'National Programme for the Development of Humanities' 2015–2020, as a part of the GASID project (Galicia and Austrian Silesia Interactive Database 1857–1910, 1aH 15 0324 83).

Frank, A. F., 2005, *Oil Empire: Visions of Prosperity in Austrian Galicia*, Harvard University Press, Cambridge, London.

Kaim, D., Szwagrzyk, M., Dobosz, M., Troll, M., and Ostafin, K., 2021, Mid-19th-century building structure locations in Galicia and Austrian Silesia under the Habsburg Monarchy, *Earth System Science Data*, 13, 1693–1709.

Munteanu, C., Kuemmerle, T., Boltziar, M., Butsic, V., Gimmi, U., Lúboš Halada, Kaim, D., Király, G., Konkoly-Gyuró, É., Kozak, J., Lieskovský, J., Moyses, M., Müller, D., Ostafin, K., Ostapowicz, K., Shandra, O., Štych, P., Walker, S., and Radeloff, V. C., 2014, Forest and agricultural land change in the Carpathian region-A meta-analysis of long-term patterns and drivers of change, *Land Use Policy*, 38, 685–697.

NGO capacity building in Ukraine to fight illegal timber harvesting

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Various publications, including international, indicate that illegal timber harvesting volume in Ukraine (including the Carpathian region) could have been in a range from 2 to 100% to those that are officially harvested and reported to the state Statistics in previous years (1990-2018). In 2019, The State Forest Resource Agency documented six times more the level of illegally harvested trees only on its territories.

Since 2015, NGO sector intensified its activities against illegal timber harvesting. For example, WWF efforts resulted in establishing a project called "Forest Watch".

The authors will share their knowledge on the topic, e.g. how fighting against corruption was organized in Ukraine with the aim to decrease illegal forest activities in Ukrainian Carpathians by engaging communities, media, and law enforcement. The activities included research, field investigations, policy development, and interactions with government, public, and media. The teams faced difficult situations and decisions but a presence of free media, good friendship, and strong willingness resulted in high level of cooperation with the Ukrainian government, international media and organizations, including Interpol.

The main topics of the presentation will also include:

- What law enforcement representatives say about illegal harvesting;
- What types of common forest offences cases were recorded;
- Role of NGOs, politics, law enforcement, researchers, international organizations, and media in fight against illegal harvesting;
- What are the present developments of the instruments and public engagement into the fight against illegal harvesting and mitigation of climate change effects.

The authors will try to get back you in time to the period starting from the Revolution of Dignity presenting his project results achieved together with WWF and U.S. Forest Service until now. You will be able to discuss the possible future scenarios.

Keywords: Ukrainian Carpathians, illegal timber harvesting, NGO capacity building, law enforcement

NGO „ForestCom“ would like to thank the United States Forest Service International Program (USFS) for its support of FORESTCOM ILLEGAL LOGGING PROGRAM IN UKRAINE.

Anatoliy Pavelko and Dmytro Skrylnikov, 2010. Illegal Logging in Ukraine: Governance, Implementation and Enforcement, Diagnostic audit. Available online: http://www.envsec.org/publications/audit_illegal_logging_eng_feb_11.pdf (accessed on 21 March 2021)

EarthSight (2018). Complicit in Corruption. How billion-dollar firms and EU Governments are Failing Ukraine's Forests Available online: https://docs.wixstatic.com/ugd/624187_673e3aa69ed84129bdf91b6aa9ec17.pdf (accessed on 21 March 2021)

NGO „ForestCom“ (2020). 2020 Annual Report. Available online: <https://forestcom.org.ua/storage/app/uploads/public/604/101/4f7/6041014f70449804834991.pdf> (accessed on 21 March 2021)

Peter Hirschberger, 2012. Improving FLEG in Ukraine. 19 c. Available online: http://fleg1.fleg.org.ua/fileadmin/user_upload/ufs/04.%20Program%20Information/4.02%20Program%20Components/4.02.05%20Public%20Awareness/Report_PH_final_Ukraine_EN.pdf (accessed on 21 March 2021)

Tobias Kuemmerle, Oleh Chaskovskyy, Jan Knorn, et al., 2009. Forest cover change and illegal logging in the Ukrainian Carpathians in the transition period from 1988 to 2007. Available online: https://www.uvm.edu/giee/pubpdfs/Kuemmerle_2009_Remote_Sensing_of_Environment.pdf (accessed on 21 March 2021)

WWF Ukraine (2019). The Forest Guard project. Development of opportunities in Ukraine to combat illegal deforestation. Project activity report for 2017-2018. Available online: http://d2ouvy59p0dg6k.cloudfront.net/downloads/4_3_report_on_the_forest_watch_activities_in_2017_2018_ukr.pdf (accessed on 21 March 2021)

Exploring and quantifying the impact of climate change on Carpathian rivers

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Climate change, an important environmental driver, is rarely homogeneous over a larger area. Understanding and quantifying its impact on specific regions or resources can be crucial for regional and local communities, their future well-being and quality of life. In this context, mountain regions around the world, rich in accumulated snow, can be particularly sensitive to global warming and therefore require special attention.

This study focuses on the Carpathian rivers, whose catchments are located in southern Poland. Carpathian rivers, like other mountain rivers, are an important source of water for regional and local communities, as well as lowland areas. To explore and quantify the impact of climate change on flowing water resources, a method of Rescaled Adjusted Partial Sums (RAPS; Garbrecht and Fernandez, 1994) was used. This method allows visualization of short-term oscillations in a time series and systematic temporal trends hidden by internal data variability. The monthly series of air temperature, precipitation and river flows studied since 1951 come from several dozen national monitoring stations located in the Polish Carpathians. The data were recorded by the Polish Institute of Meteorology and Water Management—the National Research Institute (IMWM).

The obtained results show that two fundamental sub-periods can be distinguished in air temperature studied since 1951: 1951–1987(1997) and 1988(1998)–2020, with a clearer warming trend in a second time period. The results of RAPS analysis for precipitation and river flow are more complex and different periods of dynamical changes can be distinguished for different river catchments. However, in most cases, a decrease in precipitation and river flow for the years 1980–1995 was followed by a gradual increase for the years 1996–2010, while a downward trend prevailed again in the last decade. Overall, the results obtained can be helpful in informed management of the studied river catchments.

Keywords: climate change, air temperature, precipitation, river flow, Polish Carpathians

Garbrecht, J., Fernandez, G.P. (1994) Visualization of trends and fluctuations in climatic records. *Water Resources Bulletin*, 30, 297–306.

Forest ecosystem vulnerabilities to climate change and natural disturbances in relation to forest age, structure, and management: reconciling competing views

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A number of recent pan-European, regional, and national level assessments have mapped and identified vulnerabilities to climate change across a wide range of environmental infrastructures and natural resources. In this session we will lay the groundwork for follow-up work focused specifically on forest ecosystems in the Carpathian Mountain region. Forest ecosystems in the Carpathians will continue to change into the future as compounded stresses from climate disruption, invasive species, land use pressures, and other factors increase. With changes in ecosystem dynamics will come alterations in the mix of ecosystem goods and services those forests provide. Foresters, scientists, and policy makers alike are challenged to integrate knowledge from multiple disciplines in addressing questions of climate change. This session will take an expansive approach to these cutting edge topics. Talks from a range of disciplines are welcomed, particularly those addressing: 1) criteria and methodologies for determining the most at risk forest resources, functions, and biological diversity, and 2) the challenge of sustaining forest ecosystems into an uncertain future. Research on system attributes conferring resilience or adaptability to climate change will be of keen interest. Collectively, the research presented in this session and outcomes from previous assessments will begin the process of identifying key impacts and resulting risks in forest resources that could be integrated into a comprehensive regional assessment in the near future. Please note that this session is linked to an afternoon workshop by same name (see separate announcement).

Carbon modelling of primary forests: an example from the Carpathians

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Interest grows in using carbon-rich ecosystems as nature-based solutions for mitigating climate change. New concepts for climate negotiations were introduced into the Paris Agreement regarding maintenance of ecosystem integrity and combined actions to prevent biodiversity loss and climate change. In order to limit global warming below 2 °C, greater attention is needed for the role of primary forests as a carbon storage solution.

Recent refinement of the IPCC default values for national greenhouse gas inventories increased the estimate for biomass carbon in temperate mountain forests, and differentiated between primary and secondary forests. Site data collected in many forest types has demonstrated that (a) earlier default values were underestimates, (b) primary forest and secondary forest should have separate estimates of biomass, (c) continued identification and measurement of primary forests is critical to define the carbon sequestration potential of forests.

Operationalising these provisions requires accounting for the carbon carrying capacity afforded by primary forests and the potential for increasing carbon storage through restoration of forests. Defining the qualities of carbon stocks in different types of ecosystems is an important component in assessing their vulnerability to climate change, and hence their benefit for mitigation.

Our research looks at the critical difference between primary forests managed for conservation and secondary forests managed for commodity production from a carbon storage perspective and the sequestration potential of protecting forests.

Our results from the Carpathians, which still contain some of the most intact forest habitats in Europe and have been well sampled through the REMOTE project, confirms that measured primary forest sites have higher biomass carbon densities (averages of 198 Mg C ha⁻¹ for beech forests and 273 Mg C ha⁻¹ for mixed spruce-pine-beech forest) than predicted by spatial modelling of global biomass maps.

Keywords: biomass, temperate forest, beech, climate change, forestry

The authors acknowledge the Griffith University for its grant support in the framework of Boreal and Temperate Primary Forests and Climate Change project and the *Czech University of Life Sciences Prague* as leader of the Research on Mountain Temperate Primary Forest (REMOTE) for providing the plot data across the Carpathian mountain

IPCC 2019 Refinement to the 2006 IPCC guidelines for national greenhouse gas inventories. <https://www.ipcc.ch/report/2019-refinement-to-the-2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/>

Keith, H., Mackey, B.G., Berry, S., Lindenmayer, D.B. & Gibbons, P. (2010) Estimating carbon carrying capacity in natural forest ecosystems across heterogeneous landscapes: addressing sources of error. *Global Change Biology* 16, 2971-2989.

Mackey, B., Kormos, C., Keith, H., Moomaw, W., Houghton, R., Mittermeier, R., Hole, D., & Hugh, S. (2020) Understanding the importance of primary tropical forest protection as a mitigation strategy. *Mitigation and Adaptation Strategies for Global Change*, doi.org/10.1007/s11027-019-09891-4

Mikoláš, M., Ujházy, K., Jasík, M., Wiezik, M., Gallay, I., Polák, P., ... & Trotsiuk, V. (2019). Primary forest distribution and representation in a Central European landscape: Results of a large-scale field-based census. *Forest Ecology and Management*, 449, 117466.

Stephenson NL, Das AJ, Condit R et al. (2014) Rate of tree carbon accumulation increases continuously with tree size. *Nature* 507, 90 – 93.

Morphological-hydraulic river response to management measures in Natura 2000 area (the Belá River case study, Slovakia)

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This contribution evaluates the impact of river training works designed to address problems associated with flooding on the braided-wandering Belá River in Slovakian Carpathians (Kidová et al., 2021). This impact was investigated after the flood event in July 2018 in 11 river reaches where the river engineering and management intervention was applied. We analyzed its impact by spatio-temporal variations in river morphology (12 channel parameters) and changes in cross-section and hydraulic parameters (flow velocity, shear stress, stream power, W/D ratio) between pre- and post-flood management periods. The research hypotheses related to decreasing geodiversity in managed river reaches, a rapid increase in flow velocity during an extreme flood in river reaches where there is no sufficient floodplain inundation due to artificially high banks constructed during river training works, and increasing erosive force in the channel zone thanks to river management intervention were confirmed. The intervention in the braidplain area of the Belá River resulted in an undesirable simplification of the river pattern, loss of geomorphic diversity (Kidová et al., 2016), loss of channel–floodplain connectivity, and disturbance and restraint of hydromorphological continuity. Identification of main conflicts of the Belá River management is important for clarifying different approaches of stakeholders in the study area and aims to provide an objective illustration of their consequences. The presented analyses could help in future management issues as well as in the more critical decision-making process in vulnerable and scarce braided river systems in the present when we are losing so many natural rivers by human decisions.

Keywords: *river management, morphology, hydraulics, multi-thread river, river training, Belá River*

This research was supported by the Science Grant Agency (VEGA) of the Ministry of Education of the Slovak Republic and the Slovak Academy of Sciences (02/0086/21).

Kidová A., Lehotský M., Rusnák M. (2016) Geomorphic diversity in the braided-wandering Belá River, Slovak Carpathians, as a response to flood variability and environmental changes. *Geomorphology* 272:137–149. <https://doi.org/10.1016/j.geomorph.2016.01.002>.

Kidová, A., Radecki-Pawlik, A., Rusnák, M. et al. (2021) Hydromorphological evaluation of the river training impact on a multi-thread river system (Belá River, Carpathians, Slovakia). *Scientific Reports* 11, 6289. <https://doi.org/10.1038/s41598-021-85805-2>

Equilibrium line altitude (ELA) in the highest mountain massifs of the Eastern Carpathians (Romania, Ukraine) as a proxy for the Last Glacial Maximum palaeoclimate.

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The Eastern Carpathians are the north-easternmost sector of the European Alpine mountain system, which act as a orographic barrier for maritime and continental airflows over central and eastern Europe. This region represents one of the least explored areas in terms of glacial geomorphology in Europe, which is crucial for validating the inferred zonal/meridional mode of atmospheric circulation on the continent during glacial stages. During the global Last Glacial Maximum (LGM; 29-18 ka) only high-altitude mountain massifs were subject to mountain glaciation among which Rodna Mountains in Northern Romanian Carpathians (2303 m a.s.l.) together with Svydovets (1883 m a.s.l.) and Chornohora massifs (2061 m a.s.l.) in Ukrainian Carpathians have the best glacial landscapes in the region. Based on new mapping of glacial landforms and sediments, we reconstruct the extent and ice-surface geometry as well as establish equilibrium line altitudes (ELAs) using the Area-Altitude-Balance-Ratio method (AABR). Geomorphologic mapping enabled a detailed reconstruction of the 80 LGM palaeo-glaciers in both mountain areas. The Chornohora being the highest relative to LGM ELA (324 m) show the strongest glacial modification revealed by well-developed valley-head, compound glacial cirques as well as larger glaciers (2.51 km²) and a greater total glaciation area (51.6 km²)

compared to higher Rodna Mountains (1.13 km², 45.2 km², respectively). The ELA increases from the Svydovets (1401 m) and Chornohora (1516 m) massifs to the Rodna Mountains (1697 m) and show a distinct SE rising trend controlled by the general temperature rise towards the south and precipitation decrease towards the east. The lowest ELA in the Ukrainian Carpathians was likely the effect of enhanced orographically-induced precipitation coinciding with predominant snow-bearing winds. This suggests that the dominant W-NW precipitation regime in effect during the LGM was similar to present-day conditions. This confirms the hypothesis put forward by

Niculescu (1965) that the topography of the Carpathian mountain arc had modified wind directions in the lower atmosphere in the Late Pleistocene, as it does today.

Tools for risk mitigation in sustainable forest management of Ukraine

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The tangible effects of climate change, the increase in the magnitude of natural disasters, threats to biodiversity, and the weakness of institutions are the current problems that determine the importance of risk assessment in the forest management system of Ukraine and implementation of precautionary measures to mitigate them.

The adaptive management approach embodied in the FSC® national standard for Ukraine serves as a mechanism for transforming the way of decision-making in Ukraine's forestry system considering these challenges. The preventive tools available include a systematic assessment of risks within the various components of a forest enterprise's activity (corruption risks, risks of increasing natural hazards, risks of impact on the environment and local communities, etc.) to help identify highest risks and prioritize their mitigation.

Due to the increasing overly complex and congested regulation of forestry, which is even sometimes conflicting with other legislation, the level of law enforcement is deteriorating. In recent years, the number of reports of illegal activities and fraudulent schemes allowing harvested timber to enter into supply chains has increased. To proactively prevent illegally harvested timber from entering the FSC supply chain, FSC Ukraine has developed a country risk profile as an information support system for assessing compliance with the FSC national standard. The system consists of separate modules that contain specific information for each of the FSC certificate holders. This information gathered from various sources (such as corrective action requests identified to address FSC non-conformities, media reports, statistical indicators of forest management, and monitoring of areas damaged by illegal amber mining), outlines a certificate holder's strengths and weaknesses in implementation of the FSC standard.

By opening access to the country risk profiles it provides an additional opportunity to involve a wider set of stakeholders in forest management under FSC certification and enables a capability to integrate country risk profile approaches into the tools of NGOs and public authorities to improve forest management.

Large carnivores in the Carpathians: Challenges for effective conservation and management

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Wolves, lynxes and bears have recovered their populations throughout the Europe. Most populations are increasing or stable, however conflicts appears especially in regions where large carnivores have been missing for decades or centuries. Coexistence between people and wild animals have persisted until recent times in the Carpathians. Fast economic development of the region is however not always favourable for nature conservation. Changing of farming system, development of road and rail network, new build-up areas and forest harvest in areas with high-nature value present serious threats for viability of large carnivore populations. With the example of Eurasian lynx, the most sensitive species to habitat fragmentation, we show its population dynamics during five consecutive seasons in three different sites situated at the Czech-Slovak-Polish borderland at the periphery of the Western Carpathians. We recorded 1.5-4.1-fold changes in asynchronous fluctuated densities among all study sites and seasons. Furthermore, we detected high individual turnover (on average 46.3 ± 8.06 % in all independent lynx) as well as low persistence of adults (only 3 out of 29 individuals detected in all seasons). The overall apparent survival rate was 0.63 ± 0.055 and overall transition rate between sites was 0.03 ± 0.019 . Fluctuating densities and high turnover rates, in combination with documented lynx mortality, indicate that the population in our region faces several human-induced mortalities, such as poaching or lynx-vehicle collisions. These factors might restrict population growth and limit the dispersion of lynx to other subsequent areas, thus undermining the favourable conservation status of the Carpathian population. The study demonstrates that long-term camera-trapping surveys are needed for evaluation of population trends and for reliable estimates of demographic parameters of wild territorial felids, further used for establishing successful management and conservation measures.

Keywords: *Eurasian lynx, population density, fluctuations, Carpathians, large carnivores*

Morphological changes of the Hornád River and its management - retrospective view

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For now, we don't know every detail of how exactly rivers respond to human impacts and we are still looking for answers. A lot of Carpathian rivers were influenced by human impact in the 20th century (Krzemień et al., 2015; Hajdukiewicz et al., 2019), and many of them already changed in the 19th century (Mecser et al., 2008; Procházka and Pišút, 2015). Most part of the Hornád River in Slovakia had meandered without any significant regulations, but the situation started to change in the 1950s. This paper presents the anthropogenic impact and interference on the originally meandering Hornád River on approximately 70 kilometres of its length from its mouth in the Slovak Paradise National Park to the Ružín II dam. The first interferences and flow regulations in the middle part of the stream date back to the first half of the 20th century and were conducted in relation to the massive industrialization of the southern Spiš region focused on mining activities. In the 18th and 19th centuries, most of the anthropogenic impact on the river channel was represented by watermill, weir and millrace constructions. The biggest part of the river channel transformations occurred in the 1950s and 1960s, when vast regulations and constructions were made ultimately affecting the river in a negative way. Nowadays, we continue to witness inappropriate management of the Hornád River, such as illegal interferences, mostly in river reaches with natural erosion-accumulation processes. The aim of this study was to evaluate the anthropogenic influence on the river morphology as well as present suggestions concerning the improvement of the current river management.

Keywords: Hornád River, morphological response, stream regulation, river management

This research was supported by the Science Grant Agency (VEGA) of the Ministry of Education of the Slovak Republic and the Slovak Academy of Sciences (02/0086/21).

Hajdukiewicz, H., Wyżga, B., Zawiejska, J. (2019) Twentieth-century hydromorphological degradation of Polish Carpathian rivers, *Quaternary International*, 504, 181–194.

Krzemień, K. *et al.* (2015) Effects of environmental changes and human impact on the functioning of mountain river channels, Carpathians, southern Poland, *Annals of Warsaw University of Life Sciences, Land Reclamation*, 47(3), 249–260.

Mecser, N., Demeter, G., Szabó, G. (2008) Morphometric changes of the Bodrog River from the Late 18th c. to 2006, *Acta Geographica Debrecina Landscape and Environment*, 3(1), 28–40.

Procházka, J., Pišút, P. (2015) Regulácie koryta nížinného meandrujúceho vodného toku v období r . 1782-1900 (na príklade rieky Váh v úseku Sereď -Komárno). 1900, 44–55.

Attitudes toward large carnivores in Serbia

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Hunting legislation of the Republic of Serbia recognize several autochthonous large carnivores as game species: brown bear (*Ursus arctos*), wolf (*Canis lupus*), lynx (*Lynx lynx*) and jackal (*Canis aureus*). These species occur in Serbian hunting grounds and as such are under management plans. However, their abundance, population size and protection status greatly vary. Jackal is overabundant across the whole country, while wolf populations are located in hilly and mountainous regions of Serbia. Bear and lynx are endangered species, but it appears that their population numbers are increasing, partially thanks to migrations from Carpathians. Presence of large carnivores initiates discussions among stakeholders. Since these species are managed in hunting grounds, the aim of this paper is to explore gamekeepers and wildlife manager attitudes toward large carnivores' occurrence.

