



Recommendations to the Carpathian Convention from the Science for the Carpathians (S4C) Network

Based on the inputs of participants of the 6th FORUM CARPATICUM
“Linking the Environmental, Political and Societal Aspects for
Carpathian Sustainability”, 21-25 June 2021

Editors: Joanna Zawiejska, Tamara Mitrofanenko

S4C Science for the Carpathians

2021





Recommendations to the Carpathian Convention from the Science for the Carpathians (S4C) Network



Based on the inputs of participants of the 6th FORUM CARPATICUM
21-25 June, 2021

Editors: **Joanna Zawiejska**, S4C SSC Chair, Institute of Geography, Pedagogical University, Kraków, Poland; **Tamara Mitrofanenko**, UNEP Vienna Office, Secretariat of the Carpathian Convention, University of Natural Resources and Life Sciences, Vienna.

2021, S4C Science for the Carpathians

Forum Carpaticum 2021 was co-financed by the Governments of Czechia, Hungary, Poland and Slovakia through Visegrad Grants from International Visegrad Fund. The mission of the fund is to advance ideas for sustainable regional cooperation in Central Europe

Forum Carpaticum 2021 was supported via project *Carpathian ESD: Strengthening the ESD network in the Carpathian Convention via science-policy-practice interface*, 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.





Table of Contents

Recommendations to the Carpathian Convention	1
Annex 1.Recommendations for the S4C and research agenda for the Carpathians	11
Annex 2. Facilitating A Stronger Role for the S4C in the Carpathian Region	19

Recommendations to the Carpathian Convention

S1 – corresponds to a Conference Session and Session number, from which the recommendations are derived
W – corresponds to a Workshop

S1, W Forest ecosystem and resource vulnerabilities to climate change in the Carpathian Mountain Region

***Relevant for:**

Convention Articles:

Article 3 - Integrated approach to the land resources management
Article 7 - Sustainable agriculture and forestry

Convention Working Groups:

WG Biodiversity
WG on Sustainable Forest Management
WG on Adaptation to Climate Change

Assessment and Research

- Support the on-going assessment by the Carpathian Convention Secretariat of the risks and impacts of climate change to forest ecosystems in the Carpathian region.
 - Synthesize and review existing information, addressing goals identified by regional experts and stakeholders.
 - Downscale from European-scale assessments and up-scale/aggregate from national-scale assessment.
- Support model development and forecasting methods, including participatory processes, to:
 - Anticipate shifts in habitats and plant species composition and resulting impacts on flagship species (esp. large carnivores).
 - Anticipate future changes in dead wood dynamics (recruitment and loading; differences between managed and unmanaged stands; relationships with insect and other mortality agents, etc.) in Carpathian forests.
 - Anticipate changing/reduced carbon uptake and storage dynamics, development adaptive carbon forestry techniques accordingly.

Finance

- Increase climate adaptation financing and embed adaptation planning in all policy areas¹.

Planning and Implementation

- Enhance resilience to increasing forest disturbances (e.g. fire, wind, insects and pathogens, and drought).
 - Promote landscape diversification.
- Develop adaptation responses to climate impacts on forest growth and productivity.
- Enhance ecosystem resilience to shifts in species ranges and abundance; expand geophysical representation within the region's protected areas network. Manage for high beta diversity in habitats, stand ages and structural conditions, and seral stages at landscape scales.
- Expand the use of retention forestry practices and close-to-nature forest management. Move away from salvage logging in beetle and windthrow areas as appropriate.
- Reduce vulnerabilities to the increase in forest fires, for example through stand density management, use fire-resistance species in tree planting, and creation of fuel breaks.

¹ There is research showing that the gap between costs of adaptation and available finances is widening. See the Adaptation Gap Report by UNEP: <https://www.unep.org/resources/adaptation-gap-report-2021>

Additional Recommendations re Forestry

Assessment and Research

- Support development of novel concepts for adaptive forest management and forest policy (in order to create healthy and stable forests for the next generation in the context of climate change and its unavoidable impacts on ecosystem services).

Planning and Implementation

- Enforce existing conservation measures to secure effective protection of forests.
- Focus on protection, restoration and re-connection of habitats.
- Avoid losses of carbon stocks from existing forests.

S2 Recent and future changes of agricultural areas of Carpathians

*Relevant for:

Convention Articles:

Article 7 - Sustainable agriculture and forestry

Article 3 - Integrated approach to the land resources management

Article 12 - Environmental assessment/information system, monitoring and early warning

Article 13 - Awareness raising, education and public participation

Convention Working Group/Networks:

WG on Agriculture and Rural Development

WG on Spatial Development

WG Biodiversity

Carpathian ESD Expert Network

Assessment and Research

- Conduct assessment of changes in the rural landscape of the Carpathian region (to eliminate the uncontrollable development of urbanization at the expense of the rural landscape)
- Provide site-specific assessment and solutions (consideration of vital or declining areas individually and looking for solutions which would be beneficial for all such Carpathian areas). Collect and present good examples of successful regions as capacity building for regions and communities facing challenges