In this study we interviewed staff from 80 hunting grounds in Central Serbia which manage large carnivores. Survey included 80 wildlife managers (one per hunting ground) and 150 gamekeepers (approximately two per hunting ground) which have been contacted by mail. Their responses have been used to calculate results. Findings indicate that attitudes are linked with population size and level of conflict with each species. As such, the least abundant species like lynx gather the most positive attitudes, in contrary to jackals which are the least favored.

Keywords: Large carnivores, Serbia, survey, gamekeepers, wildlife managers, attitudes

Wildlife crime in Eastern Europe – case study of Serbia

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Poaching is a direct threat to game management and wildlife conservation worldwide. Since it occurs in different forms, understanding of poaching is a challenge for the scientific community. Lavadinović et al., (in print) demonstrated in their research that knowledge on poaching produced in the last decade at the global level is biased and incomplete. Its results indicate that scientific community favor more sub-Saharan Africa than other parts of the world, as well charismatic species. Due to this bias Eastern Europe appears to be neglected and not interested for scientific community to explore poaching phenomenon. Thus, the aim of this study is to raise awareness on wildlife crime and biases in knowledge on poaching.

As a case study to analyze level of poaching in Eastern Europe was used Serbia and its stakeholders in the hunting sector. Data were collected through a survey which included hunters, gamekeepers and wildlife managers. Simple random sample, which consisted out of 382 hunters, was used to collect hunters' attitudes on poaching at the national level. Hunters were interviewed face to face. Gamekeepers and wildlife managers from all hunting grounds in the country were contacted by mail, but only those who replied back were included in this study. Although results indicate that each group has different perception about level of poaching, it cannot be denied that illegal hunting is spread activity which affects wildlife management in the country.

We hope that this paper will motivate scientists to be more involved in understanding of the poaching phenomenon in Eastern Europe.

Keywords: poaching, Serbia, survey, hunters, attitudes

LiDAR as a tool for detection of historical anthropogenic landforms: examples from Slovakia

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Airborne laser scanning is used for detecting prehistorical and historical sites for more than two decades. It was successfully applied by landscape archaeologists, for example for detecting the past landscapes of Mayan civilization, Stonehenge landscapes, or remains of past human activities in the Białowieża forest. Despite its potential to reveal the overgrown or buried anthropogenic landforms, there are only a few studies from the cultural landscape research domain. This study aims to present the examples of remains of historical anthropogenic features in Slovakia, detected by LiDAR scanning, and to present the potential of LiDAR data for cultural landscape research.

The countrywide LiDAR survey is realized by the Geodesy, Cartography and Cadastre Authority of the Slovak Republic in 2018 and now covers the western and central part of Slovakia. The average ground points density is 15–30 points/m². We interpolated the points to a 50 cm resolution digital elevation model, adopted special visualisation techniques, based on the combination of local relief models, sky view factor, slope steepness, and colour blending to exaggerate the remains of historical anthropogenic landforms. Then, we visually identified the anthropogenic features and consulted our findings with available literature.

Following the classification proposed by Tarolli et al. (2019) we provide the examples of anthropogenic features: (i) symbolic; (ii) habitation; (iii) transport/ exchange; (iv) subsistence; (v) mining; (vi) water infrastructure; (vii) waste disposal; (viii) warfare.

Tarolli, P., Cao, W., Sofia, G., Evans, D., Ellis, E.C., 2019. From features to fingerprints: A general diagnostic framework for anthropogenic geomorphology. *Progress in Physical Geography: Earth and Environment* 43, 95–128.
<https://doi.org/10.1177/0309133318825284>

Acknowledgement: This research was funded by the Slovak Scientific Grant Agency VEGA 2/0018/19 “Ecological Analyses of Landscape Acculturation in Slovakia since Early Prehistory until Today”

Keywords: *LiDAR, Landscape Palimpsests, Visual Filters, Landscape Archaeology, Anthropogenic Landforms*

The route of riverine macroplastic: a transdisciplinary perspective

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Since the 1960s rivers worldwide have started to transport macroplastic (plastic particles > 5 mm) which caused numerous problems such as secondary microplastic production, ingestion by aquatic animals, clogging flood-protection infrastructure or loss of aesthetic value of riverine landscape. The exploration of macroplastic route through the river is thus important not only to understand the process itself but also to assess the related risks. To support future works on this problem, we developed a conceptual model of the route of macroplastic debris through a fluvial system (Liro et al., 2020). We divided the macroplastic route into: (1) input, (2) transport, (3) storage, (4) remobilization and (5) output phases. Phase 1 is mainly controlled by humans, phases 2–4 by fluvial processes, and phase 5 by both types of controls. We hypothesize that natural characteristics of fluvial systems and their modification by dam reservoirs and flood embankments construction are key controls on macroplastic storage and remobilization in rivers. The zone of macroplastic storage can be defined as a river floodplain inundated since the beginning of widespread disposal of plastic waste to the environment in the 1960s and the remobilization zone as a part of the storage zone currently influenced by floodwaters and bank erosion. The amount of macroplastic in both zones can be estimated using data on the abundance of surface- and subsurface-stored macroplastic and the lateral and vertical extent of the zones. Our model creates the framework for estimation of how much plastic has accumulated in rivers and will be present in future riverscapes. The exploration of diverse factors controlling the route of macroplastic through a fluvial system requires a transdisciplinary perspective ranging from sedimentology to social sciences. This would allow for analysing among functional components humans who not only dispose plastic but are also affected by it both physically and aesthetically, and who may remove it from rivers.

Keywords: plastic pollution, riverine macroplastic, plastic waste, river

Liro, M., Emmerik, T.v., Wyżga, B., Liro, J., Mikuś, P. (2020). Macroplastic storage and remobilization in rivers. *Water*, 12, 2055.

The power of social innovations to tackle challenges in forestry: Switzerland and Ukraine in the focus

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The increasingly tangible impacts of climate change, accelerating socio-economic dynamics and growing demand of the civil society for forest ecosystem services call for an adjustment of forest management and governance practices. In this study, we examine the potential of social innovations to turn challenges in forest management into opportunities. We analyse challenges in forestry of Switzerland and Ukraine by interviewing forestry experts. We have examined examples of social innovations in each country to understand whether these have a power to tackle the challenges. The findings suggest that social innovations might foster transformative changes on

the ground and provoke further actions to develop sustainable solutions for people and nature. Our results highlight that social innovations are often motivated by failures of existing governance systems, market imperfections or institutional inertia or inaction. They could be triggered by challenges caused due to mismatches or misfits of existing institutions and the society to coevolve and put forestry on a sustainable pathway. Yet, our results show that to emerge, develop, and be transformative, social innovations must have supporting institutional conditions. Our work encompasses that relevant stakeholders need to envision alternative futures, reshape places, and become more actively engaged in decision-making processes.

Keywords: *sustainability, transformation, forest management and governance, forest ecosystem services.*

Climate data over the Carpathian Region - challenges for environmental applications

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The Carpathian Mountains host a wide variety of natural ecosystems which provides a wealth of goods and services, but they are also a natural laboratory of mountain geomorphology. In this mountain climate knowledge and land surface processes controlled by the climate or influenced by the scale of climatic features are still problematic due to the scarcity of observations and the heterogeneous mountain topography. Compared to other European mountain regions with large climate evaluation datasets (e.g. the Swiss Alps), the Carpathian Mountains have a sparse meteorological network. Long - term and high - quality climate data are therefore essential for monitoring and studying the features of mountain climate, the effects of variability and change and the timing and of processes. Although not exhaustive, the paper outlines the characteristics of the freely available climatic datasets, organized into three main categories of data resources (i.e. ground based, gridded, remote sensing), selected for their potential to be used in various environmental applications within the Carpathian Mountains (e.g. climatology, geomorphology, ecology). The paper discusses the current limitations, climate data gaps and future data needs for this mountain region. The current challenges related to climate data within this mountain range are related to the spatial and temporal resolutions of the available datasets, their temporal coverage and to the scarcity of the meteorological observations within the Carpathian countries, especially at high elevations (above the timberline).

Brown bear predation on sheep and cows in the Carpathian landscapes.

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Romania harbours the largest brown bear population in Europe within the Carpathian Mountains, a stronghold for the European brown bear population, characterized by a low, but dispersed human footprint, mostly rural, and growing cattle and sheep represents the livelihood for many local rural communities. Understanding of the spatial patterns and predictors for Human – carnivores conflicts (HCC) has the potential to benefit local communities and wildlife management agencies by providing broad guidelines for reducing the level and frequency of conflict. The overarching goal of this study was to assess predictors and spatial distribution of HCC in a high-density brown bear landscape in Romanian Eastern Carpathians using a dataset of reported livestock damage collected by local Environmental Protection Agencies (EPAs) spanning nine years (2008-2016). We evaluated the occurrence and predictors of HCC by brown bears using binomial generalized linear mixed models (GLMM). We ran separate models for different types of livestock damage: *cows*, *sheep*, and *other* (pigs, horses, chickens) and we developed a set of 32 models that tested hypotheses regarding influences of environmental and anthropogenic variables on the presence of HCC for each livestock type. Our results revealed that the likelihood of HCC caused by bears to livestock in Romania is influenced by a combination of landscape factors, local relative brown bear abundance, topography, and approaches to livestock management. Our predictions showed differences in the factors affecting the prevalence of damage for cows, sheep and other livestock, but altitude, distance from forest and land cover types are common to all livestock. Brown bear abundance was only positively associated with sheep and other livestock. The landscape configuration, composition, and heterogeneity were strong predictors of HCC, but the direction and strength was highly variables across livestock types.

Keywords: human-carnivore conflict, Ursus arctos, landscape heterogeneity, livestock management, large carnivores

The data collection was partially funded by the European Commission LIFE Nature Programme within the project LIFE08/NAT/RO/000500. The work of MIP was supported by a grant of the Romanian Ministry of Education and Research, CNCS - UEFISCDI, project number PN-III-P1-1.1-PD-2019-1207, within PNCDI III. MAD and VDP were supported by the Ohio University, Department of Biological Sciences.

Enhancement of green infrastructure in Polish Carpathians for ecological benefits and sustainable local development

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Green infrastructure (GI) plays a key role in biodiversity conservation, as well as in local development by enhancing the natural capital and delivery of ecosystem services. Sound GI development should be considered in spatial planning and decision-making. The policies should be augmented by employment of geoinformation tools and credible thematic data, as well as competence and awareness raising actions directed at individuals, organizations and institutions that have impact on how the space is being managed and natural resources used, both within and in between nature protection areas.

The LIFE project implemented by UNEP/GRID-Warsaw Centre in years 2017-2021 has been addressing these demands in a comprehensive set of actions:

- spatial (GIS) analysis of GI based on data on land cover, ecosystem types, nature conservation (protected areas, ecological corridors), spatial planning, housing and infrastructure development, etc. Based on the analysis, the current state of ecological connectivity was diagnosed and hotspots were identified;
- geoportal to visualize the GIS analysis results, which also permits uploading, editing and visualization of own, custom data on GI field-collected using a dedicated mobile application;
- series of seminars and trainings for local governments and other local and regional level stakeholders;
- knowledge base and e-learning course with GI-related materials;
- competition for local case studies related to GI development;
- published guidebook on GI management;
- awareness raising campaign for the local communities;
- replication and dissemination among other Carpathian countries.

Project outputs create potential for both professional and popular applications: for the purposes of local spatial planning and decision making, biodiversity and landscape conservation and management, territorial development, citizen science, school and informal education, etc.

Keywords: green infrastructure, biodiversity, ecological connectivity, spatial management, spatial planning, awareness raising, ecosystem services, local development, LIFE Programme.

Long-term monitoring of the recruitment and dynamics of large wood in Kamienica Stream, Polish Carpathians

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Quantifying delivery and mobility of large woody debris in small mountain streams requires long-term and repeatable observations, so far very scarcely described. Such observations have been conducted in the upper course of Kamienica Stream, Polish Carpathians, where a sample of 429 trees growing along three separated sections of the stream was tagged with metal plates and monitored during 11 years. The monitoring of standing and fallen trees has been conducted a few times per year, especially after heavy rainfall and windstorms. In the study period, 107 trees (25% of the tagged sample) were recruited to the channel during high-intensity meteorological and hydrological events, mostly as a result of bank erosion during floods and windthrow, with recent bark beetle infestation of the riparian forest considerably accelerating the turnover of riparian trees. Large wood inventory performed in 2012 in the second- to fourth-order stream reaches and the 11-year-long monitoring of tagged trees indicated variable mobility of large wood along the upper course of the stream (Mikuś et al., 2016). Observations of five flood events occurring in May 2010, May 2014, July 2016, May 2018 and May 2019 indicated that wood mobility was negligible in the second-order reach, very small in the third-order reach, and higher, but still limited in the fourth-order reach. Fifty-one trees were subjected to transport during the five floods, and mean lengths of displacement of the tagged trees were small, not exceeding 32 m in sections A and B, whereas in section C they were displaced up to 1003 m (Mikuś, Wyżga, 2020). However, an advanced state of decay of most pieces leads to their disintegration during floods, rather than to distant transport, and thus large wood retained in the upper stream course within a national park does not constitute an important flood hazard to downstream, inhabited valley reaches.

Keywords: Large wody debris, Wood monitoring, Wood inventory, Wood supply, Wood mobility

Mikuś, P., Wyżga, B., Ruiz-Villanueva, V., Zawiejska, J., Kaczka, R.J., Stoffel, M. (2016). Methods to assess large wood dynamics and the associated flood hazard in Polish Carpathian watercourses of different size. In Kundzewicz ZW, et al. (eds.), *Flood Risk in the Upper Vistula Basin*. Springer, Cham, 77-101.

Mikuś, P., Wyżga, B. (2020). Long-term monitoring of the recruitment and dynamics of large wood in Kamienica Stream, Polish Carpathians. *Journal of Mountain Science*, 17(6), 1281-1293.

Recommendations for Stronger Integration of Education for Sustainable Development into the Carpathian Convention: results of a participatory process

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The Carpathian Convention is a framework agreement focused on nature conservation and the sustainable development of the Carpathian Mountain region. Its Article 13 outlines provisions for awareness raising, education, and public participation, and as such, it is central to integrating Education for Sustainable Development (ESD) into the Convention documents and activities. The authors have been involved in ESD-related processes of the Convention since 2007, and have worked to bring the Convention activities in line with the guidance provided by the United Nations, including the recently adopted ESD 2030 Framework of the United Nations Educational, Scientific and Cultural Organization (UNESCO). We have conducted a review of the Convention documents and the results of participatory workshops, focused on ESD and implemented in 2018–2019. We would like to present the highlights of the participatory ESD-related processes of the Carpathian Convention and provide recommendations for further integration of ESD, including: (1) establishing a Convention working group or network of experts focused on education and awareness raising, and (2) facilitating stronger support for ESD by the Convention presidency.

Keywords: mountain region; education; sustainable development; regional agreement

Balsiger J, Förster R, Mader C, Nagel U, Sironi H, Wilhelm S, Zimmermann AB. 2017. Transformative learning and education for sustainable development. *GAIA* 26(4):357–359. doi:10.14512/gaia.26.4.15.

Barth M. 2016. Teaching and learning in sustainability science. In: Heinrichs H, Martens P, Michelsen G, Wiek A, editors. *Sustainability Science. An Introduction*. Dordrecht, the Netherlands: Springer, pp 325–333.

Barton A, Dlouhá J. 2014. Examining the transition toward sustainability in higher education in central Europe. In: Vávra J, Lapka M, Cudlínová E, editors. *Current Challenges of Central Europe: Society and Environment*. Prague, Czech Republic: Faculty of Arts, Charles University in Prague.

Björnsen Gurung A. 2013. Science for the Carpathians: using regional capacity to cope with global change. In: Kozak J, Ostapowicz K, Bytnerowicz A, Wyżga B, editors. *The Carpathians: Integrating Nature and Society Towards Sustainability*. Berlin, and Heidelberg, Germany: Springer, pp 13–21.

³ Attila Varga's work was supported by the ELTE Thematic Excellence Programme 2020 supported by the National Research, Development and Innovation Office (TKP2020-IKA-05)

Björnsen Gurung A, Bokwa A, Chelmicki W, Elbakidze M, Hirschmugl M, Hostert P, Ibisch P, Kozak J, Kuemmerle T, Matei E, et al 2009. Global change research in the Carpathian mountain region. *Mountain Research and Development* 29(3):282–288. doi:<http://dx.doi.org/10.1659/mrd.1105>.

Björnsen Gurung A, Wymann von Dach S, Price M, Aspinall R, Balsiger J, Baron JS, Sharma E, Greenwood G, Kohler T. 2012. Global change and the world's mountains— Research needs and emerging themes for sustainable development. *Mountain Research and Development* 32(S1):S47–S54. doi:<http://dx.doi.org/10.1659/MRD-JOURNAL-D-11-00084.S1>.

Borsa M, Chifelea C, Egerer H, Gal Z, Glowacki W, Halas M, Hopfgartner V, Illes I, Niewiadomski Z, Ptacek P, et al 2008. VASICA. Visions and Strategies in the Carpathian Area. Protection and Sustainable Spatial Development of the Carpathians in a Transnational Framework. Vienna, Austria: Carpathian Project. http://www.carpathianconvention.org/tl_files/carpathiancon/Downloads/04%20Publications%20-%20Press%20-%20Gallery/Documents%20and%20Publications/4.1.2.3%20VASICA.pdf; accessed on 19 April 2020.

Church JM, editor. 2008. A Collection on the Carpathian Convention. After the Second Conference of the Parties Held in Bucharest on 17–19 June 2008. Vienna, Austria: Carpathian Project. <https://portals.iucn.org/library/sites/library/files/documents/Bios-Eco-Ter-Mts-4-015.pdf>; accessed on 19 April 2020.

EACEA [The Education, Audiovisual and Culture Executive Agency]. 2019. Hungary 9.2 Administration and Governance. Brussels, Belgium: EACEA. <https://eacea.ec.europa.eu/national-policies/en/content/youthwiki/92-administration-and-governance-hungary>; accessed on 26 April 2020.

Forum Carpaticum. 2018. Final Program. 5th Forum Carpaticum. Adapting to Environmental and Social Risk in the Carpathian Mountain Region. Eger: Hungary: Forum Carpaticum 2018. <http://fc2018.hu/conference-program/>; accessed on 26 April 2020.

Gan D, Dal A, Könczey R, Varga A. 2019. Do eco-schools really help implementation of ESD? A comparison between eco-school systems of Hungary and Israel. *Hungarian Educational Research Journal* 9(4):1–26.

Garcia J, Aguiar da Silva S, Simas Carvalho A, Salgueirinho Osório de Andrade Guerra JB. 2017. Education for sustainable development and its role in the promotion of the sustainable development goals. In: Davim JP, editor. *Curricula for Sustainability in Higher Education, Management and Industrial Engineering*. New York, NY: Springer, pp 1–18.

Infostart. 2019. Szemléletformálási stratégiát készít az ITM [Ministry of Innovation and Technology is Making a Strategy of Sustainability Awareness]. Hungary: Infostart. <https://infostart.hu/gazdasag/2019/05/10/az-innovacios-miniszterium-harcot-indit-az-egyszer-hasznalatos-muananyag-termekek-ellen>; accessed on 28 April 2019.

Jansky L, Ives JD, Furuyashiki K, Watanabe T. 2002. Global mountain research for sustainable development. *Global Environmental Change* 12(3):231–239. doi:10.1016/S0959-3780(02)00015-8.

Kozak J, Ostapowicz K, Bytnerowicz A, Wyżga B. 2013. The Carpathian mountains: Challenges for the central and eastern European landmark. In: Kozak J, Ostapowicz K, Bytnerowicz A, Wyżga B, editors. *The Carpathians: Integrating Nature and Society Towards Sustainability*. Environmental Science and Engineering Series. Berlin, Heidelberg, Germany: Springer, pp 1–11.

Lőrinczi Z. 2018. Megtartotta éves ülését a Külhoni Magyar Oktatási Tanács [The Conucil for the Hungarian Education Abroad has Held its Annual Meeting]. *Hajdúszoboszló, Hungary: Suliszervíz*. <https://kiadvany.suliszerviz.com/kiadvanyok/29-kiadvany-2018/1136-2018-dr-lorinczi-zoltan-megtartotta-eves-gyuleset-a-kuelhoni-magyar-oktatasi-tanacs>; accessed on 29 April 2020.

Maselli D. 2012. Promoting sustainable mountain development at the global level. *Mountain Research and Development* 32(S1):S64–S70. doi:10.1659/MRD-JOURNAL-D-11-00120.S1.

Price M. 2000. The Alpine Convention: A model for other mountain regions? *Mountain Research and Development* 20(2):192–194. doi:10.1659/0276-4741(2000)020[0192:TACAMF]2.0.CO;2.

Sarabhai KV, Ravindranath S, Schwarz R, Vyas P. 2012. ESD and the Rio Conventions. *Journal of Education for Sustainable Development*. 6(2):181–190. doi:10.1177/0973408212475198.

SCC [Secretariat of the Carpathian Convention]. 2020. Carpathian Convention. Vienna, Austria: SCC. <http://www.carpathianconvention.org>; accessed on 30 October 2020.

Symeonidis V. 2019. Teacher competence frameworks in Hungary: A case study on the continuum of teacher learning. *European Journal of Education* 54(3):400–412. doi:doi.org/10.1111/ejed.12347.

Tóth M. 2018. Experiences, challenges and success of the ENSI-supported CASALEN-project in Romania. In: Affolter C, Varga A, editors. *Environment and School Initiatives. Lessons from the ENSI Network – Past, Present and Future*. Budapest, Hungary: Environment and School Initiatives, Eszterhazy Karoly University, pp 202–208. http://www.education21.ch/sites/default/files/uploads/pdf-d/news21/Lessons_from_the_ENSI_Network-book_web.pdf#page=204; accessed on 26 April 2020.

UNECE [United Nations Economic Commission for Europe]. 2016. Ten years of the UNECE Strategy for Education for Sustainable Development. Evaluation report on the implementation of the UNECE Strategy for Education for Sustainable Development from 2005 to 2015. Report No. ECE/CEP/179. New York, NY, and Geneva, Switzerland: United Nations. <https://www.unece.org/environmental-policy/education-for-sustainable-development/education-for-sustainable-development-esdpublishationshtml/education-for-sustainable-development/2016/10-years-of-unece-strategy-for-education-for-sustainable-development/doc.html>; accessed on 26 April 2020.

UNESCO [The United Nations Educational, Scientific and Cultural Organization]. 2014. UNESCO Roadmap for Implementing the Global Action Programme on Education for Sustainable Development. Paris, France: UNESCO. <http://unesdoc.unesco.org/images/0023/002305/230514e.pdf>; accessed on 25 April 2020.

UNESCO [The United Nations Educational, Scientific and Cultural Organization]. 2018. Students take the Lead to Spread an Eco-Schools Initiative in Hungary. UNESCO Building Peace in the Minds of Men and Women. Paris, France: UNESCO <https://en.unesco.org/news/students-take-lead-spread-eco-schools-initiative-hungary>; accessed on 25 April 2020.

UNESCO [The United Nations Educational, Scientific and Cultural Organization]. 2019. Framework for the Implementation of Education for Sustainable Development (ESD) Beyond 2019. <https://unesdoc.unesco.org/ark:/48223/pf0000370215>; accessed on 25 April 2020.

UN [United Nations]. 1992. United Nations Conference on Environment & Development Rio de Janeiro, Brazil, 3 to 14 June 1992. Agenda 21. New York, NY: UN. <https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf>; accessed on 8 February 2018.

UN [United Nations]. 2015. Resolution adopted by the General Assembly on 25 September 2015. Transforming our world: The 2030 Agenda for Sustainable Development. General Assembly Report No. A/RES/70/1. New York, NY: UN. http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E; accessed on 8 February 2018.

Varga AN, Molnár B, Pálfi S, Szerepi S. 2017. Education for sustainability in Hungarian kindergartens. In: Huggins V, Evans D, editors. *Early Childhood Education and Care for Sustainability*. London, United Kingdom: Routledge, pp 82–96.

Where do fine sediments come from? A study of natural and anthropogenic processes, connectivity and flood efficiency in a southwestern Carpathian basin

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The quest of accurately identifying the sources of sediments appears to be an acceptable compromise between estimating the contribution of a Carpathian watershed's geomorphologic and lithologic factors, field recognition of areas with elevated sedimentary connectivity, as well as the analysis of floods yielding most sediments.

All these aspects play a role in assessing sediment sources in our study area, the Jiu river basin (10,070 km²), a Carpathian watershed with a significant contribution of suspended sediment load (> 10t·ha⁻¹·yr⁻¹) to Danube River. This study investigates the behavior of the suspended sediment discharge within Jiu River Basin during the main flood events in the recent period after 2000, against the general background represented by the degree of sedimentary connectivity.

The floods were chosen by applying statistical criteria. For the first 10 floods corresponding to the applied criteria, we estimated the potential impact of the fine sediments transfer, by calculating the flood event efficiency index (EEI in g·l/s²) and its values were linked to the potential sources of suspended sediments and to the general characteristics of the catchments corresponding to the g.s., including sedimentary connectivity. In some cases, the suspended sediment loads were found to be lower downstream than upstream due to intermediate storage areas and local sources of suspended sediment (on Jiu River's tributaries). We also gave particular importance to the anthropic impact (coal industry, reservoirs) in the Jiu watershed on the fine sediment yield, by checking the causal link between mining operations in the Carpathian upper sector on sediments enriched with coal particles appearing in the middle and lower sector.

From a spatial perspective, we identified the most contributing sub-basins and main river sectors, while from a temporal point of view, the results highlighted the times of the year when the floods capable of carrying the most part of the sediments.

Keywords: fine sediment sources, Carpathian watershed, Jiu river basin, connectivity, floods

A century of population dynamics in the Romanian Carpathians (1910– 2020). Factors, spatial patterns and regional disparities

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Our paper aims at analyzing the multifaceted tendencies of population dynamics in the area of the Romanian Carpathians, as well as the factors and spatial processes that can explain the disparities, discontinuities and tensions that ultimately shape the manifestations of demographic evolution.

Starting from the hypothesis of an existing set of well-known particularities of the three areas of the Romanian Carpathians (Eastern, Southern and Western), in close connection with the specific manner of using natural and human resources of each area, the main objective of our study is to pinpoint the significant aspects of depopulation and population redistribution. The database was established resorting to the censuses from 1910 to the present time.

Coupled with a typology of population evolution, a regression analysis was used to assess the relationship between population size changes through time and other variables. The population growth rate was associated with population density, geographical position and accessibility, lithology, altitude, the degree of forestation and the surface of protected areas, occupational structure of the population etc.

The results highlight the contrast between the sustained dynamic in the first part of our study period (1910 - 1966) and the subsequent decline, particularly in the case of establishments specialized in industrial extraction activities, where mining overshadowed the other forms of capitalizing on economic potential. Despite all this, clear signs and tendencies of revitalization and dynamism can be observed, especially where mountainous settlements are well adapted to the natural environment and can benefit from a significant tourism potential. The results can be useful for decision-makers, from local authorities planning their interventions to developing strategies and policies to address various demographic challenges.

Keywords: population evolution, regional disparities, vulnerabilities, Carpathians, policy planning

Bănică, Al., Istrate, M. (2012). Urban identities in peripheral spaces: the Carpathian small towns in Romania, *Annals of the University of Oradea, Geography Series*, XXII, (2), 262-272.

Muntele, I., Grozavu, A. (2016). The Romanian Carpathians between settlement extension and the challenges of adaptation to modernity. *Romanian Journal of Geography*, 60, (2), 133–153.

Erdeli G., Dinca A.I. (2011), Tourism – A vulnerable strength in the protected areas of the Romanian Carpathians, *The 2nd International Geography Symposium GEOMED 2010, Procedia Social and Behavioural Sciences* 19. 190-197.

Johnson, K. M., Lichter, D. T. (2019). Rural Depopulation: Growth and Decline Processes over Century the Past. *Rural Sociology*, 84(1), 3–27. DOI: 10.1111/ruso.12266.

Merino F., Prats M.A, (2020). Why do some area depopulate? The role of economic factors and local governments, *Cities*, 97, p.102506.

Telbisz T., Imecs Z., Mari L., Bottlik Z., (2016). Changing human-environment interactions in medium mountains: the Apuseni Mts (Romania) as a case study, *Journal of Mountain Science*, 13, 1675-1687.

Stasiak A., (1992), Problems of depopulation of rural areas in Poland after 1950, *Landscape and Urban Planning*, 22(2-4), p.161-175).

Melnykovich, M., Nijnik, M., Soloviy, I., Nijnik, A., Sarkki, S., Bihun, Y. (2018). Social-ecological innovation in remote mountain areas: Adaptive responses of forest-dependent communities to the challenges of a changing world. *Science of The Total Environment*, vol. 613–614, 894-906.

Estimated impacts of climate change to selected ecosystem services of forests under different management – a case study from the West Carpathians

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Recently, forest ecosystems are being put at risk due to ongoing climate warming with unavoidable impacts on ecosystem services. However, little knowledge is available to quantify these impacts. Therefore, novel concepts for adaptive forest management and forest policy are urgently needed in order to create healthy and stable forests for the next generation. In this study, we analyse the potential impacts of climate change on forest productivity and ecosystem services provision of forests under several management scenarios during the period 2020–2080. The study area is located in the Beskydy Mountains and delimited by the protected landscape areas of Beskydy in the Czech Republic and Kysuce in Slovakia, dominated by Norway spruce. In this study, we used the individual tree growth model SIBYLA Triquetra to predict future forest development under the emission scenario RCP4.5 and baseline climate scenario of 1990 (1975-2005). The following four management scenarios were tested: no management – without any silvicultural intervention (NM), business as usual – age class shelterwood approach (BAU), assisted migration – introduction of species from lower elevations (AM), and close-to-nature forest management – conversion to uneven-aged forests (CTN). Our results imply an important role for assisted migration in sustaining forest productivity regarding carbon sequestration and economic value. In addition, the introduction of future climate-adapted tree species in forests of the West Carpathians, in particular oak at lower elevations and fir and beech at high elevations, may provide the most suitable option for the adaptation of forest to climate change. Based on forest production and aesthetic indicators, conversion to richly structured mixed uneven-aged forests is most likely to be superior compared to currently applied management. Unmanaged forests would perform best in terms of biodiversity and forest aesthetics.

Keywords: Biodiversity, Carbon sequestration, Economic value, Forest aesthetics, SIBYLA Triquetra

Forest aboveground biomass mapping from satellite optical and radar data

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Estimation of forest aboveground biomass (AGB) is critical for regional forestry and sustainable forest management. Passive optical and active radar remote sensing offers a good opportunity for forest AGB mapping and monitoring. In this study, backscatter coefficients of Sentinel-1 (S1), in addition to multispectral bands and vegetation indices of Sentinel-2 (S2), based on CzechTerra forest inventory, were used to develop biomass prediction models for the Eastern part of the Czech Republic. Backscatter coefficients were extracted from ascending and descending radar geometry with double polarization. Normalized difference vegetation index NDVI, tasselled cap transformation TC (greenness, brightness and wetness) and disturbance index DI were calculated from multispectral S2 data. AGB for each forest inventory plot (670 circular plots of 500 m²) were used for biomass model training and validation. Several regression models were tested, e.g. stochastic gradient descent with restarts, Lasso, Bayesian, Elastic Net, Support vector regression, Random Forest, Neural Network. The models were developed for coniferous and deciduous types of forests. AGB estimates for deciduous forest stands generally showed a weaker predictive capacity (accuracy ~ 20%, r^2 0.30), than AGB estimates for coniferous (accuracy ~ 80%, r^2 0.72). The resulting AGB map combined the AdaBoost method for AGB estimation of coniferous and the Decision Tree method for AGB estimation of deciduous. The proposed methodology can be applied for Central European forest AGB mapping in large areas using the freely accessible satellite optical and radar data.

BioLearn – project about how to use biomimicry in education for sustainability

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BioLearn (Learning from Nature - Biomimicry in Education) project was supported by Erasmus+ strategic partnership, started in September 2018 and will end in August 2021. Partners of the project: Magosfa Foundation, Hungary; SEVER, Czech Republic; CEA, Slovakia; Biomimicry NL, the Netherlands; Wild Awake, United Kingdom and the Center for Learning with Nature, USA.

The aim of the project is to elaborate educational modules for students age 11-16 and their teachers in topic of biomimicry. Biomimicry is a design method that uses knowledge from nature as inspiration for sustainable design. It is an interdisciplinary approach that brings together nature, biology, design and technology.

The design process can be made in two ways: the first starts with observing a natural object and continues by the question: 'what can we learn from this?'. The second starts with a given challenge and the question is, 'How would nature solve this challenge?'.

Biomimicry has 9 principles according to J. M. Benyus – these fit very well to sustainability and describe how nature operates:

1. Nature runs on sunlight
2. Nature uses only the energy it needs
3. Nature fits form to function
4. Nature recycles everything
5. Nature rewards cooperation
6. Nature banks on diversity
7. Nature demands local expertise
8. Nature seeks balance
9. Nature taps the power of limits

The method of biomimicry can be well used in teaching STE(A)M – science, technology, engineering, arts, mathematics – subjects. As we can learn from nature how to operate the world sustainable, it is a great tool also for educators for sustainability.

In the presentation we introduce biomimicry and briefly some of our 22 modules (<https://biolearn.eu/universal-manual/>). Parts of the modules are about introduction to biomimicry: the methods and the 9 principles; the other modules are about certain challenges, like packaging, sustainable buildings, health, plant protection, water management, climate change or cooperative problem solving.

Keywords: biomimicry, sustainability, learning from nature, educational modules

Benyus, J. M. (2002). *Biomimicry – Innovation Inspired by Nature*. William Morrow, New York, USA.

A new approach of phenological observations: using digital repeat photography to estimation of phenophases of European beech forest in the White Carpatian

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We investigate canopy development by a new software *Phenopix* that allows extraction of phenophases from time-lapse [1]. In this study we analysed canopy changes by phenocameras at the mature beech forest on the study plot Štítná nad

Vláří (White Carpathian). Images were taken daily during growing seasons (GS) 2018–2020. The digital colour values of each image were used to compute the greenness index (G_{cc}). Data were fitted and the phenological thresholds was calculated according to the Klosterman et al. [2]. This method identifies four thresholds in a seasonal G_{cc} trajectory. The uncertainty analysis was performed using 100 bootstraps of the original G_{cc} . The results suggest, that the period of leaf area developed of European beech was in the range of DOY 98–323 with minimal differences between years 2018–2020. The seasonal trajectory of G_{cc} showed differences between observed. According to image analyses, the phenophase of greenup (DOY 98–102) and maturity (DOY 121–125) had minimal variability. In contrast, senescence (DOY 257–264) and dormancy (DOY 300–323) thresholds showed higher variability. The seasonal trajectory of G_{cc} showed a rapidly increasing of green colour in the spring, at the same time the leaves showed the highest proportion of green colour. The peak of the G_{cc} saturation (0.51) was calculated between DOY 115–125 and then the signal continuously dropped to the original values before the GS (0.33). The blue channel (B_{dn}) was inverse to the green one. In the case of the red colour, a significant peak was observed at the end of the growing season with a maximum value of 0.47 (DOY 290–300). The *Phenopix* package [3, 4] approach for fitted thresholds proved to be useful for assessing phenophases in the deciduous mature beech forest. Our results show the G_{cc} can be used to estimate the canopy phenological transitional date, such as the leaf-development date and the ending date of growing season with a satisfactory accuracy.

Keywords: remote sensing, phenocam, thresholds, budbreak, *Fagus sylvatica* L., time-lapse

- [1.] Filippa G.E., Cremonese M., Galvagno M., Forkel M., Wingate L., Tomelleri E., Richardson A.D., 2016. *Phenopix: A R package for image-based vegetation phenology*. *Agric. For. Meteorol.* 220, 141–150.
- [2.] Klosterman S.T., Hufkens K., Gray J.M., Melaas E., Sonnentag O., Lavine I., Mitchell L., Norman R., Friedl M.A., Richardson A.D., 2014. *Evaluating remote sensing of deciduous forest phenology at multiple spatial scales using PhenoCam imagery*. *Biogeosciences*. 11, 4305–4320.
- [3.] Richardson A.D., Jenkins J.P., Braswell B.H., Hollinger D.Y., Ollinger S.V., Smith M.L. 2007. *Use of digital webcam images to track spring green-up in a deciduous broadleaf forest*. *Oecologia*. 152, 323–334.
- [4.] Gillespie A.R., Kahle A.B., Walker E.R., 1987. *Color enhancement of highly correlated images. II. Channel ratio and chromaticity transformation techniques*. *Remote Sens. Environ.* 22, 343–365.

How to turn stakeholder evaluation of multi-functional forestry into innovative forest governance practices to enhance sustainability transformation in the Carpathian Mountains?

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In this paper, we first explore public attitudes towards forestry development. Then, we analyse prevailing attitudes to wooded landscapes. Finally, phase 3, is dedicated to ecosystem services, human-environment interactions, and forest multi-functionality in the Ukrainian Carpathians. Attitudinal heterogeneity is identified through stakeholder evaluation and explained by means of a discursive analysis. The identified stakeholder attitudes appeared to be diverse. However, there is empirical evidence of end-user understanding that sustainable multi-functional forestry is the direction in which to go to multiply the benefits of trees to society and the environment. The thrust of multi-functionality is supported by our results, whilst forest multi-functionality is aligned with international trends and agreements relating to the role of forests in promoting sustainable transformation processes. Next, forest multi-functionality could mean further commercialisation of productive (timber, non-wood forest products), carbon and social forestry (e.g. recreation). Furthermore, alongside with the pressures to manage forest multi-functionally, there is a need to recognise the challenges posted by climate change and to develop strategies which confront these challenges. Social innovations could help strengthen actors' ability to respond. New forests may play a significant role in sequestering carbon and providing bioenergy. To conclude, our findings provide arguments that implementing sustainability requires innovative governance with high levels of stakeholder competence and capacity-building, and that trans-disciplinary research based on active stakeholder engagement is particularly useful for identifying of trade-offs (and potential conflicts to avoid and manage them) and for assisting decision-makers with the incorporation of public perceptions into policy measures and governance practices to promote sustainability transformation processes in the Carpathian region.

Keywords: ecosystem services, policy measures, transformation, sustainability

Can social innovation offer transformative opportunities to forestry in Ukraine?

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Social innovation is now widely recognised as having the ability to enhance society's capacity to act by turning social and economic challenges into opportunities ([Patricolo](#), 2019). The SIMRA database of social innovations includes over 300

examples amongst which success stories that are being observed in marginalised rural areas throughout Europe. They include social innovations in the forestry sector. However, social innovation records associated with post-Soviet economies are scarce and the knowledge of impacts of social innovations in rural areas in such countries as Ukraine is limited. To bridge this knowledge gap, we apply the 'action arena' methodological approach to answer the question whether social innovation can offer transformative opportunities to forestry in this country. The research methods focus on documentation of the institutional environment and arrangements, the developed framework of institutional transformation, interviewing forest policy actors and stakeholder evaluation. A Q-method is applied as the main tool to explain the diversity of attitudes towards market changes, institutional reforms, social innovation and sustainability in Ukraine's forestry sector. We examine social capital, the knowledge and skills of people and the role of individuals in the institutional transformation. Results show that for social innovation to be transformative it must challenge existing institutions, shift existing power relations and create new norms, rules and decision-making arrangements. People on the ground are to move away from old sets of norms, rules and mental models. They are to envision alternative futures, reshape places and actively participate in decision-making processes. We conclude with identification of key directions for changing the rules of the game in Ukraine's forestry. These include: an increasing role of partnerships within this sector and across sectors (including private-public partnerships); a rising importance of collaboration across agents and organizations (actively involving local communities) to share knowledge and resources; the need to develop institutional capabilities and promote social learning; and an associated need for a new type of leadership for social innovation to make impact in rural areas and offer transformative opportunities to the forestry sector.

Programme under Grant Agreement No 677622 and the Scottish Government, who supported this research through their Rural Affairs and the Environment Strategic Research Programme.

Historical remote sensing for ecology and conservation in the Carpathians Ecoregion

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Remote sensing represents an invaluable data source for ecology and conservation science, particularly in ground-data poor regions, such as the Carpathian Ecoregion. Despite its high spatial and spectral resolution, modern high-resolution remote sensing data is often restricted by its temporal availability. Here, we highlight the potential of Cold-War spy satellite imagery, to expand ecological assessments back to the 1960s. We show how the globally available historic imagery can be used for

monitoring ecosystem change at broad spatial and temporal scales. We highlight how we employed this data to map a) historical forest disturbance in the Carpathian Ecoregion as well as b) to map high conservation value forests. With additional global examples, we highlight applications of this data to support species habitat and population assessments to achieve a better understanding of the magnitude of ecological changes that occurred since the mid 20th century. Our work contributes to the broader understanding of ecological legacies, time delayed effects and shifting baselines.

Keywords: spy satellite data, historical remote sensing, conservation, high resolution

CM acknowledges financial support by the European Commission under the Marie Skłodowska-Curie Program, Project EcoSpy (Grant Agreement 793554).

Munteanu C, Nita MD, Senf C, Oeser J, Seidl R, Kuemmerle T (in review). Large tracts of high conservation value forests in Romania reveal new opportunities for Conservation; *Conservation Biology*.

Nita MD, Munteanu C, Gutman G, Abrudan IV, Radeloff VC (2018) Widespread forest cutting in the aftermath of World War II captured by broad-scale historical Corona spy satellite photography, *Remote Sensing of Environment*, Vol 204, 322-332.

Munteanu C, Kamp J, Nita MD, Klein N, Kramer BM, Muller D, Koshkina A, Prishchepov AV, Kuemmerle T (2020). Cold War spy satellite images reveal delayed declines in a keystone steppe species in response to agriculture; *Proceedings of the Royal Society B*; 287:20192897.