Finance

- Help modify funding schemes to tackle challenges facing the Carpathians: abandonment of rural areas; uncontrolled urbanization, unstable socio-economic factors; climate change and environmental degradation

Planning and Implementation

- Create an Atlas of Representative Biocultural Landscape Types of the Carpathian Region
- Prioritize strong protection of existing natural or semi-natural habitats (esp.) with lower regeneration capacity and facilitate restoration when needed
- Support the domestic population to work in the local agro-sector
 - Develop rural agricultural counselling programs to support the development and operations of farmer associations
 - Modernize formal agricultural education and vocational training

S3, 4, 8 Carpathian waters: From knowledge to management

*** Relevant for:**

Convention Articles:

Article 3 - Integrated approach to the land resources management
 Article 6 - Sustainable and integrated water/river basin management
 Article 7 - Sustainable agriculture and forestry
 Article 12 - Environmental assessment/information system, monitoring and early warning
 Article 12bis - Climate Change

Convention Working Groups:

WG on Biodiversity
 WG on Adaptation to Climate Change
 WG on Agriculture and Rural Development

Assessment and Research

- Support integrated efforts to map, assess, monitor and mitigate plastic pollution of Carpathian rivers
- Support monitoring and sustainable management of sediment and large wood transport

Planning and Implementation

- Facilitate integrated, adaptive land and water resource management
- Require management of mountain rivers that considers river history and interactions within entire river corridor
- Strengthen support for monitoring of restoration projects
- Consider and support ongoing projects on restoration and conservation of wetlands and peat bogs (incl. Natura 2000 areas).

S6 Scientists and humanists working together to propose new (and old) approaches to ecology in the Carpathians

***Relevant for:**

Convention Articles:

Article 7 - Sustainable agriculture and forestry
 Article 11 - Cultural heritage and traditional knowledge
 Article 13 - Awareness raising, education and public participation

Convention Working Groups/Networks

WG on Cultural Heritage and Traditional Knowledge
 WG on Agriculture and Rural Development
 WG on Biodiversity
 Carpathian ESD Expert Network

Assessment and Research

- Strengthen aspects of social sciences and exchange experiences with research in other European mountain ranges
- Map sustainable cultural practices to facilitate greater societal awareness about intangible cultural heritage to inform and support governance schemes aiming at a societal and ecological change - potential for a Carpathian Regional model?

Planning and Implementation

- Focus on local Carpathian identity, traditional knowledge, values and (in)tangible cultural heritage
- Consider local artistic practices as models of resilient ecological practices.
- Address local actors in inventories of value creation.
- Develop locally embedded transgenerational, transnational and transdisciplinary „schools” to help elaborate on questions of subsistence and adaptation

Additional Recommendations re Cultural heritage and traditional knowledge

*Relevant for:

Convention Articles:

Article 11 - Cultural heritage and traditional knowledge Article 7 - Sustainable agriculture and forestry
Article 13 - Awareness raising, education and public participation

Convention Working Groups /Networks:

WG on Cultural Heritage and Traditional Knowledge
WG on Agriculture and Rural Development
WG on Biodiversity
Carpathian ESD Expert Network

Planning and Implementation

- Consider material and immaterial cultural heritage
- Promote the identification and increased use of traditional ecological knowledge in nature conservation and sustainable land management.
- Adapt agri-environmental support schemes to consider local-regional cultural environments
 - Help adapt traditional practices to the recent socio-ecological changes
 - Include empowerment of local communities in these developments
- Designate bio-cultural refugia in the richest cultural landscapes of the region
- Help local, marketable product production
- Develop local-regional school curricula, with increasing respect towards heritage and traditional knowledge.

S7 The power of social innovation in mountain areas to steer a sustainable governance of nature

*Relevant for:

Convention Articles:

Article 11 - Cultural heritage and traditional knowledge
Article 13 - Awareness raising, education and public participation

Convention Working Groups /Networks:

WG on Cultural Heritage and Traditional Knowledge
WG on Agriculture and Rural Development
Carpathian ESD Expert Network

Assessment and Research

- Define Social Innovation (SI) in the Carpathian context, in collaboration with S4C
- Support promoting Citizen Science, adopting its principles and unifying its methodology

Planning and Implementation

- Create the Carpathian database of examples of SI and social-ecological innovations, and/or link Carpathian examples to already existing efforts, e.g. Seeds of the Good Anthropocene or local websites with “solutions”²
 - to popularize & share positive examples
 - to create a workable network between successful cases
 - to facilitate transboundary cooperation and SI diffusion
- Create tools for dissemination of scientific results for use by regional/local policy makers and other stakeholders (via policy briefs and practice guides)
- Facilitate networking of CC Secretariat with existing initiatives of:
 - European Citizen Science Association and
 - European Network of Living Labs

Finance

- Look for financial support (seed money) to enhance the emergence/growth of SI and help with its success

S9: Education for Sustainable Development -best practices of education for sustainable development in the Carpathians and other mountainous regions

*Relevant for:

Convention Articles:

Article 13 - Awareness raising, education and public participation

Convention Working Groups /Networks:

WG Biodiversity, CNPA
WG on Agriculture and Rural Development
Carpathian ESD Expert Network

Planning and Implementation

- Support better involvement of Carpathian countries in the international ESD scene.
 - Identify barriers and develop strategies for better/easier representation and visibility.
- Strengthen institutional and structural support for life-long teacher training.
- Promote systems thinking as a main component of educational curricula from early ages and throughout the entire educational cycle.
- Enhance communication and collaboration among academia, teachers and local stakeholders.
- Support exchange programs in other countries for life-long learning for all citizens, similarly to the Erasmus program for students (e.g. farmers gaining experiences elsewhere).
- Develop common topics and educational materials on SD in the Carpathians in native languages to be integrated into education systems (for example, embedding „Respect Nature” Principles in the Carpathian region, collecting and disseminating Carpathian examples of locally-based nature-inspired solutions).

² e.g. in Romania: <http://www.romaniapozitiva.ro/>

S10 Cross sectoral issues- the Carpathians valued as a living place

*Relevant for:

Convention Articles:

Article 3 - Integrated approach to the land resources management

Article 5 - Spatial planning

Article 12 - Environmental assessment/information system, monitoring and early warning

Article 13 - Awareness raising, education and public participation

Convention Working Groups/Networks:

WG on Biodiversity, CNPA

WG on Agriculture and Rural Development

WG on Sustainable Industry, Energy, Transport and Infrastructure

Carpathian ESD Expert Network

Data: Planning and Implementation

- Promote development, collection and use of data in strategic and local decision making and spatial planning, incl. cross-sectoral and trans-border dimension (harmonisation of data and management practices across national borders).
 - This requires accelerated and strategic digitalization of administration (e.g. assigning dedicated digitalization managers), as well as the development of data collection and data reporting standards.
 - Promote open data.
- Ensure harmonized, coordinated provision by national agencies of relevant thematic data on Carpathian environment and socio-economic topics.
- Support conversion of adequate (scientific) data into more operational formats applicable for decision makers, planners, local organizations and communities.

Planning and Implementation

- Facilitate improved management capacities of Carpathian protected areas.
 - Promote the Carpathian Network of Protected Areas as the framework and tool for transnational collaboration between the protected areas.
 - Harmonize biodiversity protection measures and socioeconomic strategies to facilitate transboundary cooperation.
- Solicit “grass-roots input” by promoting citizen science and education.
- Ensure proper and efficient communication with local communities about planned and implemented solution.
- Reconcile and link conservation of biological and landscape diversity to sustainable local socio-economic development.
- Develop action plans to minimise wildlife - vehicle collisions.

Finance

- Allocate funds and human resources to allow knowledge and experience exchange between Carpathian countries to promote transboundary Carpathian project.

S14 Global changes and local responses: Resilience, adaptations, innovations for the sustainable development of Carpathians tourist destinations

***Relevant for:**

Convention Articles:

Article 9 - Sustainable Tourism

Article 11 - Cultural heritage and traditional knowledge

Article 13 - Awareness raising, education and public participation

Convention Working Groups/Networks:

WG Biodiversity, CNPA

WG on Sustainable Tourism

WG on Cultural Heritage and Traditional Knowledge

WG on Agriculture and Rural Development

Carpathian ESD Expert Network

Assessment and Research

- Map tourism phenomena in a unified format for the entire Carpathian region.

Planning and Implementation

- Facilitate practical implementation of research on visitor management in protected areas.
- Prioritize effective cooperation between destination management organizations for common tourism development and provision of attractive offer on local level.
- Support regulations requiring new tourism infrastructure to harmonize with local climate and culture.
- Consider local art practices as models of ecological resilience.
- Collaborate with professionals from different sectors and disciplines (i.e. in the Arts and Humanities), experienced in preservation of traditional ecological knowledge.

S17 Getting it done right: Mediation for sustainable use and reuse of the Carpathians resources

***Relevant for:**

Convention Articles:

Article 3 - Integrated approach to the land resources management

Article 7 - Sustainable agriculture and forestry

Convention Working Groups/Networks:

WG Biodiversity

WG on Sustainable Forest Management

WG on Adaptation to Climate Change

Planning and Implementation

- Recognize and use Forest Stewardship Council public reports in addressing forest management issues
- Consider trade-offs between energy strategies and ecosystem service scenarios
- Consider building common policy for forest certification requirements among the Carpathian countries
- Facilitate cooperation and trade-offs between policy makers, stakeholders and communities to optimize benefits from local bioenergy strategies while protecting Carpathian ecosystems

S19 Modelling of the biodiversity and ecosystem functions/services for nature protection and sustainable use of natural resources in the Carpathians

***Relevant for:**

Convention Articles:

Article 3 - Integrated approach to the land resources management

Article 4 - Conservation and sustainable use of biological and landscape diversity

Article 5 - Spatial planning

Article 12 - Environmental assessment/information system, monitoring and early warning

Convention Working Groups/Networks:

WG Biodiversity

WG on Spatial Development

WG on Sustainable Tourism

WG on Adaptation to Climate Change

Assessment and Research: Data

- Use up-to-date and detailed integrated data and tools in landscapes planning and evaluation
 - Facilitate data collection and access to quality data

Planning and Implementation

- Optimize landscape management practices to foster provision and conservation of relevant ecosystem services for tourism and recreation
- Promote carbon sinks through sustainable use of the landscape, particularly forests where carbon sinks are highest
- Support conservation of semi-natural areas and ecosystem services in the Carpathians, at local, national and international levels, and development of green infrastructure

Annex 1. Recommendations for the S4C and research agenda for the Carpathians

Adding New Chapters or amending existing chapters:

- New chapter on Education for Sustainable Development.
- Natural and human disturbances of ecosystems (agricultural and forest burns, clear-cuts, thermal regime of landfills, illegal dumps, exclusion zones).
- Local communities' participation / involvement in research (e.g. Citizen Science).
- Plastic pollution; Including riverine microplastic topic in the Water resources and management chapter of the Research Agenda.
- A chapter on 'cultural heritage' (e.g. in addition to 'traditional knowledge', i.e. 'traditional knowledge and cultural heritage').
- Address the role of non-English-language science for the Carpathian region³.
- Integrating inter-and transdisciplinary approaches and participatory methods into the Research Agenda.

Integration of Applied and participatory research into the Agenda:

- Work in research triangle University or Academia – NGO – local government.
- Promote research on social innovation as a trigger for transformations towards sustainability in the Carpathians (thought better collaborative links of science, local stakeholders, and policy makers to tackle the challenges that the mountainous region face).
- Integrate participatory action research⁴ and implementation, as well as participatory approaches (e.g. citizen science). Examples of participatory action research and implementation:
 - Addressing poor water quality and water use: support with funds and small pilot infrastructure, such as construction of eco toilets, repair of water supply system.
 - Shift to Renewable Energy: Implement a thermal solar facility on the roof of a kindergarten.
 - Support social innovations initiatives – collaborate with local communities (being knowledge brokers) in talking challenges that are not addressed by existing institutions or markets (e.g. activities in national parks with organization of events to promote local culture, local food, tourism, creating value added local products, etc.).
 - Identify conflicts between humans and wildlife (build on e.g. Swiss experience on resolving wolf-livestock conflicts)⁵.
 - Promote research on sustainable green energy provision in the Carpathians (action research with relevant stakeholders involved (e.g. NGOs, Universities, local authorities) as it could be seen in the project on sustainable wood energy provision and capacity building for the stakeholders in the Ukrainian Carpathians).
- The draft Red List of Species and Red List of Forest Habitats (2014) should be finalized with involvement of relevant experts from all Carpathian countries.
- Supporting green infrastructure planning.
- Adopting a broader approach to protecting the few remaining valleys in the Carpathians where natural processes and dynamics are operating at truly landscape scales.

³ This is a relevant topic for the Carpathian region, in case of biodiversity research but also for cultural heritage, traditional ecological knowledge etc. May be it would be useful to discuss this in the future, via S4C initiate (e.g. <https://doi.org/10.1371/journal.pbio.3001296>).

⁴ Chevalier, J. and Buckles, D. 2019. Participatory Action Research: Theory and Methods for Engaged Inquiry, Routledge. DOI: 10.4324/9781351033268.

⁵ <https://www.eurolargecarnivores.eu/en/feature/bruno-zaehner> (under AGRIDEA; in German).

Integrating applied research into education:

- University Education with minimum one Real world lab, as experiencing work on site for senior Researchers, Juniors and Students in the Master and Bachelor studies.
- Researchers need to train teachers instead of teaching pupils directly.
- Integrate main research findings and resulted applied knowledge into school and university curricula (eg. large carnivores).
- Improve cooperation with research institutes in the field of environmental education, e.g. with the Researchers' Nights⁶ which has been a well-known and popular program in research institutes across Europe for many years, with focus on the new "Researchers at Schools" initiative.

S1 Forest ecosystem and resource vulnerabilities to climate change in the Carpathian Mountain Region

Participants in this session identified the following topics and concerns, recommending these for inclusion within an assessment of climate change vulnerabilities, risks, and adaptation alternatives for the forest sector:

- Role of close to nature forestry
- Need for long-term monitoring
- Change in dead wood dynamics (recruitment and loading; differences between managed and unmanaged; relationships with insect and other mortality agents, etc.)
- Forest harvest trends, variation over time and by country/sub-region
- Shifts in natural disturbances as a primary vulnerability; implications for ecosystem services, biodiversity, resilience, and forest management
- Long-term drought as an increasing vulnerability in the Carpathians
- Species ranges shifts; altered species composition in the future → variation within regions (e.g. increased beech predicted for Ukraine, decreased beech abundance predicted for Hungary); uncertainty regarding oak; major implications for adaptive management
- Role of shifting relative abundances of spruce vs beech vs oak forest types
- Many robust climate modelling studies to build on in the assessment, both at European, Carpathian, and sub-Carpathian spatial scales
- Extreme weather: drought and fire, wind, snowfalls, heavy rains. New threats like fire will increase...
- Lack of funding for adaptive management; identifying critical vulnerabilities will help prioritize funding
- Role of afforestation/reforestation as a climate mitigation strategy
- New investments needed in adaptations and natural climate solutions
- Landscape homogenization has increased vulnerabilities; need for landscape diversification to increase resilience to disturbances
- Decreased resilience of forest systems from compounded anthropogenic stresses.
- History of forest management; plantation forests have made forest ecosystems more vulnerable to drought and climate change – time for a wholesale shift in forest management
- Bark beetle outbreaks are a primary concern throughout the region. Likely to increase with climate change. Implications for carbon flux and forest management
- Czech forest are now a carbon source because of forest management and bark beetle
- Concept of biological legacies; expand use of retention forestry practices. Move away from salvage logging in beetle and windthrow areas.

⁶ <https://ec.europa.eu/research/mariecurieactions/event/2021-european-researchers-night>

- Debate over the trade-offs in relying on natural regeneration following disturbance vs. salvage then planting
- There is a new “living with bark beetle outbreaks report”
- Process knowledge into a “tool box” for climate smart forestry approaches
- Social and economic components noticeably missing today. Do we include these or keep the assessment scope narrow?

Workshop on Forest ecosystem and resource vulnerabilities to climate change in the Carpathian Mountain Region

Risks and impacts (robust climate modeling studies available to build on in the assessment, both at European, Carpathian, and sub-Carpathian spatial scales):

- Increasing forest disturbances (through fire, insect infestations, drought, disease outbreaks, decrease in reproducing potential first of all because of frequent summer heat waves, etc.) as a primary vulnerability
- Impacts on forest growth and productivity (through increases in temperature, changes in precipitation, and increases in CO₂)
- Change in dead wood dynamics (recruitment and loading; differences between managed and unmanaged⁷; relationships with insect and other mortality agents, etc.)
- Changing/reduced carbon uptake (forest carbon sequestration and carbon management)
- Shifts in species ranges and abundance; altered species composition in the future but variation within regions (e.g., increased beech predicted for Ukraine, decreased beech abundance predicted for Hungary); uncertainty regarding oak with a wide range of subspecies that react to climate factors in different ways (also leading to varying economic effects)
- Shifts in habitats and plant species composition and resulting impacts on flagship species (esp. large carnivores)
- Bark beetle outbreaks are a primary concern throughout the region, which are likely to increase with climate change with implications for carbon flux

Mitigation and adaptation measures/responses:

- Role of afforestation/reforestation as a climate mitigation strategy
- Landscape homogenization has increased vulnerabilities -> need for landscape diversification to enhance resilience to disturbances
- Managing the increase in forest/vegetation fires e.g., through increasing density, use of specific species in tree planting (changing stock), inserting fuel breaks (such as valuable infrastructure, distances)
- Ecosystem restoration needs incl. sustaining ecosystem services; old forest restoration gaps; role of Natura2000 areas
- From the history of forest management, plantation forests have made forest ecosystems more vulnerable to drought and climate change -> time for a wholesale shift in forest management
- Concept of biological legacies; expand use of retention forestry practices. Move away from salvage logging in beetle and windthrow areas
- Need for long-term monitoring

Further suggestions:

- Process knowledge gathered into a “toolbox” for climate smart forestry approaches.

⁷ Comment HU: Dead wood dynamics are mostly managed artificially (regulations, controlled actions)