Land use intensity trajectories on forest-rural-urban areas obtained from dense Landsat time series

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Monitoring of agricultural intensification in mountainous regions in Europe is an important part of studies that focus on complex land use change and their driving forces. For agriculture, forests, and urban change mapping over large areas we are often using remote sensing techniques. Although mapping change in land use intensity over time with Earth observation is often challenging because of phenology (e.g., seasonal changes) and data gaps (e.g., clouds and cloud shadows) (Rufin et al. 2015). Our study aimed to better understand land-use intensity patterns in the northern Carpathians. We used dense Landsat time series to analyze land use intensity trajectories between 1986 and 2020 in our study region. We evaluated the use of spectral-temporal metrics derived from intra-annual Landsat time series to improve the mapping of forest-rural-urban gradients and land use intensity change. Obtained land use intensity trajectories indicated a trend towards much less intensive land use in the last decade in the northern Carpathian region. This study shows one

more possibility of dense Landsat time series used to monitor land-use intensification changes, in our case in mountainous regions.

Rufin P., Müller H., Pflugmacher D., Hostert P., 2015, Land use intensity trajectories on Amazonian pastures derived from Landsat time series. *International Journal of Applied Earth Observation and Geoinformation*, 41, 1-10

Sustainability measured by annual statistical reports – Đerdap National Park (Serbia)

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Protection and sustainable development are the backbone of the Carpathian Convention (2003). The Convention was created to ensure the application of the sustainable approach at the international level, referring to economic, social and environmental aspects. The evaluation of sustainability is under constant reconsideration, which includes the issues of indicator selection and the data availability (Bell & Morse 2018). This research considers availability of longitudinal data and, based on that, it aims to recognize 1) the trajectory of the basic sustainability indicators in Đerdap National Park and 2) whether the trajectory coincides with the signing of the Carpathian Convention and its implementation in Serbia. Here are used the annual statistical reports covering data applicable for measuring three sustainability aspects since the establishment of the Carpathian Convention. Therefore, the year of the signing the Convention (2003) is defined as the starting point of the trajectory, the year 2008 is taken for the middle point (2008), whereas the year of the last published statistical report (2019) represents the finishing time-point. Social sustainability is measured by population size, population average age, structure of employed (agriculture, forestry, fishery, tourism); economic sustainability by unemployment rate, number of employed per 1,000 inhabitants, number of tourists and touristic overnight stays, local budget incomes; and environmental sustainability by structure of employed (tourism, mining), share of forest areas, average wood volume, and share of households connected to the sewage system. Changes in the share of protection designations are used to measure protection aspect. The Đerdap National Park is chosen as the case study because its territory coincides with the geographical scope of the Carpathian Convention in Serbia.

Keywords: sustainable development, Carpathians, Đerdap National Park, statistical reports, Serbia

Framework convention on the protection and sustainable development of the Carpathians (2003), www.carpathianconvention.org/tl_files/carpathiancon/Downloads/01%20The%20Convention/1.1.1.1_CarpathianConvention.pdf

Bell, S., Morse, S. (2018). Sustainability Indicators Past and Present: What Next? *Sustainability* 10(5), 1688.

Patterns and drivers of tree longevity across primary mountain forests of Europe

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Specifying the values of potential maximum lifespans of trees, and how different environmental factors affect the longevity can importantly contribute to the understanding of growth processes that lead to diverse forest structures. We used dendrochronological data acquired in the period 2010-2018 in 68 stands on 973 permanent sample plots set up in the primary forest remnants of mountain mixed and spruce-dominated forests across the Carpathian Arch and Balkan peninsula. We examined how disturbance history, growth patterns, and environmental factors influence longevity of the four most represented tree species in the collected database: silver fir (*Abies alba*), sycamore maple (*Acer pseudoplatanus*), beech (*Fagus sylvatica*), and spruce (*Picea abies*). The results show that trees were less likely to reach old age in areas affected by more severe disturbance events, whereas

individuals that experienced periods of slow growth and multiple episodes of suppression and release were more likely to reach old age. Aside from a weak but significant negative effect of vegetation season temperature on fir longevity, no other environmental factors included in the analysis influenced longevity. Additionally, we examined differences in longevity potentials between the named species in the researched region. Beech trees reached markedly higher ages than the other three species in the analysis. Nevertheless, there are specimens of all four species that exceeded 400 years, while several beech trees attained the ages over 500 years, with the oldest one being at least 578 years old.

Keywords: Disturbance, European beech, growth patterns, lifespan, longevity, Norway spruce, silver fir, site conditions, sycamore maple

Cooperation for the digital promotion of destinations in the Polish Carpathians: DMOs' perspective on the use of ICT

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Currently, the DMOs in the Polish Carpathians are strongly involved in providing digital tools which allow visitors to easily search for tourist information but also to sightsee, spend time actively, and use outdoor games. For some neighboring destinations, the similar features are the basis of tourist attractiveness such as bike routes, mountain trails and cross-country skiing trails, thematic routes and eco-museums. Great majority of these attractions has been prepared during last years under the cooperation of DMOs focused on tourism development in rural areas and smaller towns. What is crucial, with the development of ICT the cooperation of DMOs has gained a new dimension. Nowadays, the DMOs pay the attention to promote the attractions with the use of digital tools (websites, mobile apps and mobile technology, social media), and consequently to assist, enhance, and empower tourism experiences on the basis of use of ICT, referring to the typology by Neuhofer, Buhalis & Ladkin (2014). Results obtained for the DMOs in the Carpathians are a part of complex research on the approach of DMOs in Małopolska, Poland to the use of ICT for promotion. The research was conducted from 2013 to 2018. According to the established set of criteria a desk research was performed for 182 municipalities. Some municipalities were evaluated as the leading users of ICT for promotion. Among the above-mentioned leading users are DMOs representing destinations in the Polish Carpathians. Within the scope of the research, the cooperation of the DMOs in the Beskids is particularly evident. The main goal of the paper is to discuss possibilities of cooperation for the digital promotion of mountain destinations on the example of Poland.

Keywords: DMOs, ICT, promotion, tourism experience, Polish Carpathians

This work was supported by the Marshal Office of the Małopolska Voivodeship in Kraków, Poland, Małopolska Centre of Entrepreneurship under DOCTUS – the Małopolska scholarship fund for

Ph.D. Students; and Faculty of Biology and Earth Sciences of Jagiellonian University, Poland, under Grants K/DSC/003025 and K/DSC/004021

Neuhofer, B., Buhalis D., & Ladkin A. (2014). A Typology of Technology-Enhanced Tourism Experiences. *International Journal of Tourism Research*, 16(4), 340-350.

Risk assessment of biodiversity loss in the Beskydy Protected Landscape Area

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Sustainable functioning of the landscape is one of the manifestations of sufficient diversity of the landscape. This is directly reflected in the ability of the performance of ecosystem functions and services, as well as in the internal mechanisms of ecological stability and self-regulation. However, human society is constantly putting pressure on the surrounding environment, often leading to the loss of landscape biodiversity. Biodiversity is a complex phenomenon and therefore a comprehensive approach needs to be used to assess its threat, such as the integration of multiple models.

The area of interest was the Beskydy Protected Landscape Area, located in the mountains of the Outer Western Carpathians; occupies almost the entire territory of the Moravian-Silesian Beskydy, a substantial part of the Vsetín Hills and the Moravian part of the Javorníky Mountains. It has an area of 1197 km², forest cover is 71%. The subject of protection is mainly the original mountain primeval forests and species-diverse meadow communities.

First, the classification of natural and non-natural habitats in the Czech Republic was performed and evaluated by the Habitat Valuation Method (Seják et al., 2003). Using the CZ-GLOBIO model (Cudlín et al., 2019), threats to habitat biodiversity due to land use change, proximity to infrastructure, landscape fragmentation and air nitrogen deposition were identified. In parallel, on the basis of the Marxan model (Cudlín et al. 2020), small, hitherto insufficiently protected segments, containing valuable remnants of natural habitats, were selected. The partial outputs were integrated with each other. Both models have been adapted to reflect the heterogeneity of our landscape well enough and are on a scale of 1: 10,000.

The application of this procedure enables the assessment of the state of biodiversity and the identification of stable (hot-spot) and risky (cold-spot) places for the preservation of biodiversity and ecological stability of the area.

Keywords: Biodiversity threats, CZ-Globio model, Habitat assessment method, Marxan model, Integrated tool

Impacts of social innovation on spatiality in mountain–lowland relationships: Trajectories of two Swiss regional initiatives in the context of new policy regimes

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This presentation places the topic of “social innovation” in the context of the paradigm shift of the 1980s. This shift from Fordism to post-Fordism has led to a weakening of the model of the European welfare state. Social innovation has become an instrument to promote regional self-responsibility and entrepreneurial activity by local authorities. The concept of social innovation has become widespread among various disciplines and controversially used by them. Referring to regional and corporate success stories based on the commitment of grassroots movements and civil society has its shortcomings as the new spatiality regimes show increasing disparities. The article shows the different lines of conflict in the discussion about social innovations and makes suggestions for the specification and delimitation of the concept. Using two case studies on social innovations from mountain regions of Switzerland, based on standardized interviews, including the results of a social network analysis, the article distinguishes between adaptive and transformative social innovations. The adaptive social innovations analysed did not result in changing the inferior position of the regions; however, they prevented even greater destabilization by mobilizing the dynamic actors in the valley to work together. This is helpful for ensuring that the urban majority continues to show solidarity with the population in rural and mountain areas. The constructive interaction between public, private, and civil society institutions is seen as the key factor of social innovation in the European peripheral areas to which most mountain areas belong.

Keywords: impacts of social innovation; transformative social innovation; post-Fordist regime change; urban–rural linkages in mountain areas; European mountain areas

What is possible future of the European beech in the Carpathians?

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The main representative tree species across the Carpathians oblong is European beech (*Fagus sylvatica* L.). Its ecological conditions range can be specified as: shade-tolerant, wet but not inundated sites, more less rich sites independent on a geological bedrock. Predicted future climatic conditions include air elevated CO₂ concentration, increased air temperature and unchanged amount of precipitation, but its changed redistribution both in temporal and spatial scale. Under such climate conditions: bud burst, foliage and senescence will be slightly affected (earlier flushing and leaves yellowing); stimulation of photosynthesis, respiration and stomatal conductance decrease; Lammas shoots production; stimulation of tree height and

stem thickness increment (positive effect of temperature); lower increment of coarse roots; higher biomass production, especially on calcareous soils (lower on acid soils) are expected (e.g. Overdieck et al. 2007). However, beech has higher water use efficiency than Norway spruce, it is also susceptible to drought. Beech is susceptible to cavitation (-1,8 MPa) and carbon starvation, despite well acclimatization of stomatal conductance (e.g. Lemoine et al. 2002). Therefore, a competitive ability of beech can be reduced across the current areal of distribution in the future.

Keywords: global climate change, growth potential

Lemoine, D; Cochard, H; Granier, A. (2002). Within crown variation in hydraulic architecture in beech (*Fagus sylvatica* L): evidence for a stomatal control of xylem embolism. *Annals of Forest Science* (1): 19 - 27.

Overdieck, D., Ziche, D., Boettcher-Jungclaus, K. (2007). Temperature responses of growth and wood anatomy in European beech saplings grown in different carbon dioxide concentrations. *Tree Physiology* 27 (2): 261-268.

Large wood and the city: the case study of the Ostravice river, Czechia

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Large wood (LW) is a common part of a natural or seminatural river. It is well recognised that this component brings many positive aspects to the river, e.g., increased channel heterogeneity, enriched nutrient retention, carbon sequestration, and others. These benefits of LW can also be described or quantified as ecosystem services. However, in some areas, especially urban, LW can contribute to flood risk, which can be considered as a disservice. We investigated a one-year regime of LW in the Ostravice River, Ostrava, Czechia. In this research, we focused on a 2-km-long part of the river which flows through the city centre. At this place, the river is heavily channelized, the riverbed and banks are embanked, and the whole river floodplain is partly or fully constricted by stone floodwall protection. The goal was to better understand the dynamics, dimensions, and preferential retention sites of LW during a whole year. We measured LW with >10 cm diameter and >1 m length and clusters consisting of organic material (fine wood, grass) after each of four high-flow events producing out-of-channel LW deposition. We quantified the amount of wood, noted the place of its retention, and we evaluated its potential to provide ecosystem services. Furthermore, we wanted to pinch the protection ecosystem services of LW and the role of policy and water managers in this phenomenon. Preliminary findings showed that 95% of LW pieces were deposited on the right riverbank because of the higher hydraulic roughness of this bank and larger suitable area for potential LW storage. The mean diameter of deposited LW was 0.32 m, and mean length was 2.51 m. We considered LW pieces of this size do not represent a risk for bridge piers. However, they do not provide many ecosystem services because large wood pieces

were trapped on the bank (and not in the channel) and they had been cleaned up by local authorities after approximately two weeks from their deposition.

Keywords: large wood, urban river, ecosystem services, river management

Brown bear predation on sheep and cows in the Carpathian landscapes.

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Romania harbours the largest brown bear population in Europe within the Carpathian Mountains, a stronghold for the European brown bear population, characterized by a low, but dispersed human footprint, mostly rural, and growing cattle and sheep represents the livelihood for many local rural communities. Understanding of the spatial patterns and predictors for Human – carnivores conflicts (HCC) has the potential to benefit local communities and wildlife management agencies by providing broad guidelines for reducing the level and frequency of conflict. The overarching goal of this study was to assess predictors and spatial distribution of HCC in a high-density brown bear landscape in Romanian Eastern Carpathians using a dataset of reported livestock damage collected by local Environmental Protection Agencies (EPAs) spanning nine years (2008-2016). We evaluated the occurrence and predictors of HCC by brown bears using binomial generalized linear mixed models (GLMM). We ran separate models for different types of livestock damage: *cows*, *sheep*, and *other* (pigs, horses, chickens) and we developed a set of 32 models that tested hypotheses regarding influences of environmental and anthropogenic variables on the presence of HCC for each livestock type. Our results revealed that the likelihood of HCC caused by bears to livestock in Romania is influenced by a combination of landscape factors, local relative brown bear abundance, topography, and approaches to livestock management. Our predictions showed differences in the factors affecting the prevalence of damage for cows, sheep and other livestock, but altitude, distance from forest and land cover types are common to all livestock. Brown bear abundance was only positively associated with sheep and other livestock. The landscape configuration, composition, and heterogeneity were strong predictors of HCC, but the direction and strength was highly variables across livestock types.

Keywords: human-carnivore conflict, Ursus arctos, landscape heterogeneity, livestock management, large carnivores

The data collection was partially funded by the European Commission LIFE Nature Programme within the project LIFE08/NAT/RO/000500. The work of MIP was supported by a grant of the Romanian Ministry of Education and Research, CNCS - UEFISCDI, project number PN-III-P1-1.1-PD-2019-1207,

within PNCDI III. MAD and VDP were supported by the Ohio University, Department of Biological Sciences.

Saving the timber but not the forest: Post-disturbance management is ineffective in preventing further Norway spruce forest decline in Slovakia

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Ongoing climate change exposes temperate forests to the increasing frequency of disturbances, and following sanitation measures to prevent further forest decline in Norway spruce forests. However, its continuous decline questions effectiveness of salvage logging and sanitation felling.

To answer this question, we compared cumulative rates of Norway spruce forest loss from 2000 to 2017 between strictly protected reserves (n=122, PA) and surrounding commercial forests in three spatial scales: buffers 500 (in 0-500 m distance from PAs), buffers 2000 (500–2000 m), and randomly generated control sites (> 4000 m from PA). Norway spruce decline data origins from optical remotely sensed data. We used generalized additive mixed models to test the differences in cumulative rates and temporal trends of spruce forest loss among the zones. Our environmental predictors included spruce proportion, age, elevation, and Shannon index as a diversity measure.

We found that spruce forest loss in control commercial spruce forests nearly doubled than in PAs (yearly 1.1% loss in PAs, 1.7% in commercial forests, in total 19.4±26.1% and 31.4±24.7% for PA and control zones, respectively). Spruce forest decline trajectories started diverge widely between PAs and the other zones after 2005. The highest forest loss was recorded in buffer 2000 (from 500 to 2000 m from PA) that likely suffered from combined human and natural disturbances. Significantly lower forest loss in PAs than in control commercial forests indicates that currently applied post-disturbance measures such as salvage logging and felling are not efficient to prevent forest canopy decline in years following the disturbance. Our

results the need to reconsider current post-disturbance management, and instead of preventing single risk (e.g. avoidance of beetle outbreak), forest management needs to aim forest resilience.

Keywords: Ips typographus; forest disturbances; canopy mortality; forest cover, protected area

Scaling effect on the aboveground carbon stock assessment

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Currently, the need for increasingly accurate estimation of aboveground carbon storage requires comparison of multiple approaches, that estimate biomass from field techniques in combination with satellite data at different scales of underlying layers. The main question of our contribution is in which smallest area and at what spatial scale can tasks, such as time changes of carbon stocks in the catchment area or comparison of current carbon stocks (large-scale layer) with a map of potential vegetation (small-scale layer), be solved. The work was performed in three study areas differing by order in size, the Všeminka catchment (21.53 km²), the Dřevnice catchment (435.19 km²), and Czech Republic (78,866.81 km²). Both catchments and about one quarter of the Czech Republic are part of the Carpathians. As the underlying layers Detailed combined layer (DCL) at a scale of 1:10,000, CORINE Land Cover (CLC) data from several time periods (CLC of 1990, 2000, 2006, 2012, 2018) at a scale of 1:100,000, and Potential natural vegetation at a scale of 1:500,000 were used. The values of aboveground carbon pools for individual land cover categories and habitats were derived by look-up table method from literature and experimental results. For the estimation of carbon stocks even in the smallest monitored catchment Všeminka, it is possible to use the map base of the medium-scale CLC (1:100,000); the difference compared to the calculation from a more detailed DCL layer (1:10,000) is 6.1%. Sentinel-2 multispectral satellite imagery data used for the verification of carbon stock results coincided in the range from 76 to 88%. By using widely available data sources (CLC and Sentinel-2), it is possible to compare results from different areas and perform analyses throughout Central Europe. The results can contribute to improve the monitoring of changes in carbon stocks, which can be used, for example, in obtaining data for the Monitoring Report on the carbon budget in the Czech Republic.

Keywords: carbon stock, CORINE LC, habitat layer, scaling, Sentinel-2

Changes in selected land cover forms in Galicia in the 20th century and the diversification of socio-economic development in Poland and Ukraine. The study based on cartographic and statistical materials - preliminary results

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The aim of this presentation is to show the changes in selected land cover forms in historical Galicia and their relationship to the level of local socio-economic development since the turn of the 19th and 20th centuries up to now. The research problem is the qualitative and quantitative detection of the relationship that is/was occurring between these two factors. The rationale for undertaking this research topic is the numerous reported land cover changes in the area of research, documented even since the 18th century. However, there are no comprehensive studies linking the variation in the dynamics of local development under conditions of intensive socioeconomic, political and cultural transformations that took place during the 20th century with the changes in land cover.

A map of statistical data (population numbers) from 1904 was compiled and aggregated to the boundaries of modern municipalities on the Polish side and on the Ukrainian side. Contemporary population data was aggregated to the same units. All data was linked to a vector layer representing the above mentioned administrative division.

For the prepared administrative division, land cover maps were drawn for two periods. The map for the pre-war period was drawn on the basis of maps of the Military Geographical Institute at a scale of 1:100,000, while the contemporary land cover was obtained from the Military Topographic Map and on the Ukrainian side from topographic maps, all at a scale of 1:100,000. Due to the sources used, only the main land cover types (water bodies, artificial surfaces, forsts, wetlands and others) were designated. In a final step, the relationship between socio-economic indicators and land cover was checked.

In order to determine the major land cover changes in the Polish Carpathians with reference to administrative units (towns and villages), an index of land cover structure change (LC) was developed. For this purpose, on the basis of the odds ratio and the logit function, the change in the land cover structure of the Carpathians was calculated for the year 1904 and the present. In turn, to determine the level of local socio-economic development, a synthetic local development (LD) index was created. The sum of the normalised values of the indicators, using the standard deviation and the mean, was used to calculate the index. Then, a mixed model was used to build a

model of the impact of the level of development on changes in land cover in the studied periods. Two models were examined in the analysis. In the first model, the calculated local development index was adopted as the value of y (LD). In the second model, changes in land cover structure were taken as the y (LC) value. In the first case, indicators representing contemporary local development were used as variables. In the second model, the variables were the magnitudes of change in the proportion of land cover in each class.

Moreover, on the Ukrainian side, a reform at the lowest administrative level has recently been completed, which creates a framework for the practical implications of the topic addressed.