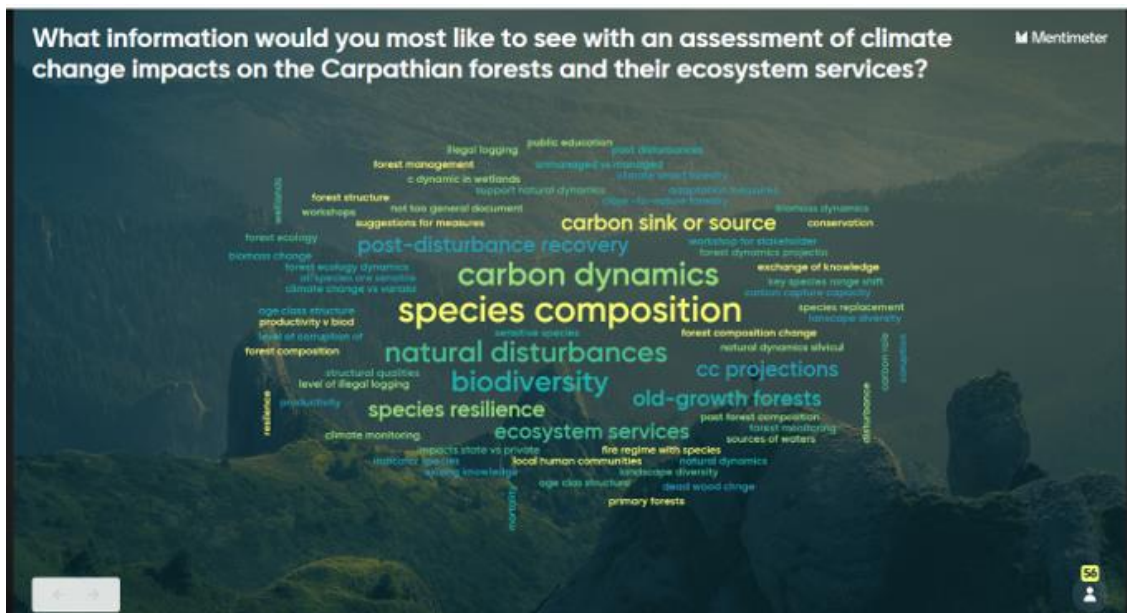


Figure 1. Key words and topics of concern raised by Workshop 1 participants weighted by number of times mentioned. Figure generated in www.mentimeter.com.

S2 Recent and future changes of agricultural areas of Carpathians

- To include multi-disciplinary research of rural areas especially in context of their depopulation, including measures to stop this trend.
- Section „Traditional knowledge“: it will be good to include topic of Biocultural value of Carpathians and typology of biocultural landscapes.
- It may be useful to create a platform for collecting and sharing regional research data on diversity of bioindicator groups of invertebrate organisms (butterflies or bees are recommended in this respect, they reflect global warming, land use extensification or intensification by the species migration/regional extinction, change in community species composition, etc., which may indicate general trends in whole ecosystems).
- Research to facilitate ecological restoration of Carpathians grasslands.
- Balanced support and promotion of the Carpathian region also through lesser-known, peripheral areas (for example, at the junction of the Carpathian and Pannonian regions) with preserved traditional land management. Protection of these peripheral areas, which often form a buffer between the intensively used agrarian landscape (e.g. in the conditions of Slovakia) and the forest sub-mountain and mountain landscape.

S3, 4, 8 Carpathian waters: From knowledge to management

- While numerous studies explored the pollution of the environment with microplastic, the pollution of riverine environment with macroplastic debris has only recently been recognised and research allowing for identification of mechanisms and rates of macroplastic storage, transport, and redeposition in rivers is required.
- Improved river management practices require recognition of impacts of floodplain forest development in mountain valleys on riverine ecosystems and flood hazard.
- Sustainable management of in-channel wood requires knowledge of its mobility, which can differ considerably between channels of different size and can be assessed with a variety of monitoring techniques.
- Research on impacts of climate changes on characteristics of river flow, such as flow amount, seasonality of extremes and temperature regime, is required.

- Conventional engineering management of mountain streams can have negative impacts on all dimensions of sediment connectivity and, thus, on hydromorphological stream quality and downstream river reaches. Therefore, there is a need to find and apply more environment-friendly approaches to the management of mountain streams.
- Scientific monitoring of river restoration projects is required as it will help evaluate their immediate and long-term effects and may contribute to a wider use of innovative, cost-effective restoration measures aimed to improve the functioning of degraded mountain watercourses.

S6 Scientists and humanists working together to propose new (and old) approaches to ecology in the Carpathians

Recommendations focus on the “Tourism and Sustainability” section of the 2016-20 Research Agenda, particularly the “Where should we go between 2015 and 2020” section, which overall remains relevant and forward-thinking. Areas that may benefit from revisions include:

- The conception of “local communities” could be clarified. [In some regions (such as the Polish Tatras region, Podhale) there are long-standing tensions between some (górale) whose ancestors lived in the area before tourism was developed (beginning in 1873 in Podhale) and more recent settlers from elsewhere who historically have been more wealthy and thus powerful. In the most desirable areas, more recent residents outnumber the older families, and this causes some social tension.
- For example, the concept and discussion of “local communities” could be refined to (a) openly recognize the above distinctions, and (b) prioritize the ancestors of traditional residents in particular regions as integral to our understanding of those regions’ ecologies.
- Where possible, defer to Traditional ecological knowledge (TEK) as interpreted by traditional residents of regions-of-interest as the starting point for any land use, including touristic.
- Make the causes of depopulation and population ageing a priority research question that precedes policy recommendations of tourism development.
- Change or pair the concept of “sustainability” with “resilience” since “to sustain” too often implies keeping things as they are rather than adapting to changing circumstances.
- Prioritize in our research agendas slowing climate change and supporting regional ecosystems over tourism development and economics.
- Strengthen the link between the protection and valorisation of cultural heritage and climate mitigation.