Keywords: land cover change, local development, Galicia, Poland, Ukraine

Primary forest biomass dynamics across scales driven by natural disturbances

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Primary forests hold unique characteristics with an asymmetrical structure and age distribution, driven by natural ecological processes and with no direct impact from anthropogenic activities. There is a precedence to understand the interactions between natural disturbances and environmental conditions as the primary modes of shaping the functional and ecological traits of an old-growth, uneven-aged forest. Underpinning the complexities of primary forest development is vital to quantify the current levels of biomass productivity and carbon storage potential accumulated for centuries. Natural disturbances help promote ecological change in forest demography, however, it is lesser-known to what extent and how these interactions influence biomass at scales. In this study, we investigate total (living and dead tree) biomass across the temperate, primary forests of the Carpathian Mountains, in 748 plots, nested within 54 stands in Romania, Slovakia, and Ukraine. We assess the trends in biomass across the Carpathians and how biotic and abiotic interactions vary across the two distinct forest types: mixed beech (*Fagus sylvatica*) and silver fir (*Abies alba*) and pure Norway spruce (*Picea abies*). First, we aim to assess spatial variability in biomass across scales (plot, paired plot, stand and landscape) in the mixed beech-fir and spruce dominant forests. Hypothesising that biomass density in the mixed beech-fir forests in the low-mid altitude is greater than in the spruce dominant forests in the upper altitude. Second, to address the importance of natural disturbances and environmental condition in the distribution of biomass. We hypothesise that the uneven-aged structure has a greater influence on biomass distribution than recent disturbances. Our dataset comprises 34,033 living trees, 4,401 dead standing [snags] trees and 11,431 downed deadwood from the REMOTE primary forest network, used to assess the trends in total biomass in central and eastern Europe. The extensive network of plots employs a hierarchical-scale approach to assess the distribution of biomass and the interactions between

biophysical and natural disturbances drivers. We use a generalised linear mixed-effects model to assess the relationship between biomass, age, and environmental conditions across the temperate mountain forests.

Keywords: Forest ecology – biomass dynamics – Primary forests – Natural disturbances – Mixed beech-fir – Spruce - Temperate old-growth forests – Biomass drivers – fine-to-coarse scale

Special thanks to my supervisor, co-authors and the Department of Forest Ecology for their support. Thank you to *Research on Mountain Temperate Primary Forests* (REMOTE) for permission to use the extensive network of permanent plots from the primary forests of the Carpathians.

Signs of glacial activity in the mid-height mountains of Ukrainian Carpathians

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The prevailing opinion is that in Ukrainian Carpathians, glaciers existed only in the massifs of Chornohora, Svydovets and Chyvchyn, where distinct erosional forms of glacial excavation (glacial cars, cirques, troughs) and moraines have been preserved. Most researchers accept the snow line's lowest altitude for the Ukrainian Carpathians in Pleistocene at 1400-1500 m, and sometimes 1200 m (Lushchyk, 2017). Our observations on the Chorny Dil Range, situated in the upper reaches of the White Cheremosh River (the highest mark is 1483 m), indicate the possible existence of glacial processes here in the past. The well-rounded boulders of the quartzite (metamorphized quartz conglomerate), up to 1.5 m in diameter, can be observed on the flatted top of the range, on the upper part of adjacent slopes, and in the channel of the Sarata River, at the eastern foot of the range. The source of these rocks is the Permian basal stratum of the conglomerate-breccia, up to 30-50 m thick. Partly, the long-distance displacement of the rock material and deep carving of the gorges in hard metamorphic rocks of the range could be provided by avalanche transportation. The hard rocks' composition of the Chorny Dil Range caused its slopes' steepness, like the Rodna Mts. Due to the steep slopes, snow accumulation caused by avalanches could occur not only at the top of the range but also in the valleys of Sarata and Perkalab. Nowadays, avalanches occur even in low mountains if the slopes are enough steep and deforested (Ridush et al., 2020). The observation of modern snow accumulations caused by avalanches can be used for the modelling of similar processes in the Pleistocene.

Keywords: glacial processes, Ukrainian Carpathians, Late Pleistocene, glacial boulders, avalanches

Lushchyk A. 2017. History of study of Glacial relief of Ukrainian Carpathians. Scientific Herald of Kherson University (in Ukrainian).

Ridush, O., Ridush, B., and Kholiavchuk, D. 2019. Avalanche hazard in low-mountain part of Eastern Carpathians, EGU General Assembly 2020, Online, 4–8 May 2020, EGU2020-879, <https://doi.org/10.5194/egusphere-egu2020-879>.

Transition from even aged spruce to uneven-aged close-to-nature mixed forest stands - a challenge for economical optimisation and planning

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Carpathian mountain forests currently often consist of old pure spruce forests. A high amount of spruce forest stands fail due to storm and bark beetle. A measure to reduce the risk of spruce stand failure is a higher admixture of beech and fir (Roessiger et al. 2020), but natural regeneration of these tree species is often missing or insufficient due to lack of seed trees. A further step towards a more near-natural forest stand are uneven-aged structures that allow for a continuous cover management.

The study uses data from the protected landscape areas of Beskydy in the Czech Republic and Kysuce in Slovakia about beech, fir, and spruce. The density-dependent matrix transition model provides an ecologically realistic modelling of growth, regeneration and mortality. E.g., only seed trees on the site allow for natural regeneration. An optimiser decides about harvest and planting to ensure the highest financial income (Roessiger et al. 2020).

In the case of a pure economic optimisation, the next stand generation continues as a nearly pure spruce stand with just minor admixture of beech, related to a high proportion of mortality by storm and bark beetle. Therefore, the presented study investigates which political instruments invest funding most purposeful and quantify required funding.

A change towards a near-natural and site-adjusted species composition requires planting. In the study region fir proportion increases by funding of planting. Beech is limited because of its still too low growth potential in the region.

Maintaining existing old beeches and firs with a high diameter as biotope trees requires funding not to harvest as the diameter of biotope trees exceeds the commercial target harvest diameter. Thick biotope trees support the initiation of uneven-aged stand structures. The results of optimisation indicate that investments in funding are necessary to initiate uneven-aged mixed forests with reduced spruce proportion.

Keywords: Forest management planning, Uneven-aged forest management, Forest matrix transition model, Funding policy for biodiversity, Forest politics, Subplex optimisation algorithm

Roessiger, J., Kulla, L., Sedliak, M., 2020. A high proportion of Norway spruce in mixed stands increases probability of stand failure. *Cent. Eur. For. J.* 66, 218-226.

Roessiger, J., Kulla, L., Murgaš, V., Sedliak, M., Kovalčík, M. (in preparation 2021). An optimised planting under funding supports biodiversity, adapts forests against and mitigates climate change – and causes unintended effects. Planned to submit to *Forest Policy and Economics Management*.

Exploring tourism in Tatra National Park and Low Tatras National Park by using social big data

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This study explores the potential of social big data in form of geotagged photos from a social photo-sharing website Google Panoramio in Tatra National Park and Low Tatras National Park. Both national parks are one of the most visited national parks in Slovakia. Google Panoramio is directly focused on landscape site photos. The metadata of geotagged photos contains information about geographic coordinates, date, time and photographer's identification number. A total of 26,526 geotagged photographs were recorded in the period from 2006 to 2014. To avoid the bias caused by photographing more photos from one place by one user, we have counted only one photo per user per square kilometer. Then we calculated photos density in order to identify points of interest. We used the date information to help us identify temporal patterns for both parks. The highest photos density in Tatra National Park was found in Skalnaté pleso (142 photos/km²), in Low Tatras National Park it was the Jasná area resort with 92 photos/km². The most photos were taken on Sundays. The geotagged photos from social media platforms provide useful information about tourist behavior. They can help manage the national park by identifying spatial and temporal patterns of visitation. This data can be used to develop effective communication strategies and programs about the park characteristics, activities and efficiently communicate conservation and environmental values.

Keywords: geotagg photo, Low Tatras National Park. Tatra National Park, tourism

This research was funded by the Scientific Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic and the Slovak Academy of Sciences, grant number VEGA 2/0018/19 Ecological Analyses of Landscape Acculturation in Slovakia since Early Prehistory until Today.

Respect Nature in the Carpathians

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The Carpathians are being impacted by a rising number of visitors. Therefore, raising awareness and providing education on proper behaviour in nature is critical, contributing to minimise the impact visitors have on nature.

Respect Nature is an initiative of the European Wilderness Society, which aims to spread awareness and train people to protect the nature we love. This is achieved through the provision of guidelines on appropriate behaviour in the great outdoors. The Respect Nature initiative offers key guidelines to support nature conservation as well as further sustainable tourism development in Europe, particularly in the Carpathians.

Respect Nature's 9 principles help to communicate the guidelines on how to behave in nature without harming it:

- Know where you go
- Stay on trails
- Minimise camping impact
- Keep nature clean
- Make fire responsibly
- Show respect
- Respect wildlife
- Respect others
- Respect livestock protection

Respect Nature offers educational posters and folders, and outdoor signs in various sizes, as well as online and offline trainings focused on sustainability in the outdoors. The aim of this presentation is to introduce the Respect Nature initiative and its recent pilot implementation in Ukraine, where:

- 57 Protected areas of Ukraine have already completed the Respect Nature training course
- 1000 posters and 500 folders are being distributed among Ukrainian protected areas, schools, tourism and environmental state administrations, NGOs
- Carpathian Biosphere Reserve and National Nature Park Synevyr are equipped with 8 big bilingual (Ukrainian-English) outdoor and 36 small signs and there is demand for more
- Respect nature module became a part of the "Sustainable Green Tourism School", launched in 2020, so far 161 participant
- Number of indoor and outdoor Respect nature trainings conducted for youth in Ukraine and Austria.

These tools will be soon available in over 20 European languages.

More information is available here: <https://wilderness-society.org/more-respect-nature-educational-tools-in-ukraine/>.

Keywords: Respect Nature, sustainable tourism, Carpathians, visitor education

Unfolding the Potential of Cultural Heritage: a Case Study from Val Venosta (South Tyrol, Italy)

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How can cultural heritage contribute to the sustainable development of rural areas?

The case-study from Val Venosta presents the first results of the Interreg Italy-Switzerland-project 'Cross-border governance instruments for the safeguarding and valorisation of the living intangible cultural heritage'. The Venosta valley is located in the north-westernmost part of South Tyrol on the border to Switzerland. The intensive cultivation of apples has led to a mono-sectoral development in some parts of the valley and brought several problematics, e.g. total dependence on the world market, biodiversity-loss and landscape homogenisation. However, in the upper part of the valley, a manifold, small-scale farming system with various different production lines has survived or has even been re-established during the last years. Its spectrum covers both cattle breeding and milk production including the cultivation of grasslands and Alpine pastures as well as the cultivation of a great variety of partly rare seeds and species. This nature-oriented farming is responsible for the preservation of an abundant agro-biodiversity and led to the development of specific customs and traditions over the centuries that constitute a relevant aspect of the local people's identity. Therefore, we consider them as cultural heritage. The first step of our project is to identify the cultural heritage by means of a community-based bottom-up approach.

To a certain extent, cultural heritage is in a constant state of flux. Favourable conditions are therefore needed to keep the traditions and customs vital and thus the system running. The long-term collaboration of different stakeholders, cross-sectoral approaches and the political willingness are essential to allow cultural heritage to unfold its potential. We will present the so-far collected data and information and will discuss about the potential of our approach in other mountain regions.

Keywords (5): cultural heritage, governance, cross-sectorial, agro-alimentary product chains, preservation

Climate regulating ecosystem services of old-growth forests: case study from Ukrainian Carpathians

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One of the most important services of forest ecosystems is climate regulation, which mitigates change of the global climate and simultaneously buffers its impact on local ecosystems. It is considered that natural unchanged ecosystems can ensure provision of more ecosystem services than intensively managed ones (Foley et al., 2005).

We studied climate regulation service of forests in the Ukrainian Carpathians using data on land surface temperature (LST) from Landsat 8 satellite as a proxy of ecosystem cooling capacity and compared its values with some environmental indicators (elevation, slope, aspect, TPI, tree cover density and loss). We analyzed three classes of forests: old-growth forests (OGF) identified before (Smaliychuk & Gräbener, 2018); forests that has experienced disturbances within last 15 years (DistF); and neither OGF nor disturbed forests (OthF). We carried out our study for summer period of 2015 within two districts of Transcarpathian region in Ukraine.

To find out the link between selected variables and LST values, we used boosted regression trees method. For that, we built three global (one per forest class) and 12 individual models (for four bioclimatic belts within each forest class). The models explained between 34 and 64 % of the LST deviance with maximum detected by one built for OGF within beech-oak bioclimatic belt. For DistF class most significant variables are year of forest loss, forest loss in the neighborhood, and elevation, whilst for OthF class important factors of LST are elevation and tree cover density.

We also compared LST values with elevation and revealed that for beech bioclimatic belt average LST ranged from 25.5° C for OGF, to 26.2° C for OthF and to 26.9° C for DistF class. Moreover, in the spruce-beech bioclimatic belt the difference in LST between DistF and OGF was estimated as 2.5° C on average. Thus, our findings are in line with the recent results from North America on low climate sensitivity in older forests (Thom et al., 2019).

Keywords: old-growth forests, climate change, Landsat, land surface temperature, spatial analysis.

Foley, J. A., DeFries, R. et al. 2005. Global consequences of land use. *Science*, 309 (5734), 570-574.

Smaliychuk, A., Gräbener, U. (eds.) (2018). Natural forests of Ukrainian Carpathians. Lviv: Carty i Atlasy, 104.

Thom, D., Golivets, M., Edling, L., Meigs, G. W., Gourevitch, J. D., Sonter, L. J., Galford, G. L., Keeton, W. S. (2019). The climate sensitivity of carbon, timber, and species richness covaries with forest age in boreal–temperate North America. *Global Change Biology*. Vol. 25, 7, 2446-2458.

Policies for integration of ecosystem services into local bioenergy strategies: challenges and opportunities for the Ukrainian Carpathians

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The transition to a low carbon economy already is affecting landscapes and ecosystems around the world, including Carpathian region. The most recent infrastructural developments planning at the Ukrainian Carpathians (such as the ski resort Svydovets, Olympic complex "Borzhava" and also renewable energy object -

the wind farm on the mountain Borzhava) can impact on biodiversity and ecosystem services. In order for landscape transformation to be sustainable land use planning should take into account the critical trade-offs between the energy provision and other ecosystem services.

Ukraine is preparing an energy transition towards renewables, although its economy still relies strongly on fossil and nuclear energy. Apart from ample wind and solar capacities, the country has abundant agricultural and forestry bioenergy resources. In the densely-forested regions (first of all Carpathians and Polissya), energy wood is the most prominent bioenergy source. Therefore, it is crucial to identify the trade-off in order to achieve sustainable solutions. The economic approach to ecosystem services may represent an effective tool to include conservation related issues in land-use planning (Grilli & Paletto 2015). In line with national environmental and energy policies, Ukraine is preparing an energy transition towards renewables, although its economy still relies strongly on fossil and nuclear energy. Apart from ample wind and solar capacities, the country has abundant agricultural and forestry bioenergy resources. In the densely-forested regions (first of all Carpathians and Polissya), energy wood is the most prominent bioenergy source used to meet the heat demands of households and public buildings. Despite increasing forest area and timber volume in this regions, affordable wood bioenergy remains scarce for local communities in many areas. It causes preconditions for illegal logging and social conflicts. For research, further work is required to better reflect social and environmental issues in energy scenario narratives and to quantify environmental and ecosystem service impacts of, and influence on, energy system scenarios. For policy, a holistic consideration of the influence of energy pathways on ecosystem services that exists both within and outside markets could help to identify pathways that deliver routes to decarbonisation while simultaneously maximising the benefits that people derive from nature (Holland et al 2018). The integration of energy and ecosystem service scenarios (based on their identification and mapping) exercises, ideally embedded into a local energy strategy developed by the communities themselves, will allow policy makers to identify sustainable pathways consistent with the challenges of climate change, loss and degradation of biodiversity, cultural and other ecosystem services.

Grilli, G. & A. Paletto. Valuing and mapping ecosystem services for renewable energy planning. Available from: http://www.recharge-green.eu/wp-content/uploads/2015/02/04_Grilli_ESS2-Kopie.pdf

Holland, R.A.; Beaumont, N.; Hooper, T.; Austen, M.; Gross, R.J.K.; Heptonstall, P.J.; Ketsopoulou, I.; Winskel, M.; Watson, J.; Taylor, G. Incorporating ecosystem services into the design of future energy systems. *Appl. Energy* 2018, 222, 812–822.

Van der Horst, D., Vermeylen, S., 2011. Local rights to landscape in the global moral economy of carbon. *Landscape Res.* 36, 455–470. <https://doi.org/10.1080/01426397.2011.582941>.

Model-based potential natural vegetation projections accounting for climate change to assist decisions for forestry and grazing practices

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The potential natural vegetation (PNV) is a concept that represents the environment's capacity to foster certain vegetation types under the contemporary environmental conditions. Thanks to this, PNV, particularly if estimated by models, emerges as a tool to assess vegetation sustainability and vulnerability to climate change. The environmental parameters in model predictions can be set to represent future scenarios, to which PNV rules can be applied and thus differences from current state can be assessed.

The multiple PNV (MPNV) framework we introduced is particularly fit for climate change impact assessment. It handles PNV as a probability distribution of vegetation types per site accounting for uncertainties in modelling success as well as stochasticity of vegetation realization per sites. The utility of the MPNV framework will be demonstrated through the MPNV estimations for Hungary, which we carried out both regarding the current conditions and one future scenario with two regional climate models considered for the period of 2071–2100. Estimations are based on gradient boosting models of 47 habitat types. Hydrologic, edaphic, topographic and climatic parameters were used as predictors.

We investigated how MPNV can be applied for restoration optimization and in the assessment of the vulnerability of existing forest stands. MPNV was found to be a useful support in planning restoration under constraints when a single-outcome PNV estimation would not have served the complex contingencies of the project. The significance of considering MPNV in planning restoration or forestry is also demonstrated by the outcome of the vulnerability assessment. Vulnerability of the habitats were assessed using sensitivity and adaptive capacity estimations. It showed for Hungary that saline grasslands are the least and closed forests are the most vulnerable. Thus a shift towards open forests may serve sustainability especially in the lowlands.

Keywords: modelling, Multiple Potential Natural Vegetation, open forests, restoration, vegetation type distribution, vulnerability

The project LIFEstockProtect. Livestock protection from farmers for farmers

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The return of wolves causes severe conflicts in the German-speaking area of the Alps, mainly about predation on livestock. Nevertheless, livestock protection is barely used and is refused by many livestock farmers in Bavaria, Austria and the province of South Tyrol (IT). LIFEstockProtect is the first project coordinated by a farmers' association, in cooperation with organizations from the organic and conventional agricultural sector, as well as the environmental, research and tourism sectors to define and implement effective strategies for the coexistence with wolves and

preserve also small scale livestock breeding for the future. Using a bottom-up approach, peer-to-peer capacity building training on livestock protection will take place through farmers' associations. The project will establish a volunteer and an ambassador network in each project area that provide practical assistance to livestock farmers and shepherds with implementation and promotion of livestock protection. Additionally, scientific activities will investigate the environmental impact of grazing on the site-specific biodiversity and define parameters to measure the feasibility of livestock protection in the Alpine ecosystem. The success of the innovative "from farmers for farmers" approach to encounter this human-nature conflict will be monitored during the next four years. First reactions from the main target group of livestock farmers confirm this strategy and encourage to apply the peer-to-peer approach also in other contexts and geographic areas such as the Caucasus region.

Keywords: Human-wildlife interaction, herd protection, shepherd, education for coexistence

LIFEstockProtect (LIFE19 NAT/AT/000889) has received funding from the LIFE Programme of the European Union.

Gifts of the forest - contemporary use of wild mushrooms: Cases from the Carpathians in Romania and Ukraine

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For ages, forests have sustained local livelihoods with variety of products including mushrooms. In some high income European countries wild mushrooms have become fashionable cuisine while, in other countries they still play important role in everyday cooking (Colfer, 2021). Bukovina is a multicultural and multi-ethnic region of Eastern Europe and belongs to Ukraine and Romania. This territory has similar ecological conditions, but is divided by the border since 1940s, thus is an excellent model for comparison (Pieroni and Soukand, 2017) to address the role of the different governance systems.

Aim of the study is to analyze the contemporary use of wild mushrooms for daily livelihoods in the Bukovinian Carpathians comparing two ethnic groups -Hutsuls and Romanians- living in the same ecological conditions but currently located in different countries.

In summers 2018 and 2019, we conducted 131 semi-structured interviews in Romania and Ukraine, focusing on the use of mushrooms for food and cultural practices. We recorded 186 detailed use reports (DUR) in Romania and 297 DUR in

Ukraine belonging to 23 taxa and 12 Families. In both Romanian and Ukrainian Bukovinian Carpathians, mushrooms continue to play an important role in local livelihoods. The most used taxa in all groups were *Boletus edulis*, *Russula* spp., *Armillaria mellea*, *Lactarius deliciosus*, *Cantharellus cibarius*. However, the level of dependence and the role differs in Ukrainian and Romanian Bukovina. Wild mushrooms are of crucial importance for economic insurance and poverty reduction in remote rural areas of Ukrainian Bukovina, while in Romanian Bukovina the use of wild mushrooms is mainly recreational purposes. Moreover, our results demonstrated the homogenous use of mushroom species for cultural purposes (e.g. ritual foods). We discuss the similarities and differences in the use of wild mushrooms and influence by different governance systems. The appurtenance of an ethnic group did not define the use of wild mushrooms in our case study.

Keywords: rural areas, wild food, ethnobiology, non-wood forest products, sustainable forest management

Colfer, C.J.P. (Ed.), (2012). Human health and forests: A global overview of issues, practice and policy, People and plants international. Earthscan, London. <https://doi.org/10.4324/9781849771627>

Pieroni, A., Soukand, R., (2017). Are borders more important than geographical distance ? The wild food ethnobotany of the Boykos and its overlap with that of the Bukovinian Hutsuls in Western Ukraine. Journal of Ethnobiology. 37, 326–345. <https://doi.org/10.2993/0278-0771-37.2.326>

Measures to support wild bees and their pollination service

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Wild bees contribute to pollination of crops and wild flowers. Their species diversity and abundance have declined during last decades, mainly due to loss of nesting and feeding habitats in response to land use change. This may jeopardize the fruit production in orchards, which relies on bee pollination. We surveyed the diversity of bees in fruit orchards by coloured traps and found more than 20 pollinating bee species in period of fruit blossoming (April – May). When considering the results of summer surveys, we identified in total 140 bee species in orchard sites after 5 years of trapping. Since a majority of these bees nest in the soil, we tested artificial nesting sites in order to support above-ground nesting bees in fruit orchards. By this way we succeeded to enhance populations of mason bees *Osmia bicornis* and *Osmia cornuta*, which contribute to pollination of fruits in the spring. We also tested artificial flower strips as a source of food for pollinators after the fruit-tree blossoming period is over. This is important mainly for the development of bumblebee colonies, which takes several months from spring to summer. Numbers of bumblebee queens, produced in summer, determine the intensity of pollination service supplied to crops

in the following year. These measures, applied by crop producers, have a potential to enhance pollination service in agricultural crops.

Keywords: wild bees, pollination, Osmia bicornis, Osmia cornuta, flower strips

“Is it still our land?” Between traditional and modern ways of using the land. Example of the Tatra mountain region called Podhale

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In my presentation I will discuss the tension between traditional ways of using the land based on pastoral activities and contemporary tourist exploitation of the landscape in Podhale. While describing these two models, I will focus on the problem of rapid tourist development and its impact on ecology and the local environment (air and water pollution, devastation of the landscape by tourist infrastructure – hotels, pensions). I will also take under consideration Górale attitudes towards these changes and challenges: how to mesh/bring together tourist development, which is the main source of their incomes, and environmental protection. These problems could be expressed by statements of some Górale: “We devastated our land”; “I feel out of place in my homeland”; “I love my region, but now it is not the place I wanted to live”. Can every increasing tourism development be ecologically sustainable? What options does this leave to Górale children who may want to work with the beautiful land in the Carpathians?

Keywords: Tourist, Górale, Tatra, Podhale, Pastoral

Holeksa, J., Jaloviar, P., Kucbel, S., Saniga, M., Svoboda, M., Szewczyk, J., ... Żywiec, M. (2017). Models of disturbance driven dynamics in the West Carpathian spruce forests. *Forest Ecology and Management*, 388, 79-89.

Comaroff J. and J. (2009) *Ethnicity, INC*, Chicago, University of Chicago Press.

Ekströmer M., (1987). Ethnicity as culture: Some examples from the Górale-society in Southern Poland, in: *Zeszyty Naukowe Uniwersytetu Jagiellońskiego, Prace etnograficzne*, 23, 7-29.

Tokarczyk N. (2018). Challenges for the Conservation of semi-natural grasslands in Mountainous National Parks – case studies from the Polish Carpathians, in: *Carpathian Journal of Earth and Environmental Sciences*, vol. 13, No. 1, 187-198.

Zaręba D. (2019). *Ekoturystyka*, Warszawa, PWN.

Between space and view: Inhabiting a landscape in the Bieszczady Mountains

the session title: "Scientists and Humanists working together to propose new (and old) approaches to ecology in the Carpathians", lead convenor: professor Tim Cooley

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This presentation will be devoted to the problem of constructing landscapes on the example of a Carpathian region, which in the common imagination is strongly grounded as a series of views. The theoretical findings of landscape anthropologists and different modes of constructing local landscapes will be shown based on two general perspectives: guest/outsider and inhabitant/insider. The first is also the

perspective of the ethnographer who looks at “views,” but also perceives the agency of objects/things that participate in the production of the landscape. The construction of the Bieszczady landscapes takes place through things and objects, by shaping places and by using references and objects from the past. The relationship of inhabitants with the environment, appropriate for the second perspective, will be illustrated by several aspects of this relationship, captured in the field.

Keywords: landscape/view, objects/things agency, Bieszczady Mountains, insider/outsider perspectives, anthropology

Ingold Tim 1993, The temporality of the landscape, „World Archaeology”, Vol. 25, Issue 2, s. 152-174.

Smyrski Łukasz 2018, Między władzą spojrzenia a praktyką. Antropologia krajobrazu, Oficyna Naukowa, Warszawa.

Tilley Christopher, Cameron-Daum Kate 2017, An Anthropology Of Landscape: The Extraordinary In The Ordinary, UCL Press, London.

Conservation and valorisation of the Carpathians landscape from the environment legislation point of view. Case study

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Sustainable development of a territory implies a thorough analysis of the landscape. The essential landscape's quality perceived by the society refers to its aesthetic function. For this reason we have chosen to analyse the mountains from the central part of the Eastern Carpathians. The overall quality of the landscape in this area indicates a rational and balanced use of the natural potential, due to the early interest for the protection and conservation of the natural environment. The diachronic analysis of the Carpathian landscapes shows a relatively slow recent evolution, following the implementation of the environmental legislation. The first law for nature protection was decreed in 1930, based on which the forest from the Hășmașul Mare massif was preserved since 1938. Later, other natural reserves have been set up, therefore the limits of two national parks (Ceahlău and Cheile Bicazului–Hășmaș) were drawn in 1990 and large areas of the considered territory have been included. These protected areas are considered natural parks in the IUNC list, yielding an inconsistency between the Romanian legislation and the international classifications. Subsequent regulations propose various modifications regarding the structure of the protected areas. Since 2003 both natural areas mentioned are classified as national parks, the internal zoning is regulated, the strategies for the development of ecotourism are designed and the administrative structures established. The transposition of the EU directives into the national legislation since 2007 has led to the management plans of the two national parks (Ceahlău, 2015, Bicz Gorges - Hășmaș, 2016). The reduced human pressure from the central part of the Eastern Carpathians, highlight in the composition of the landscape picture, justifies the conservation of the landscape by the mentioned law regulation. The current anthropic exploitation, mainly silvo-pastoral, together with an eco-touristic exploitation of the

territory would allow, still, a natural evolution of the landscape without major imbalances.

Keywords: landscapes, conservation, protected areas, national park

Bastian, O., Krönert, R., Lipsky, Z. (2006) – Landscape diagnosis on different space and time scales – a challenge for landscape planning, *Landscape Ecology*, Springer.

Dincă, I. (2005) – Peisajele geografice ale Terrei. Teoria peisajului, Ed. Univ. din Oradea.

Forman, R., T. (1999) – The ecology of landscapes and regions, University Press, Cambridge.

Ielenicz, M. (1995) – Contribuții la teoria peisajului, Terra, an XXXVI-XXXVII.

Marin, I. (coord.) (2002) – Gestiunea durabilă a peisajelor geografice prin organizare și amenajare teritorială, Ed. ArsDocendi, București.

Effect of management interventions after windstorm on ectomycorrhizal fungal community

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In relation to ongoing climate change, forests are expected to face significant disturbances more frequently than in the past. Appropriate management is intended to facilitate forest regeneration. Ectomycorrhizal (ECM) fungi, as symbionts of most tree species in European temperate forests, probably play an important role in forest regeneration after large disturbances. Understanding their role is important for developing strategies to effectively restore forests. Reaction of ECM fungi to different disturbances and management interventions was studied in mountain spruce forest affected by a severe windstorm in the Tatra National Park (Slovakia). We found out that proportion of ECM fungi in soil decreased with increased intensity of disturbances and subsequent management interventions. The ECM species composition in the site left for natural succession was more similar to the mature forest than in the site where timber was harvested. These effects were less pronounced in the composition of ECM fungi on spruce seedlings, probably because seedlings host only a specific subset of ECM fungi present in the site. The potential of regenerating tree species (Norway spruce, European larch, and silver birch) to form mycorrhizal networks was not significantly affected by post-disturbance management 15 years after the windstorm. In both, managed and unmanaged, sites

dominated five ECM fungi and the total numbers of ECM species did not differ significantly. On the other hand, their composition was affected in spruce and larch. These changes can be explained by the persistence of the original ECM fungal assembly on seedlings and in soil. The impact of disturbances and management interventions is obvious, but the consequences are difficult to assess without knowledge of ecology of individual ECM symbionts.

Remote sensing for monitoring the fulfilment of vegetation functions

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The role of vegetation in the landscape and the degree of fulfilment of the corresponding ecosystem function is to a certain extent linked to the current vegetation fitness. However, this is a very variable attribute in time and space and it is difficult to mapping. Satellite and aerial images are suitable data sources that can capture the current condition of vegetation, including variability of vegetation. The condition of vegetation and the function of vegetation can be identified and also quantified by using the appropriate type of images.

The paper presents testing results of monitoring and quantification of the following ecosystem functions: above-ground biomass production, carbon sequestration, anti-erosion and water-retention effect. The study area is located in the basin of river Dřevnice, in the southeast part of the Czech Republic in the Carpathian flysch zone. The area of the basin covers 435 km². The river Dřevnice is left tributary for river Morava. In the half part of the basin is located regional city Zlín.

For the determination of selected functions, high-resolution multispectral images from the Sentinel-2 satellite have been used. A time series of images (from March to December) was prepared to capture variability during the vegetation season. Furthermore, we calculated and applied a collection of potentially suitable vegetation indices. The achieved results were compared to each other and also with expert knowledge. Based on this comparison, the collection of most suitable vegetation indices for our study and vegetation types were selected and finally, ecosystem functions have been quantified.

Keywords: Sentinel-2, Remote Sensing, Ecosystem Function, Above-Ground Biomass, Carbon sequestration

BEECH POWER: World Heritage BEECH Forests: emPOWERing and catalyzing an ecosystem-based Sustainable Development

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The integrity of untouched, intact old-growth beech forests, one of the last biodiversity strongholds in Europe, is very vulnerable. Amongst others, climate change and connected extreme weather conditions, such as intensive droughts put these forests at risk. The enhanced protection of a diversity of beech forests is the key. The 'Primeval and Ancient Beech Forests of the Carpathians and other Regions of Europe' is the largest transnational serial site on the UNESCO World Heritage list, spanning 12 countries, with 78 components in more than 40 protected areas. Therefore, from the start, this nomination represents an unprecedented level of international cooperation and is the most challenging and complex site to manage.

Single components of the World Heritage site face various local and national challenges, that can only be solved through transnational solutions. Buffer zones, ensuring to minimize outside impacts, are managed differently across single beech forests, visitor numbers are rising, and there is a clear shortage of proper management resources in the protected areas. Therefore, involved practitioners, public authorities, scientists and civil societies in Germany, Austria, Slovakia, Slovenia and Croatia joined efforts under the BEECH POWER project to develop adequate strategies to increase the management quality and effectiveness.

The presentation will introduce the activities of BEECH POWER, aiming at increasing local participation in protected area management and supporting practitioners in the management of the surrounding landscapes to ensure the conservation of the ecosystem functionality of World Heritage beech forests.

By positively affecting the perception of the natural and connected cultural values of old-growth beech forests and by creating tools that support the protection of their integrity, we strive to enhance the protection of the last fragmented remnants of this globally significant forest ecosystem – even beyond the World Heritage property.

Keywords: European beech forests, old-growth forests, UNESCO, sustainable development, human-environment interactions

Soil biological activity changes as a result of windthrow in the Javorová Valley (the High Tatra Range)

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Damage to forests caused by strong winds is a natural phenomenon shaping forest ecosystems in the Tatra Range, although the planting of spruce and climate change have contributed to the frequency of windthrow in the last few decades. Windthrow areas trigger changes in the entire ecosystem by affecting the circulation of chemical elements. The research focuses on the dynamics of the biological processes related to carbon and nitrogen cycle in windthrow soils. The research were carried out in the Javorová Valley in the High Tatra Range, where windrows have occurred in 2016 and 2018, three years and a half year after the windfall events. Overall soil respiration, activity of soil enzymes responsible for decomposition of carbon substrates, the rate of nitrogen mineralization and the potential for nitrification in the windthrown and forest soils were measured. The results showed greater differences between abovementioned soil features as a result of windthrow in organic (litter) horizons, than in humus horizons. In the soils of half-year old windthrow, a slight decrease of β -D-celobiosidase and xylanase activity occurred, but in three-years old windthrown the activity of the enzymes reached the rate occurred in forest soils (β -D-celobiosidase, xylanase) or exceeded it (β -glucosidase, N-acetylo- β -D-glucosaminidase). Both nitrogen mineralization and nitrification potential were higher in the soils of a 3-year-old windthrow relative to forest soil. Differences in biological activity in organic horizons occurred independently on small differences in soil chemistry, while in humus horizons they are correlated to soil chemical and physical properties. Thus, we presume that the most important reasons for change in soil microbial activity occurred in soil organic horizons are changes in soil temperature or temporary food deficiency in the rhizosphere. We expect that changes in physical and chemical soil properties need several years, but differences in soil biological processes may affect soil chemical properties in the future.

Keywords: soil biological activity, soil carbon, soil nitrogen, Tatra Mts., windthrow

Scientific monitoring of immediate and long-term effects of river restoration projects in the Polish Carpathians

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Relatively short time that passed since the onset of river restoration activities worldwide and a scarcity of monitored restoration projects cause that scientific evidence of changes in restored rivers is still meagre, particularly with respect to innovative restoration techniques and long-term effects of restoration activities. Restoration projects realized in the first half of the 2010s in three Polish Carpathian watercourses resulted in establishing of an erodible corridor in reaches of the Biała and the Raba rivers and installation of block ramps in the deeply incised channel of Krzczonówka Stream downstream of a lowered check dam. Environmental monitoring was conducted in the initial and final phases of the restoration projects and is to be repeated 5 years after their completion. This contribution (i) presents the area of the restoration projects, (ii) informs on their objectives and implementation, (iii) outlines the methodology of the environmental monitoring and of the analysis of immediate and long-term effectiveness of the projects in improving the ecological state of the watercourses and reducing flood hazard, and (iv) overviews results obtained during the initial phase of the monitoring. The analysis of the monitoring data will increase knowledge on effects of the innovative, cost-effective restoration measures that could be widely used in the Carpathian context, and thus will be useful for changes in the management of degraded mountain rivers.

Keywords: *River restoration, Hydromorphological quality, Ecological river state, Flood hazard, Mountain river*

Endosymbionts of threatened thick shelled river mussel *Unio crassus* Philipsson, 1788 in Carpathians

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Molluscs, including Unionidae mussels, play an important role in freshwater ecosystems. As filter feeding animals, they take part in water purification. They are also crucial nodes of the ecological network, in which species are connected by pairwise interactions. The existence of unionid mussels depends on the presence of a specific fish species because their larva (glochidium) can transform only while it is encysted on the fish. On the other hand, the mussels are hosts of many species of endosymbionts (Brian & Aldridge, 2019). Among them parasites showed negative effects on the mussel health and fitness, e.g. complete castration by the larvae of digenean trematodes. Infestation with parasites leads to mussel diseases and can contribute to a weakening of the population of endangered species of bivalves and undermine the effects of costly conservation programs, such as the species restitution and captive breeding.

Unio crassus is a freshwater mussel endangered in the Carpathians (Carpathian Red List) and protected in the EU (Annexes II and IV of the Habitats Directive). The species is an object of the conservation activities but until now its parasitofauna was remaining almost unexplored. We investigated parasites occurring in populations of *U. crassus* inhabiting basins of Carpathian tributaries of the Vistula: San and Dunajec rivers. These populations harboured totally 8 endosymbionts taxa: three taxons of Ciliata - *Conchophthirus* sp., *Trichodina* sp. and *Tetrahymaena* sp., as well as castrating trematode *Rhipidocotyle campanula* (Digenea), *Chaetogaster limnaei* (Oligochaeta), *Glyptotendipes* sp. (Chironomidae), watermites *Unionicola* sp. (Hydracarina), and fish - bitterling *Rhodeus amarus*.

Prevalence *R. amarus*, *R. campanula*, *C. limnaei*, *Glyptotendipes* sp. and *Unionicola* sp. was low - these endosymbionts were found relatively rarely in *U. crassus* compared to other species of Unionidae occurring in Poland. However, all ciliate species are quite common in studied populations.

Keywords: *endangered species, endosymbiont, parasite, unionid, host species.*

Brian, J., & Aldridge, D. (2019). Endosymbionts: An overlooked threat in the conservation of freshwater mussels?. *Biological Conservation*, 237, 155-165.
<https://doi.org/10.1016/j.biocon.2019.06.037>.

Patterns of beaver (re)colonization of the Orava-NowyTarg Basin, Polish Carpathians

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Beaver recolonization of watercourses in the Orawa-Nowy Targ Basin has progressed at an unprecedented rates over the last decade, and results of beaver activity are now pronounced across the basin. The Orava-Nowy Targ Basin seems particularly favourable for beavers as its unique combination of physiogeographic conditions (topography, geology and hydrology) and land use provide ample space for colonization, especially along wide watercourses with young riparian forests and relatively little human presence. Beaver colonies are now present along the entire spectrum of the basin's unusually diverse fluvial environments – from semi-natural braided river sections, peat bog streams and ditches, to mill races and channelized river reaches. In wide and dynamic sections of the largest rivers, beavers now occupy and transform the wide riparian areas and dam low-flow channels, as the dynamic nature of the main channels precludes persistence of beaver dams and gravelly substrate limits burrowing but presence of in-channel islands still offers secluded forage areas. In relatively narrow channels underlain by loam deposits burrowing dominates, beaver dams are frequent and relatively high, dramatically changing water levels and inundation of valley floors and locally impacting erosion patterns in meandering streams. Beaver colonization progresses also along river sections severely modified by engineering works: beavers were observed to commonly utilize man-made structures as foundation for dams and ponds and excavate tunnels between river bank burrows and the main channel. In all cases, beaver activity seems to increase the variability of habitats and possibly counteracts the negative impacts of human modification, such as incision and loss of lateral connectivity of watercourses. However, the environmental effects of considerable change to riparian vegetation due to beaver foraging and construction activity may vary.

Chestnut groves as a habitats for threatened and rare plant species – case study of Nagymaros

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Chestnut (*Castanea sativa*) groves, or what have remained of them, around Nagymaros area in Hungary are a major nature conservation value on account of their natural and landscape features as well as cultural history importance. The various types of chestnut populations that have evolved in response to different exposures with different specific micro climates, form habitats for varied and rich wildlife. The aim of this contribution is to present on the case study of Nagymaros area that chestnut groves create diverse habitats for different plant species as nearly two hundred plant species identified so far in chestnut forests are valuable medicinal herbs and as many as 17 protected plant species have been found so far. One can marvel at the *Orchis purpurea* or the fragrant yellow flowers of *Erysimum odoratum*, a typical East European species without even an English name. Even plants typical of beech coppices are to be found here, including *Cephalanthera longifolia*, *Cephalanthera damasonium* and *Cephalanthera rubra*, a plant with particularly eye-catching flowers. Another orchid species *Platanthera bifolia* also has its home in the chestnut forest. *Helleborus purpurascens* appears in patches among chestnut trees. Of the species preferring deciduous forests mention must be made of *Iris graminea*, *Epipactis helleborine* and *Neottia nidus-avis*. Of typical meadow species *Clematis integrifolia*, which prefers wet meadows, *Dianthus deltoides* as well *Potentilla rupestris* species of hilly meadows are also encountered in chestnut groves. Chestnut groves are special cultural habitats on account of their rich flora as well, being parts of landscape, natural and cultural history heritage.

Posters

Long-Term Development Trend of the Historical Cultural landscape of the UNESCO Monument: Vlkolínec (Slovakia)

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

Keywords: Vlkolínec; UNESCO; Slovakia; historical structures; land use changes

This work was supported by the Scientific Agency VEGA 2/0077/21 "Integration of supply of selected ecosystem services for societal demand in terms of developing sustainable forms of tourism" and under the Contract No. APVV-18-0185.

Water Reservoirs in the Paríž Stream Catchment

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In the Paríž stream catchment located in the south part of Slovakia, we selected six water reservoirs and one water area near the Ramsar locality called Parížske močiare. We were interested in near reservoir settlements Jásová, Dubník, Rúbaň, Nová Vieska, Ľubá and Gbelce. Since 2017, we periodically monitored water quality, water levels and management regime of these reservoirs and of nearby area. We measured basic physical and chemical parameter, such as temperature, conductivity, TDS, ODO, pH, ORP, fDOM, turbidity and content of chlorophyll a. Location of the reservoirs in intensively used agricultural landscape makes them an ideal source for irrigation, which causes in summer months significant drops in water levels and contents of dissolved oxygen and mass development of algae, cyanobacteria and macrophytes.

In the period of measurement water pH was neutral to alkaline and ranged between 7,12 to 9,47. Conductivity was between 268,80 to 1591,80 $\mu\text{S}/\text{cm}$, TDS was between 296,50 to 1008,25 mg/L and salinity was between 0,23 to 0,78 psu. Turbidity ranged from 1,94 to 120,25 FNU and fDOM ranged from 12,02 to 81,19 RFU. Concentration of dissolved oxygen in 50 cm depth varied between 0,03 to 27,82 mg/L, depending on locality a season. Recorded concentrations for chlorophyll a ranged from 0,12 to 102,50 $\mu\text{g}/\text{L}$.