S7 The power of social innovation in mountain areas to steer a sustainable governance of nature

- It is important to analyse, design and ensure the ways of how public & private sectors, various partnerships & collaborations can enhance, scale-up & scale-out social innovation in mountain areas & communities.
- Consideration and understanding of enablers & barriers to answer the question of how SI can deliver transformative opportunities to people (& socio-ecological systems) on the ground. For doing this, the initial steps suggested would be:
 - To define SI in the Carpathian context
 - To create the Carpathian database of examples of SI & social-ecological innovations (under the Carpathian Convention Platform) to popularize & share positive examples, advance the KN of SI & create a workable network between successful cases, providing & extending the opportunities for wider (transboundary) cooperation and SI diffusion.
 - To create tools for dissemination of scientific results for use by regional/local policy makers & other stakeholders (via policy briefs and practice guides).
 - Look for financial support (seed money) to enhance the emergence/growth of SI & help with its success

- Productive mountains: How to maintain balanced regional production systems in agriculture and manufacturing beyond the main tendency to leisure and residential functions in mountains.
 - Considering problems of food security, security and human rights standards of value chains, regional production systems in European mountain areas should be maintained and stabilised. This concerns the agro-food system as well as manufacturing.
 - A mere residential/leisure function or an «ecology island» without considering global processes contradicts the overall goals of sustainability.
- Social innovation in mountain areas: How to gain external new knowledge without losing own competences. How to benefit from migrants, inclusion and heterogeneity to overcome the problems of periphery and marginality.
 - In the 1990s regional identity and distinction was a key word for strengthening mountain areas. Today we have to consider that the gap between metropolitan areas and peripheries has deepened, with protest movements as Brexit, Gilets Jaunes, etc.
 - A rethinking of specialisation and distinction should be started.
 - Social Innovation in this sense means new knowledge, inclusion and heterogeneity instead of the offer oriented growth paradigm.
- Comparative mountain research on different social practices and strategies with the approach of dichotomies
 - Mountain distinction versus mountain/lowland linkages dichotomies.
 - Territorial cleavages vs. urban-rural linkages
 - Distinction vs. Inclusion
 - Isolation vs. Immigration
 - Production vs. Consumption
 - Environmental/cultural protection vs productivism.

S9: Education for Sustainable Development -best practices of education for sustainable development in the Carpathians and other mountainous regions

- Several 'society-based' approaches should be integrated into the research methods in the Carpathians: Living Labs, Citizen Science, etc.
- More examples should be collected from the Carpathian region of learning from nature, nature-inspired solutions, such as biomimicry, and published, accordingly.
- Research should both contribute to locally-based solutions, and address the under-representation of Carpathian countries in the ESD research scene.
- Carpathian countries are under-represented in the ESD research scene. Possible barriers need to be identified and strategies for better/easier participation need to be developed.
- **Potential research questions for follow-up research on ESD in the Carpathians:**
 - What are previous experiences of networks related to or created in the framework of the Carpathian Convention? What can be learned from these experiences?
 - What are the needs of the educational community - how the Carpathian ESD Expert network can contribute to the practitioners, to research at universities etc. (for example, development of specific guidelines for implementing ESD or other ESD-related concepts, with the view that we are operating in the framework of the Carpathian Convention)?
 - How can we identify the needs, the quality of research, methods that should be further developed, barriers that can be overcome with a help of the ESD Network?
 - What are the connections within the ESD network at different level - like universities and schools, research and practice.
 - How can we map these connections (network analysis?)
 - Can we enhance the connections? Do we want to do it? Who will do it?

- **The Concrete strategies and Best practices and examples from the Carpathians**
 - What potential strategies linked to learning, sharing and integration of knowledge can we use to address Carpathian Sustainability challenges? and which roles can specific actors plan in these strategies?

- **Role of the scientists / Universities / S4C**
 - Could Universities support the process of collection of good examples?
 - How can (academic) research institutes cooperate with the S4C in the activities on environmental education for teachers and pupils?
 - How can the S4C and scientific community in general contribute to identifying and strengthening the links between Carpathian Convention activities, Informal, and Formal education?
 - Could Universities (and other CC stakeholders) play a role in supporting teachers, and governments in integrating local / Carpathian issues into the curriculum?

- **Informal /Nonformal Education**
 - How can we integrate / strengthen learning / informal education components of Carpathian Convention activities?

- **Formal Education**
 - What are the good examples of ESD embodied in practical teaching-learning in the Carpathians?
 - How do schools/teachers use the curricula and textbooks? how do they learn to be able to perform quality ESD? What obstacles do they overcome and how?

S10 Cross sectoral issues- the Carpathians valued as a living place

- The use of non-wood forest products (NWFP) in the Carpathians depends on economic circumstances. In a way, Carpathians are divided into EU and non-EU Carpathians with different chances for fundraising and different starting points in development. This divide might be useful to address in the research agenda.
- More researches are needed to reveal the most threatened habitats and species to be able to prepare action plans for the protection of these:
 - Animal-vehicle collision is an everyday problem, due to an increasing extent of road network and the number of vehicles, including the Carpathian region;
 - Presumably millions of animals are dying every year in the Carpathians due to collision with vehicle, which threatening the unique fauna of the region;

S11 Applications of historical data in geography, land use, ecology and conservation

- Historical data in digital form are increasingly available in the region.
- Long-term processes and phenomena will be easily detectable in many research areas in the Carpathians thanks to increasing availability of historical data.