The overall rural character of municipalities has a major influence on their structure and land use in the cadastres. The business structure is focused on agriculture and agricultural services, what is related to appropriate natural and climatic conditions of the territory. A negative element that affects the quality of life and the water quality is the absent public sewer system with water treatment plants. The area is rich in biocultural elements. The settlements have conditions for development of tourism, especially agrotourism and cycling tourism. This is also linked to the development of local wine production in the last three decades.

Keywords: water quality, agricultural landscape, biocultural elements

This work was supported by the Vega project 2/0078/18 Research of biocultural values of landscape.

Negative effects of road traffic on vertebrate species – A literature review from Hungary

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Transportation is one of the most important pillars of economy and is a central part of our everyday life society. In the last decades, the road network and the number of vehicles increased considerably all around the world. These effects put a serious pressure on the wildlife and the human-wildlife conflicts including animal-vehicle collisions are major problems nowadays. In this literature review we collected the related publications from Hungary, in order to identify the negative effects of road traffic on the vertebrates. We found 36 articles related to animal-vehicle collision, in which 133 roadkilled vertebrate species were listed by the authors. The nature conservation damage caused by the roadkills exceeded one billion Hungarian forint in the case of the vertebrate fauna in Hungary.

Keywords: animal-vehicle collision, roadkill, nature conservation damage, human-wildlife conflict, habitat fragmentation

Mapping and assessment of recreation as a cultural ecosystem service

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The Hungarian National Ecosystem Service Mapping and Assessment project (MAES-HU, 2016-2021) coordinated by the Ministry of Agriculture is a science-policy interface to detect main ecosystem services (ESs) in Hungary. Twelve ESs were selected for mapping and assessment including 3 provisioning, 7 regulating, and 2 cultural services. During the investigation the cascade model was applied as a conceptual framework, and four cascade levels were distinguished arching from ecosystems to society (Haines-Young & Potschin 2018): 1) condition of ecosystems, 2) capacity of ecosystems to provide ESs, 3) actual use of ESs, 4) benefits for society through ESs. Our aim now is to give an overview about results related to recreation as a cultural ecosystem service. During the prioritisation process, hiking was selected as a nature-close recreation type. For quantitative assessment and mapping we applied a combination of expert-based assessment and biophysical models. Several indicators were chosen to determine each cascade level. The condition and capacity of ecosystems and their services we were able to assess on a national scale. Due to the lack of spatial data, the level of actual use was assessed in sample areas, and mapping was not carried out. The last step in the project was to link human well-being to the first three stages. We hope our results will show the connection between ecosystems and society, and help lead interdisciplinary discussion between scientists and actors in many policy sectors.

Keywords: cultural ecosystem services, recreation, hiking, mapping and assessment, Hungary

Haines-Young, R., Potschin, M. (2010). The links between biodiversity, ecosystem services and human well-being. In: Raffaelli, D.G., Frid, C.L.J. (Eds.), *Ecosystem Ecology: A New Synthesis*. Cambridge University Press, Cambridge, UK.

The connection between environmental predictors and regeneration capacity of sandy habitats in Hungary

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European temperate grasslands are threatened due to the intensification of agricultural practices, the abandonment of traditional grazing and the use of non-native species in forest management. Understanding the factors that influence the regeneration capacity – an indicator of healthy ecosystems – can facilitate the preservation as well as restoration of these habitats. We investigated the regeneration capacity of Pannonian sandy habitats at national scale: (i.) Open sand steppes (*Festucetum vaginatea*), (ii.) Closed sand steppes (*Astragalo-Festucetum rupicolae*), (iii.) Poplar-juniper sand dune forests and thickets (*Junipero-Populetum albae*). We used the Hungarian Vegetation Mapping database (MÉTA - Horváth et al. 2008) that includes local estimates of regeneration capacity of semi-natural habitats based on expert judgments after local vegetation mapping. We have selected sixteen environmental predictors that could possibly influence regeneration, including proxies for habitat naturalness (MÉTA), landscape context (Corine Land Cover data) and abiotic factors used as predictors in Multiple Potential Natural Vegetation models (Somodi et al. 2017).

Using the decision tree method, the local regeneration of sandy habitats is primarily determined by naturalness, supposedly providing a sufficient source of propagules. Higher temperature seasonality is the second most important factor. At the third level lower groundwater level favors, whereas the presence of artificial surfaces hinders regeneration. Regeneration of sandy habitats is also possible on neighbouring areas and in abandoned fields. The regeneration is primarily affected by the sand content of the soil. Higher habitat naturalness or total local habitat area promotes regeneration on the second place. The presence of artificial surfaces hinders regeneration, but agricultural areas represent a potential for regeneration after abandonment.

Keywords: regeneration capacity, temperate grassland, sandy habitat

Horváth F., Molnár Zs., Bölöni J., Pataki Zs., Polgár L., Révész A., Oláh K., Krasser D., Illyés E. (2008). Fact sheet of the MÉTA Database 1.2. *Acta Botanica Hungarica* 50 (Suppl.) pp. 11-34.

Somodi I, Molnár Z, Czúcz B, Bede-Fazekas Á, Bölöni J, Pásztor L, ... Zimmermann, N. E. (2017). Implementation and application of multiple potential natural vegetation models—a case study of Hungary. *Journal of Vegetation Science*, 28, 1260–1269. <https://doi.org/10.1111/jvs.12564>

Green for Care - Stakeholder Analysis in Romania

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The Green4C (GreenForCare) project, co-funded by the Erasmus+ Programme by the European Union, is a three-year project that aims at increasing Europe's innovation capacity among universities and businesses to promote nature-based solutions for health, well-being and social inclusion. The project was conceived with the overarching aim of integrating two business and scientific sectors that are currently disconnected: the health and social inclusion sectors and the sectors related to the use of natural resources in both rural and urban areas. To support successful integration of business and scientific sectors, Green4C is proposing the development of four innovative thematic sectors: Forest-based care, Social agriculture, Urban green care and Green care tourism.

The objectives of the study were to conduct a Stakeholder Analysis to identify, analyze and create an initial database of stakeholders relevant for Green4C project and to identify beneficiary training needs in social innovation and entrepreneurship. The contents of the study thus focus mainly on two types of assessment: stakeholder analysis and beneficiary training needs assessment. The stakeholder analysis was carried out to identify all possible key factors that could be interested and targeted within the project, from and what sectors they operate in. These include targeted MSc and PhD courses, Green Care (and associated topics) research groups, business sectors and networks, alliances, initiatives.

Green4C offers the opportunity to develop new and innovative training for emerging and future Green Care professionals. The project aims to complement a rich and varied offer in training already available from the university to the professional level integrating a set of four different thematic sectors through the development of new business models. As such, the project brings together a varied set of scientific interdisciplinary knowledge with entrepreneurial skills on the topic of nature-based solutions to health, wellbeing and social inclusion.

Key words: Social inclusion, Forest-based care, Social agriculture, Urban green care and Green care tourism.

The effects of road crossings on stream macroinvertebrate diversity

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Linear infrastructure such as roads, railway lines, canals and pipelines are among the most widespread manifestations of human activity. Despite the fact that roads can

promote diversified societal and economic benefits, they can also generate high environmental costs. Although it is well known that roads and associated crossings of roads and streams (bridges and culverts) can modify and degrade the natural flow and biodiversity of streams, the subject of whether or how the intersection of roads and streams influence the diversity of stream macroinvertebrates is under-researched. To fill this gap in our knowledge, we collected stream macroinvertebrates from road crossings (bridges and culverts) and compared their diversity with upstream and downstream sections. A kick and sweep sampling technique was used to collect macroinvertebrates using a hand net (500 µm mesh). At each section (upstream, road crossings, downstream) we took 3 replicate three-minute samples covering most microhabitats present in the section. Stream sections were characterized by nine visually estimated environmental variables considering water depth, current velocity and substrate composition. Water chemistry parameters were also measured. We found that road crossings had negative effects on the richness and abundance of native macroinvertebrates, as well as on the number of protected taxa. Our results showed also that alien individuals were more abundant at road crossings. These findings support the assumption that road crossings contribute to the spread of alien species. The assessment of environmental variables indicated that road crossings caused habitat modifications, and based on these it can be assumed that habitat modifications and associated phenomena (e.g. pollutants and storm events) were the major drivers of the observed patterns in biodiversity. Our results fill a knowledge gap and contribute to the deeper understanding of the effect of road crossings on freshwater biodiversity.

Keywords: road crossings, diversity decline, freshwater biodiversity, human impact, macroinvertebrates

This work was supported by the GINOP 2.3.3-15-2016-00019 and OTKA K128496 grants.

Lessons learned for resilience of tourism industry in the Romanian Carpathians during Sars-Cov-2 Pandemic

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Sars-Cov-2 Pandemic affected the society, economy as whole and at different levels. The study identifies the dynamics of resilience of the tourism industry in the Romanian Carpathians during the pandemic, using quantitative methods based on modeling specific indicators of the last two years and qualitative methods through interviews with several successful representatives who managed to overcome barriers to restrictions. In general, the tourist infrastructure, given by the accommodation structures, registered fluctuations, in the sense of decreasing it in the destinations affected by the large number of Covid 19 cases while on the whole, it increased both in hotels, pensions, villas but especially in agro-tourist structures and caravan parks. The increases were specific in the mountain areas with ski facilities, one of them being in Hunedoara county, Straja. Tourist arrivals have halved in the Carpathian area, although they were slightly higher than in Romania as a whole,

sliding locally from one-third to two-thirds. The specific seasonality of mountain tourism has been replaced by outbreaks given by the relaxation of pandemic measures, for several periods in the summer months and then in January and February. The winners were those who benefited from large spaces for outdoor tourism, which focused on accommodation facilities with everything that comes from the tourist's residence (caravans), amid low incidents of Covid 19, all doubled by a strict and widely publicized management.

Keywords: Resilience, Sars-Cov-2 Pandemic, tourism, qualitative analysis, Romanian Carpathians

Crețan R., Light D., (2020). COVID-19 in Romania: transnational labour, geopolitics, and the Roma 'outsiders', *Eurasian Geography and Economics*, On line at: <https://doi.org/10.1080/15387216.2020.1780929>.

Huynh T.L.D., (2020). The COVID-19 risk perception: a survey on socioeconomics and media attention, *Economics Bulletin*, 40, 758-764.

Matei, E., Ilovan, O. R., Sandu, Ch. B., Dumitrache, L., Istrate, M., Jucu, I.S., Gavrilidis A. A. (2021). Early Covid-19 pandemic impacts on society and environment in Romania. Perception among population with higher education, *Environmental Engineering and Management Journal*, Vol 20(2), 319-330.

Perriam J., Birkbak A., Freeman A., (2020). Digital methods in a post-API environment, *International Journal of Social Research Methodology*, 23, 277-290.

Countertrending local knowledge erosion: persistence of traditional cattle healing practices in the Bukovinian Carpathians

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Livestock husbandry plays a key role in rural communities worldwide, especially among those living in harsh environments where agriculture cannot alone support local livelihoods throughout the year (van Zanten et al. 2016). In spite of the relevance of ethnoveterinary knowledge among these communities, this knowledge is rapidly vanishing in several European regions (e.g. Gonzalez et al. 2020), including Eastern Europe (e.g. Kalle and Kass 2020).

Therefore, we aimed to document the plant-based ethnoveterinary knowledge of Romanians and Hutsuls living in Bukovina, and to analyze possible drivers of ethnoveterinary knowledge persistence/erosion in the Carpathians. The 60 interviews carried out in the summers of 2018 and 2019 revealed that among the seven species encompassed by ethnoveterinary practices (including pig, cow, sheep, bees, turkey, goose, chicken), cattle is the most represented. Indeed, we documented the use of

22 wild plants and 12 cultivated plants to treat cattle disorders. Most of the reported remedies address problems of the digestive system, particularly diarrhea (for which *Rumex* spp. was the most mentioned), and of the reproductive system, especially as postpartum supplements (e.g. *Linum usitatissimum*). Possible reasons for such persistence include the geographical remoteness of the Bukovinian Carpathians, and the deep cultural and economic significance of cattle in the area.

Our results indicate that Hutsuls and Romanians living in Bukovina still retain considerable knowledge regarding traditional remedies for treating cattle disorders compared to other Eastern European countries where cattle husbandry almost disappeared (e.g. Kalle and Kaas 2020 in Estonia; Sõukand et al. 2017 in Belarus). Further studies should address contexts of knowledge persistence or recovery to identify the variables underpinning this persistence and thus to design programs of local development that include these knowledge and practices.

Keywords: *Ethnoveterinary, Ethnobiology, Local Ecological Knowledge, Minorities, Mountains.*

González, J. A., Verde, A., & Pardo-de-Santayana, M. (2020). The Use of Plants for Animal Health Care in the Spanish Inventory of Traditional Knowledge. In *Ethnoveterinary Medicine* (pp. 391-426). Springer, Cham.

Kalle, R., & Kass, M. (2020). Local Practice of Cattle Farming and Ethnoveterinary Medicine in Estonia: Case Study of Saaremaa and Muhumaa. In *Ethnoveterinary Medicine* (pp. 345-374). Springer, Cham.

Sõukand, R., Hrynevich, Y., Prakofjewa, J., Valodzina, T., Vasilyeva, I., Paciupa, J., ... & Kalle, R. (2017). Use of cultivated plants and non-plant remedies for human and animal home-medication in Liubań district, Belarus. *Journal of ethnobiology and ethnomedicine*, 13(1), 1-31.

van Veen Schillhorn, T. W. (2004). Eastern Europe and the former Union of Soviet Socialist Republics: animal health systems in transition. *Revue scientifique et technique (International Office of Epizootics)*, 23(1), 305-18.

van Zanten, H. H., Mollenhorst, H., Klootwijk, C. W., van Middelaar, C. E., & de Boer, I. J. (2016). Global food supply: land use efficiency of livestock systems. *The International Journal of Life Cycle Assessment*, 21(5), 747-758.

Social innovation and Biodiversity Conservation through Participatory Management of protected areas in Eastern Slovakia: Reconciling nature conservation with local development

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This paper presents transdisciplinary “action research” approach integrating stakeholder participation, local development, and management of traditional cultural landscape under protection in Slovakia. The research was carried out in the context of efforts by the State Nature Conservancy of the Slovak Republic to develop and improve its methodology for participatory management of protected landscapes in the Carpathians.

As part of the transdisciplinary research, a joint team of Slovak and Swiss researchers carried out baseline assessments of selected protected areas concerning their ecology, society, and economy. The specific research approach adapted to the transition context of Slovakia also included facilitation of participatory processes with stakeholders in selected large protected areas to negotiate ways of linking nature and landscape conservation with economic development.

Moreover, a joint Slovak-Swiss financing mechanism i.e. Seed Money Actions (SMAs) enabled Slovak project partners to implement small innovative projects related to cultural landscapes proposed by local stakeholders. These projects considered as social innovations expected to bring tangible and lasting benefits to local stakeholders, mostly farmers, within and around protected areas. SMAs includes landscape conservation efforts such as mowing of pastures, as well as projects to improve tourism infrastructure or other actions proposed by local mayors or stakeholder groups. Our research shows that such initiatives could be new fruitful form of cooperation between managers of protected areas and local populations, as it may ultimately lead to a higher acceptance of landscape conservation among locals while offering Slovak mountain farmers more tangible benefits from protected areas in a close vicinity.

Key words: Participatory management of cultural landscapes; protected areas and local people; Seed Money Actions (SMAs); scaling-up innovative approaches on landscape protection, Slovakia, Carpathian Convention regions.

Meessen H., Juraj Švajda, Thomas Kohler, Vladimíra Fabriciusová, Dobromil Galvánek, Miroslav Buraľ, Marcela Káčerová et Ján Kadlečík. 2015. Protected Areas in the Slovak Carpathians as a Contested Resource Between Metropolitan and Mountain Stakeholders », *Journal of Alpine Research* | *Revue de géographie alpine* [En ligne], 103-3.

URL : <http://rga.revues.org/3055>, DOI :10.4000/rga.3055

Meessen H., Maselli D., Haslinger A. 2003. Protected Areas in the Former Soviet Union – The Transition to Participation, *Mountain Research and Development* 23(3): 295-297.

Meessen H. 1992.– Anspruch und Wirklichkeit von Naturschutz und Landschaftspflege.

The great landed property in Galicia in the middle of 19th century: its legacy and influence on contemporary forest areas.

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The great landed property in the Austrian Galicia (approx. 78 000 km², currently located in Poland and Ukraine) covered about 25% of the western Galicia and about 75% of eastern Galicia between the middle of the 19th century and at the beginning of 20th century. A single great landed property (usually hundreds or thousands of square kilometers) was typically owned by noble families, government, funds, church, with forests being an important land use form. The mid-19th century land tenure

system was dramatically altered following political changes of the World War 2, with part of the land (Poland) or almost entire land changing the legal ownership after 1945. The aim of this paper is to find out potential land use legacies of the former structure of land tenure, in particular how historical structures of the great landed property influence the distribution of forest areas. The study uses census data of great landowners and structures of the great landed property for 5933 cadastral communes, acquired from historical maps in scale 1:28 800 (mid-19th century) and compares them to contemporary forest cover distribution from the Global Forest Change database.

Keywords: Land-use legacies, Historical GIS, census data, historical maps

Modeling present and prospective distribution of *Phyteuma* genus in Carpathian region with machine learning techniques using open climatic and soil data

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Species distribution modeling can be effectively carried out using open data and data analysis tools with machine learning techniques. Modeling of the distribution of *Phyteuma* genus in Carpathian region has been carried out with data from GBIF database, climatic data from Worldclim database, and soil properties data from Soilgrids soil information system. Predictive modeling was based on two sets of data relating to ecological factors. Climatic data consisted of bioclimatic variables, presumably biologically meaningful and derived from the monthly temperature and rainfall values. Data on several soil properties measured at 15–30 cm depth were added to these to account for soil acidity, organic carbon stock, cation exchange capacity, and total nitrogen.

Spatial distribution modeling was accomplished with R SDMtune package that provides useful tools and convenient interface for data processing and machine-learning analysis techniques (Vignali et al., 2020). Machine learning techniques have marked advantages over more traditional statistical methods, like the ability to fit complex nonlinear relationships common in ecology.

As data available were presence-only, background data had to be simulated, with random coverage of geographic space. Four model techniques have been examined: Maxent, Random forest, Artificial neural networks, and Boosted regression trees (BRT). AUC and TSS criteria calculated for testing data with cross-validation have been applied for judging the performance of the models. BRT with a reduced set of predictor variables (7 from initial 21) appeared to fare the best. The map of estimated distribution of *Phyteuma* genus has been produced. As Worldclim database also contains prospective data based on future climate projections, these can be input to the model to get the prospective distribution of the plant taxon considering expected climate changes under different RCPs.

Keywords: species distribution modeling, boosted regression trees, Phyteuma genus, Carpathians, open geospatial data

Vignali, S., Barras, A.G., Arlettaz, R., Braunisch, V. (2020). SDMtune: An R package to tune and evaluate species distribution models. *Ecology and Evolution*, 10(20), 11488-11506.

Green infrastructure as an active tool of support to spatial stability and biodiversity of landscape

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The European Union stresses the inevitability of the continuous development and maintenance of green infrastructures and encourages activities that implement them. The intention of building green infrastructures is to stop reduction of biodiversity and help ecosystems to provide services. Location of specific protected areas and their connection to the overall network of protected territories supports the formation of territorial systems of ecological stabilities on all hierarchic levels. Plantation of biocentres, biocorridors and interacting elements with the preference given to the original vegetation species provides support to the protection of gene pool, natural and cultural/historical sources and preservation of historical landscape structures with traditional forms of husbandry. The aim of this paper is to present the methodological steps involved with the formation of green infrastructure on a super regional level. The central idea of the proposed methodology is to assess the synthesising effect of anthropic activities on landscape structure through the anthropization of the settlement environment, to generate a database of positive and negative socio-economic phenomena and to specify barrier to the possible threats to green infrastructure in the Slovak Republic (SR). A system of eco-stabilizing measures focused on the ecologically optimal landscape organization and land use will follow. Green infrastructure proposed in this way may help increase landscape diversity, landscape biodiversity and ecological stability thus contributing to the optimal functionality of the existing system of ecological stability. As an active tool, it may be also used on a local level as it is expected to discover the real need to plant green elements appropriate for each settled cadastral territory in the SR. It will be necessary to project the obtained results into spatial planning and territorial development.

Ecosystem services provided by wild plant as a basis for sustainable livelihood

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Wild plants from grasslands provide numerous ES (TEEB, 2010). However, due to land abandonment and reforestation processes, which take place currently in mountain areas, both grasslands and ES provided by them are endangered (Babai et al., 2015; Tokarczyk, 2018). The research aimed at the investigation how local people benefit from collecting wild plants. The study included also recommendations for combining sustainable livelihood based on wild plants with the conservation of grasslands. The basis for the research was the survey conducted with inhabitants of the Polish part of Pieniny Mountains (Carpathians). The results showed that 89% of the respondents collected wild plants. The most common ES were: natural medicine, direct consumption and food, whereas none of respondents declared preparation of biofuel or fertilizers. The provision of ES differs taking into account socio-demographic factors (age, education level and place of residence). Furthermore, in the case of some ES, i.e., direct consumption, food, natural medicine, cosmetic purposes, specific species have crucial meaning, whereas in the case of others, i.e., decoration, ritual purposes or forage only specific type of plants, i.e., flowers, herbs or grass, are desirable regardless specific species. Apart from that, 38% of respondents households use ES for livelihood. Most residents is involved in livestock production (33%), whereas sale of collected herbs and fruits concern only 4% of households and other types of livelihood – only individuals. In order to make the utilization of wild plants more profitable and combine it with grasslands conservation, the effort should be put to promote engagement in activities more adapted to the current economic situation (e.g., eco-tourism, selling of processed wild plants products).

Keywords: conservation, provisioning ecosystem services, survey, the Pieniny Mountains

I am grateful to Michał Jakiel for the advice concerning sample selection, Dr. Joanna Hibner for the help during field studies and Dr. Ewelina Mocior for the help during results analysis. This research was supported by the National Science Centre (2018/02/X/HS4/02962).

Babai D., Tóth A., Szentirmai I., Biró M., Máté A., Demeter L., Szépligeti M., Varga A., Molnár A., Kun R., Molnár, Z., 2015, Do conservation and agri-environmental regulations effectively support traditional small-scale farming in East-Central European cultural landscapes?, 197, *Biodiversity and Conservation*, 24, 3305–3327.

TEEB, The Economics of Ecosystems and Biodiversity, 2010, Ecological and Economic Foundations, Routledge Abingdon, UK.

Tokarczyk N., 2018, Challenges for the conservation of semi-natural grasslands in mountainous national parks – case studies from the Polish Carpathians, *Carpathian Journal of Earth and Environmental Sciences*, 13, 1, 187-198.

Cost-benefit analysis of spruce monocultures conversion: evidence from the Ukrainian Carpathians

A large forest area in Europe in the 19th century, naturally dominated by broadleaves, was reforested by Norway spruce (*Picea abies* [L.] Karst) that led to loss of vitality and resistance of forest ecosystems against destructive abiotic and biotic impacts. Spruce monocultures conversion into uneven-aged mixed stands is internationally thought as an urgent and efficient solution of the challenge posed by climate change and a former, yield-oriented forest management. Ecological, and to some extent – economic aspects of the conversion, are broadly presented in scientific literature, while the attempts of assessing this silvicultural measure in terms of benefits and losses with respect to socio-cultural ecosystem services is almost nonexistent. To understand all conversion benefits and losses and to get an insight into gains of the conversion process using a monetary dimension, a cost-benefit analysis (CBA) was applied.

CBA of spruce monocultures conversion is based on a modelling of this silviculture measure in the Ukrainian Carpathians (Pelyukh et al., 2018) by tree growth simulator SIBYLA (Fabrika & Ďurský, 2005). Nexus approach rooted in ecological economics perspective and proposed by Zahvoyska et al. (2017) was applied to evaluate the conversion benefits. Such benefits as carbon sequestration and release, soil protection and recreational value of the forest were evaluated. Calculated net present value confirms the efficiency of spruce monocultures conversion from the point of financial and social perspectives.

Accomplished CBA does not consider all conversion benefits due to lack of reliable monetary values. Integrating these values into CBA may increase the validity of the evaluation of spruce monocultures conversion efficiency, disclose the advantages of conversion for "opponents" of this process (Pelyukh et al., 2019) and thus provide forest decision-makers and society with important information on the attractiveness and necessity of the conversion process.

Keywords: forest conversion, efficiency of silviculture, ecosystem services, total economic value

Fabrika, M., Ďurský, J. (2005). Algorithms and software solution of thinning models for SIBYLA growth simulator. *Journal of Forest Science*, 51(10), 431-445.

Pelyukh, O., Fabrika, M., Kucbel, S., Valent, P., Zahvoyska, L. (2018). Modelling of secondary even-aged Norway spruce stands conversion using the tree growth simulator SIBYLA: SE "Rakhiv Forestry" case study *Bulletin of the Transilvania University of Brasov. Forestry, Wood Industry, Agricultural Food Engineering. Series II*, 11(2), 29-46.

Pelyukh, O., Zahvoyska, L., Maksymiv, L., Paletto, A. (2019). Stakeholders' interests and roles in the context of secondary Norway spruce forest conversion: Ukrainian Carpathians case study. *Bulletin of the Transilvania University of Brasov. Forestry, Wood Industry, Agricultural Food Engineering. Series II*, 12(1), 59-72.

Zahvoyska, L., Pelyukh, O., Maksymiv, L. (2017). Methodological considerations and their application for evaluation of benefits from the conversion of even-age secondary Norway spruce stands into mixed uneven-aged woodlands with a focus on the Ukrainian Carpathians. *Austrian Journal of Forest Science*, 134, 251-281.

Changes in the use of agricultural land and soil quality properties in the conditions of the submountain countryside land in the Slovak part of the Carpathians

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For the last two decades is one of the trends of land use changes in Slovakia soil sealing and gradual loss of agricultural land. They are also changing in the landscape elements. In the long run, there is a loss of agricultural land and an increase in forest land and especially built-up areas. Within agricultural land, we are seeing a significant process of land abandonment. In the period 2002-2017, the share of fallow land increased from 0.26% to 3.38%. A characteristic feature of these land use changes is the process of extensification of agricultural land. This is especially evident in areas with lower soil production capacity. These areas occur mainly in the conditions of the rural settlement of the Slovak part of the Carpathians. Land use changes represent a qualitative change in the form of land use. Arable land often turns into permanent grassland or being abandoned. They are formed by fallow land with advancing succession. This changes the nature of land use. In this paper, we focused on land use changes in the period 2002 - 2018 on the example of model areas. The time period captures changes in the conditions of accession and the first years of Slovakia's membership in the EU. The aim of the paper is to confirm the relationship between the processes of change in the use of agricultural land and selected properties of soil quality (humus horizon thickness, soil depth, soil types). We follow the hypothesis that changes in use correlate with the qualitative soil properties. The extensification process is taking place in localities with shallow soils and a soil of low thickness of the humus horizon. On the contrary, there was no change using on deep soils. The cadastral areas of Malá Lehota, Važec and Runina were selected as model areas. Malá Lehota is an area with a late onset of collectivization and the remaining individual land management in the conditions of the submountain landscape with scattered settlements. Važec is an open submountain land in basin with extensive meadows and pastures. Runina is situated in the conditions of an isolated closed Carpathian forest landscape. At present, the common features of selected areas are the predominance of forests and the low share of arable land, cattle grazing, forestry. The areas have a high potential for the development of agritourism and rural tourism.

Keywords: Land use changes, Extensification, Humus horizon thickness, Soil depth, Soil types

This paper was supported by project APVV-17-0377 Assessment of recent changes and trends in agricultural landscape of Slovakia and project KEPA No. 025UKF-4/2019 Erosion-accumulation processes as a limiting factor of agricultural landscape.

Online environment as tool to push forward the recherche: an example for landscape disservices

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The pandemic Covid-19 period has brought multiple changes in our lives. The researchers had to find resources in order to support their research. Our study is in the same situation in which we want to show that the use of online information can be a temporary solution. Our research is mainly focusing on landscape which offers services but also disservices. Recent studies have appeared that rely on landscape services (Ceașu et al., 2019). We associate wildlife-human-interactions (*WHI*) and human-wildlife-interactions (*HWI*) as part of landscape disservices. More precisely in the first category (*WHI*) we have included the interaction of the bear and wild boar with human, and in the second category we have created a database with attacked animals, killed by human (bear, deer, wild boar, black goats). For this analysis we have selected all the local newspapers but also Facebook groups. The study area is represented by the Southern and Eastern Carpathians.

Our hypothesis is that the newspapers and Facebook could provide valuable data. Preliminary data show that the most affected mammals for this type of interactions (*HWI*) are the bears followed by wild boars and deer. The main cause of these interactions are the car accidents in which a small number of animals may be saved. Regarding *WHI*, in the last five years this type of interactions have intensified. From the analyzed data we can conclude that the animals who generate the most disservices to humans are the bear and wild boar. From the identified disservices the most frequent are the attacks upon households, direct attacks humans in the settlements and the mountain trails. The main cause for *WHI* is tied up to food supply which they seek in their habitats upon which cities were built and developed (Pătru-Stupariu et al. 2020). The identified solutions in online sources for both *HWI* and *WHI* are relocation, rescue, capturing of the animals in reservations or as last resort euthanasia. To reduce these types of interactions ecological education, development and the promoting of certain attitudes and behavior that have a visible impact upon *HWI* and *WHI* is important.

Keywords: mountain data, landscape disservices, human-wildlife interactions (HWI), wildlife-human interactions (WHI)

Ceașu, S., R. A. Graves, A. K. Killian, J. C. Svenning and N. H. Carter (2019). Governing trade-offs in ecosystem services and disservices to achieve human-wildlife coexistence. *Conservation Biology* 33: 543-553. doi: 10.1111/cobi.13241.

Pătru-Stupariu I., Niță A., Mustătea M., Huzui-Stoiculescu A., Fürst Ch. (2020) Using social network methodological approach to understand human-wildlife interactions. *Land Use Policy*, 99, 105009.

Stable isotope variability in precipitation and underground drip water along an orographic transect (South Carpathians, Romania)

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Water stable isotope ratios ($\delta^{18}\text{O}$ and $\delta^2\text{H}$) are ideal tracers in the hydrological cycle, providing information about air mass history, moisture sources, or underground flow. We present here the isotopic composition of precipitation and cave drip water on the south-facing side of the Buila–Vânturarița Massif (central South Carpathians). Precipitation and dripwater samples were collected between November 2016 – May 2019 from three locations with a maximum altitude difference of ~1250 m.

We show that the temperature-dependent seasonal effect and the altitude effect have the strongest control of stable isotope variability. The local meteoric water line calculated at 570 m a.s.l. plots to the left of the global meteoric water line, showing that vapor and condensation was produced under low humidity and high evaporation. The $\delta^{18}\text{O}$ and $\delta^2\text{H}$ winter average values (–13‰; –90‰) are considerably lighter than summer values (–5.5‰; –30‰). A discrete altitude effect is given by a difference in $\delta^{18}\text{O}$ values ranging between 0.3‰ in summer to 1‰ in winter, resulting in a lapse rate lower than –0.8‰ km^{–1}.

The underground dripwater shows more depleted isotopic values and mirror the site-specific infiltration mechanisms. Short infiltration paths reflect higher ranges (1.5–2‰ in $\delta^{18}\text{O}$ and 13–23‰ in $\delta^2\text{H}$), closer to the seasonal isotopic values of precipitation. A thicker bedrock resulted in longer residence time of underground water, and more homogenous values of $\delta^{18}\text{O}$ (<1‰ in range) and $\delta^2\text{H}$ (<3‰). Outlier values could be explained as an effect of the local fractures, which favor a more rapid infiltration and provide connections between multiple recharge sources.

Keywords: Stable isotopes, Hydrology, Precipitation, Speleothems, South Carpathians.

The authors acknowledge the Commission on Speleological Heritage and administration of Buila–Vânturarița National Park for authorizing fieldwork activities. We are grateful to M. Stoica for supporting fieldwork and water sampling.

Sentiment analysis as feedback for improving sustainable management in Northern Subcarpathians of Oltenia Destination

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In the three decades after the fall of communism, Romania has moved from most modest structures serving social tourism to more competitive ones. In the same time, the marketing process was improved through the online facilities. Thus, the evaluation of tourist satisfaction, as one of the most relevant indicators of the sustainable development of a destination, becomes an advisable instrument. Therefore, the present study tries to figure out the tourist satisfaction in hotel industry based on the reviews of tourism websites for reservation in Northern Subcarpathians of Oltenia destination. Thus, the sentiments analysis of tourists was applied, using 10,975 online reviews mined from Booking, TripAdvisor and Infoturist In R program and GIS analysis. The results extracted for 248 accommodation units showed that in general satisfaction is governed by positive emotions. The key findings demonstrate that female, business travelers, small units and five stars hotels, short stays during summer have the most optimistic reviews. Spatially, the tourists accommodated nearby mountain area experienced more positively stays. The study also reveals that the platforms may include other features in order to capture better the sustainable option for tourist services.

Keywords: reviews, sustainable, Booking.com; Tripadvisor, Infoturist, sentiment analysis

Ainin, S., Feizollah, A., Anuar, N.B., Abdullah, N.A. (2020). Sentiment analyses of multilingual tweets on halal tourism. *Tourism Management Perspectives*. vol.34 DOI: 10.1016/j.tmp.2020.100658.

Cantallops, A. S., Salvi, F. (2014). New consumer behavior: A review of research on eWOM and hotels. *International Journal of Hospitality Management*, vol.36, p.41–51.

Park, E., Kang, J., Choi, D., Han, J. (2018). Understanding customers' hotel revisiting behaviour: a sentiment analysis of online feedback reviews. *Current Issues in Tourism*. vol.23(5), p.605-611, DOI: 10.1080/13683500.2018.1549025.

Xiang, Z., Schwartz, Z., Gerdes, J. H., Uysal, M. (2015). What can big data and text analytics tell us about hotel guest experience and satisfaction? *International Journal of Hospitality Management*, vol.44, p.120–130.

Workshops

Inter- and transdisciplinary mountain data in the Carpathians: Identifying user requirements and access preferences - GEO Mountains scoping workshop and survey

Conveners: Adler C., Palazzi E., Thornton J. (*Geo Mountains*)

Workshop description: GEO Mountains (formerly GEO-GNOME) is one of several partners responsible for implementing Adaptation at Altitude – a global programme funded by the Swiss Agency for Development and Cooperation (SDC).

As outlined in the GEO Mountains Implementation Plan, over the period 2020-2022, tasks are being carried out in relation to three main objectives:

1. Identifying the needs of diverse users of data and information pertaining to global mountain environments and, as far as possible, satisfying these needs by making relevant data freely discoverable, accessible, and usable;
2. Improving the monitoring and understanding of mountain processes;
3. Communicating and linking the community in order to develop reporting capacity that responds to policy needs.

Three questions are of particular interest regarding Objective 1:

1. What requirements/wishes do users of mountain data have with respect to an online database/portal through which mountain data will be searchable and made available?
2. Which organisations and institutions are major providers of relevant data?
3. What are the major gaps experienced by users with respect to the discoverability, accessibility, and usability of the datasets themselves?

This workshop would be an opportunity to learn from the relevant actors in the region, identify and complement our inventories and databases with their inputs and contributions. It will also offer an opportunity to identify collaborations and exchanges that support both GEO Mountains (or other MRI Flagship Activities) and the S4C agenda, as well as priorities in support of your community.

Given the scope of the Adaptation at Altitude programme, specific emphasis will be placed on data related to climate change drivers, processes, impacts, and adaptation in the region, but other topics and corresponding types of data and information will also remain in scope.

Workshop format: Firstly, participants will briefly be introduced to the broader aims of GEO Mountains and Adaptation at Altitude. Then the rationale behind this particular consultation will be communicated, followed by an open discussion of the questions posed. Following the event, a survey will be circulated which will enable participants to communicate and specify what their most pressing data needs are, and to learn more about their current and/or possible future applications of mountainous data, in a more structured format.

Biodiversity and connectivity of rural-urban forests: planning and sustainable land management at the peripheral edges

Convener: Diaz-Maroto I.J. (*Agroforestry Engineering Department, University of Santiago de Compostela, Spain*)

Workshop description: Rural-urban forests and their outlying edges have diverse functions, from offering people leisure opportunities, the occasion to practice different sports, to the well-being that comes from enjoying nature close to the urban environment.

These areas play an essential role in increasing green infrastructures for the sustainable development of cities. To do this, they must face a major challenge because of: i) a changing environment, ii) the need for technical means to analyze and evaluate their ecological problems, and iii) a generally positive social perception. Know-how to right planning the potential of these forests should be the focus of our research inside a scenario where urban pressure is growing.

Our goal is to generate a rational debate analyzing their socioeconomic importance as areas of particular significance for biodiversity conservation. Scientific perspective of how rural-urban forests and green spaces benefit people has increased in latest years to include social, environmental, and economic aspects. However, there is a delay in the response of the municipality policies. These ecosystems and its landscape could be thought of as green infrastructures. Research has confirmed that their benefits are optimized by long-term management, so these forests reach their maximum efficiency.

There is a full awareness about how forest resources and land use enables planning of the multifunctional use to develop economic returns. For instance, areas dedicated to other infrastructures, such as power lines, can be managed to grow products for nearby neighborhoods, from fuel wood to food. For example, in Japan, rural-urban green spaces are planned for both recreational use and areas for disaster relief services.

Workshop format: Active audience participation is required for the success and the proper development of interactive workshop. Our idea is to facilitate interaction and contribute to the development of competences. The workshop is conceived as a training workshop and also to prepare a joint publication on the proposed topic.

Forest ecosystem vulnerabilities to climate change in the Carpathian Mountain region, a participatory workshop

Conveners: Keeton W. (*University of Vermont, Burlington, VT USA*); McCallum S. (*United Nations Environment Programme, Vienna Programme Office, Austria*); Kuraś C. (*Secretariat of the Carpathian Convention, Vienna Programme Office, Austria*); Musco E. (*Eurac Research – United Nations Environment Programme – SCC, Vienna, Austria*); Egerer H. (*Secretariat of the Carpathian Convention, Vienna, Austria*)

Workshop description: In this two-hour afternoon workshop, participants from the linked morning session, members of relevant Carpathian Convention Working Groups, and any other interested attendees will brainstorm and discuss alternate designs for assessing impacts of climate change on Carpathian forests and their ecosystem services. Building on the foundational science, research, and previous assessments presented in the morning session, the participatory workshop will synthesize ideas and design options for a region-wide assessment of climate impacts and resulting risks to forest systems in the Carpathians. Recommendations developed in the workshop will inform an initiative of the Carpathian Convention to gather and assess information on climate-related impacts affecting Carpathian forest ecosystems and key risks that need to be addressed by effective adaptation, responses in line with the Decisions of the last Conference of the Parties to the Carpathian Convention.

Workshop format: Following the Science for the Carpathians recommendations, the event shall further strengthen science-policy-practice interface and cooperation between the Carpathian Convention and scientific networks, as well as facilitate transboundary and regional research. Please note that this workshop is linked to a morning organized session by same name (see separate announcement). All Forum Carpathicum attendees interested in the topic are invited and welcome to participate in the workshop. Attendees will be asked to actively engage through brainstorming exercises and dialogue.

Integrating Education for Sustainable Development into the activities of the Carpathian Convention – towards the Carpathian ESD Working Group

Conveners: Mitrofanenko T. (*Secretariat of the Carpathian Convention/BOKU university*); Zawiejska J. (*Institute of Geography, Pedagogical University, Kraków, Poland*); Kater-Wettstädt L. (*Leuphana University Lüneburg, Germany*)

Contributors: Reti M. (*Ministry of Human Capacity of Hungary*); Varga A. (*Institute of People–Environment Transaction, ELTE Eötvös Loránd University, Hungary*); Haczek B. (*Ministry of Climate, Poland*); Szuba G. (*Ministry of Climate, Poland*)

Workshop description: The workshop will bring together stakeholders and experts, who have been engaged in the previous ESD-related activities of the Carpathian Convention, as well as ESD experts who will be engaged in these activities in the future.

The workshop will be a step towards establishing an ESD Expert Network, consisting of representatives of all Carpathian Countries.

The objective of the Workshop is to collect inputs and feedback on:

- Outlining the elements of a vision and a strategy for integrating ESD into the Carpathian Convention, and for how the Convention can help the Carpathian countries implement the UNESCO ESD for 2030 framework
- Considering how Carpathian Convention activities can be linked with informal and formal education, and how can the S4C / the scientific community contribute to this - Topics to be addressed at the second Carpathian ESD Seminar (to take place in Poland in 2022) - Accompanying Carpathian ESD activities with transdisciplinary research The format of the workshop will be: virtual format.

Workshop format:

- An Introductory presentation
- Participatory facilitated discussion in break-out sessions (virtual World Café format)
- Brief presentation of group results and conclusions

The project Carpathian ESD: Strengthening the ESD network in the Carpathian Convention via science-policy-practice interface is funded by the German Federal Environment Ministry's Advisory Assistance Programme (AAP) for environmental protection in the countries of Central and Eastern Europe, the Caucasus and Central Asia and other countries neighbouring the European Union. It is supervised by the German Federal Agency for Nature Conservation and by the German Environment Agency

Becoming better science writers and science communicators for the Carpathians

Convener : Munteanu C. (*Leibniz Institute of Agricultural Development in Transition Economies (IAMO) and Humboldt Universit Berlin*)

Workshop description: Our careers and our science depend on our ability to write and communicated effectively. Well-written papers motivate further research and are more likely to have an impact on the ground in policy and management. However, science writing is not often integrated in scientific training, often leading to valuable research being poorly communicated. This workshop will present a few simple guidelines to help us write better, well-structured manuscripts that get published sooner and cited more often. The workshop will also include “hands-on” activities using examples of your own writing and/or examples from published literature.

Workshop format: This workshop is limited to 25 participants. We kindly ask you to register your participation and areas of expertise using the following link.

https://docs.google.com/forms/d/e/1FAIpQLSczt7XCy5ugLdXyaXPfbMJo481yNI__ge6plbXOzrJVL9T62g/viewform?usp=sf_link