S14 Global changes and local responses: Resilience, adaptations, innovations for the sustainable development of Carpathians tourist destinations

- Mapping of the entire region in a standardized way and the development of a living atlas of the Carpathian Region.
- Consider human-wildlife conflict in tourism-related research.
- Re-evaluating alternatives to the regular understanding of ecotourism.

S16 Advances in Earth observations for sustainable development in mountainous regions

- LiDAR landscape palimpsest could be used for mapping and identifying current and historical anthropogenic landscape features. However, LiDAR can also be used for mapping soil degradation and geomorphic processes.
- As LiDAR data are becoming available in Carpathian countries, collecting available LiDAR data for a unified LiDAR dataset for Carpathians is recommended

S17 Getting it done right: Mediation for sustainable use and reuse of the Carpathians resources

- Building a ground for creation of common policy, enforcement the law in terms of voluntary and obligatory forest certification requirements.
- A holistic consideration of the influence of energy pathways on ecosystem services that exists both within and outside Carpathian markets could help to identify pathways that deliver routes to decarbonization while simultaneously maximizing the benefits that people derive from nature.

Biodiversity-related knowledge gaps⁸

- Long-term processes and management measures for preservation of biodiversity;
- Indirect effects of human activities to species/biodiversity
- Effects of climate change to biodiversity.
- Consequences of forestry management to biodiversity.
- Invasive species and their regulation
- Data on large carnivores' populations are mostly available from foresters; there is a need to apply other methods. Questions to be investigated: optimal size of large carnivores' populations, knowledge of human interaction with large carnivores, effect of legal hunting to pack structure and behaviour.
- Recent spruce dieback in Carpathians could be considered as threat to natural forests while in monocultures it could be considered as an opportunity.
- The gaps exist in more complex approaches to biodiversity: ecosystem approach, services to humans, ecosystem effects to human health, methods of mapping and assessment of ecosystem services.
- Biodiversity-related data collection for spatial planning, landscape conservation
- Identification of ecosystem services provided by natural areas
- Considering Capercaillie as an indicator/umbrella species
- Select a list of Indicator Species, and monitor these species on a long term to assess the state of Carpathian ecosystems

⁸ Inputs from the Workshop on improving knowledge exchange among scientists and decision makers in Carpathians, Ostrava, Czech Republic, 2019

Annex 2. Facilitating A Stronger Role for the S4C in the Carpathian Region

Ideas collected during FC2021 on how to enhance the role of Carpathian scientists in Carpathian society?

- Empowering collaboration, providing good examples - perhaps through thematic S4C working groups.
- Organizing common projects:
 - Producing books, guides, etc. for the whole Carpathians.
 - R&D projects, organize guests lectures.
 - A common study/s which is close to research field of co-authors and publish with the "label" of Carpathian society.
- A specific schedule for lecturers exchange between universities for integration of transdisciplinary approaches into education and research.
- Researchers should take the risk to work in the action research triangle University - NGO - local government:
 - Participation of local stakeholders is key.
 - Implementation of some research findings in concrete on-side projects.
- Training of young scholars – for example, co-organizing a Summer School on inter-and transdisciplinary approaches.

What are concrete ways and opportunities for scientists to cooperate with CC Secretariat in order to support CC work⁹

There is a lack of communication between the S4C and the CC focal points and WGs, which should be addressed:

- S4C colleagues should be present at the WG meetings and CCIC
- Focal points are open to requests for interviews, etc.
- S4C should select a national S4C contact point, which would be one S4C representative, which could be in touch with the respective CC national focal points, so that they can inform each other about activities
- Secretariat can provide space for selected relevant research on the CC website
- Inviting focal points to the relevant scientific events on the national and regional level

S4C could support inter-sectorial linkages of the CC, such as by integrating information on Biodiversity into other thematic WGs, such as agriculture, tourism, forestry, and vice-versa.

Inter-connection of platforms and databases should be considered, such as thematic platforms (on Biodiversity) or databases of experts (such as those from the S4C and those who are not linked with this network, but still do research).

S4C should be linked with networks and researchers and practitioners involved in various Convention areas of work

S4C could facilitate preparation of position-papers and recommendations, to be communicated by the Carpathian Convention to the focal points (for example, on the Common Agricultural Policy). This can support the Focal Points when they approach other ministries and other organizations with requests for cooperation and action.

The Carpathian Convention can facilitate organization of inter-sectorial multi-stakeholder events to facilitate the above. S4C could support such events by providing space for them during Forum Carpaticum conferences, and cooperating with CC on organizing them. Recommendations “officially”

⁹Inputs from the Workshop on improving knowledge exchange among scientists and decision makers in Carpathians, Ostrava, Czech Republic, 2019



elaborated by the Carpathian Convention in this way could strengthen the position of focal points and facilitate their action on the national level.

Researchers of the S4C could provide scientific information needed to support decisions made in the WGs. Moreover, research briefings can be prepared on specific topics relevant for CC events, such as recommended references of S4C publications. Invited WG participants could look at these recommended research in order to be better prepared for the meetings.

The scientists from S4C could be involved in advocacy and awareness-raising initiatives.

