MEETING REPORT

Workshop on Forest ecosystem vulnerabilities to climate change in the Carpathians

22 June 2021 – ONLINE MEETING within the Forum Carpaticum 2021

Background

The Carpathian Convention Conference of the Parties at its 6th meeting (COP6, 2020) through its decisions[1] encouraged the development of an **assessment of the impacts of climate change on the Carpathian forests and their ecosystems services** by relevant Convention Working Groups and partners and with support of the Convention Secretariat. Subsequently, this activity has been included in the Implementation Framework 2030 accompanying the Long-term Vision towards combating climate change in the Carpathians. The related Workplan for the implementation period 2021-2023 of the Working Group on Climate Change sets out concrete activities and expected results with regard to achieving the strategic objectives and related targets of the Long-term Vision 2030 towards combating climate change in the Carpathians.

As announced at the 8th meeting of the Carpathian Convention Working Group on Climate Change, held on 6 May 2021 in an online format, the very first engagement for developing the assessment of the impacts of climate change on the Carpathian forests was planned at the **Forum Carpaticum 2021**. Within the Forum a ***Special Session and Workshop on Forest ecosystem vulnerabilities to climate change in the Carpathians"*** was **organized by Dr. William Keeton, University of Vermont and Member of the Science for the Carpathians, and the Secretariat of the Carpathian Convention on 22 June 2021 in an online format.**

In this respect, prior to the Special Session and Workshop, the Secretariat requested the Focal Points of the Carpathian Convention to **nominate experts to be involved in this activity,** providing expertise and knowledge on both climate change and forest ecosystems and management. This approach shall allow for establishing an informal subgroup of the Working Group on Climate Change and the Working Group on Sustainable Forest Management, that supports the development of the assessment and shall at the same time strengthen cooperation between these topics under the Carpathian Convention – in line with the COP Decisions and the "Long-term Vision 2030 towards combating climate change in the Carpathians".

The report provides a detailed overview of the *Workshop on Forest ecosystem vulnerabilities to climate change in the Carpathians*. Abstracts of presentations delivered during the related *Session* are available on page 13. of this report.

Opening of the Workshop

The workshop was opened by Mr. Harald Egerer, Head of the UNEP Vienna Programme Office – Secretariat of the Carpathian Convention, who welcomed the participants and thanked them for joining the kick-start of the development of a comprehensive assessment on climate change impacts on the Carpathian forests and their ecosystem services, emphasizing that participants' valuable input to the workshop will be key to gather and assess existing information on the widespread consequences of climate change on Carpathian forest ecosystems, including environmental, economic and cultural benefits these forests provide. He stressed that a region-wide assessment shall not only identify common climate risks and related impacts, but most importantly share knowledge and experiences on effective adaptation responses for long-term conservation. Additionally, it should foster

[1] DECISION COP6/13 Sustainable forest management Article 7 of the Carpathian Convention

Para 5. Appreciates the strengthened cooperation between the WG Forest and the WG Climate Change and WG Biodiversity, facilitating the implementation of Article 14 of the Forest Protocol, welcomes the idea of collecting information from the Parties with the goal of assessing the impacts of climate change on the Carpathian forests and their ecosystem services, including, if possible, climate change effects on large carnivores and their habitats, in that regard recognizes the complexity of the issue and wide range of ecosystem services Carpathian forests provide to the society, and requests the relevant Working Groups and partners to support the development of such assessment, and the Secretariat to facilitate the process;

DECISION COP6/18 Climate Change Article 12bis of the Carpathian Convention

Para 8. Specifically encourages the WG Forest and the WG Biodiversity and partners to jointly further develop with the WG Climate Change an assessment of the impacts of climate change on the Carpathian forests and their ecosystems services, including, if possible, climate change effects on large carnivores and their habitats, and requests the Secretariat to facilitate the process.

collaboration on ecosystem restoration needs in line with the Long-term Vision 2030 towards combating climate change in the Carpathians and the accompanying implementation framework, adopted at Carpathian Convention COP6.

The workshop was facilitated by Ms. Sabine McCallum, Senior Strategic Advisor and Climate Change Expert representing the Secretariat of the Carpathian Convention and Prof. William Keeton, University of Vermont, who informed that the workshop aims to gather and synthesize information from previous assessments undertaken in the Carpathian countries, the current status-quo of responses to climate impacts and resulting risks to forest ecosystems, as well as challenges and opportunities to cope with current and future climate variability.

Referring to the stock-taking of available information regarding climate change impacts and risks affecting forest ecosystems and respective adaptation responses, the designated country experts were requested to deliver presentations on the following questions, which were shared prior to the workshop:

In your country:

1. **Which are the most pressing vulnerabilities of forests and their ecosystem services to climate change?**
2. **Which scientific studies (concluded or underway) have identified and assessed those current and future vulnerabilities? (please highlight the most comprehensive and relevant ones and mention if they possibly include specific reference to Carpathian mountain forests)**
3. **Which responses to identified climate impacts and risks are already being implemented? (please provide few examples)**
4. **What are the main challenges, but also opportunities, when dealing with current and future climate variability in forest ecosystems?**
5. **[OPTIONAL: are national/regional/sector policies specifically including climate risks of Carpathian forests and suggesting mitigation and adaptation measures?]**

A summary of all the presentations is available below in a table format. The presentation delivered during the workshop can be accessed via the Carpathian Convention website. The Carpathian Convention Parties were represented by the following experts:

Czech Republic:
Prof. Ing. Miroslav Svoboda, Ph.D., Czech University of Life Sciences Prague.
Another expert designated by the Czech Republic to be involved in the development of the assessment is Ms. Eliška Rolfova, Ministry of the Environment of the Czech Republic.

Hungary:
Ms. Imelda Somodi, Centre for Ecological Research, as well as by Mr. Sándor Szala, Szent Istvan University and Ms. Borbala Galos, University of Sopron.

Poland:
Mr. Bożydar Neroj, Bureau for Forest Management and Geodesy, as well as Mr. Wojciech Grodzki, Forest Research Institute and Ms. Małgorzata Czyżewska, Directorate General of the State Forest of Poland.

Romania:
Mr. Laurentiu Radu, Ministry of Environment, Waters and Forest, as well as Ms. Liliana Virtopeanu, Ministry of Environment, Waters and Forest of Romania.

Slovakia:
Mr. Libor Ulrych, State Nature Conservancy of Slovak Republic (not present at the workshop, however, relevant information was provided)

Serbia:
No representative so far.

Ukraine:

Ms. Liubov Poliakova, Head of International Cooperation, Science and Public Relation Division, State Forest Resources Agency. Another expert nominated by Ukraine to be involved in the development of the assessment is Mr. Volodymyr Korzhov, Deputy Head of Ukrainian Scientific Institute of Mountain Forestry.

Summary of the presentations delivered at the workshop					
Country	**which are the most pressing vulnerabilities of forests and their ecosystem services to climate change?**	**which scientific studies (concluded or underway) have identified and assessed those current and future vulnerabilities?**	**which responses to identified climate impacts and risks are already being implemented?**	**what are the main challenges, but also opportunities, when dealing with current and future climate variability in forest ecosystems?**	**Related publications**
Czech Republic Representatives: Mr. Miroslav Svoboda, Ph.D., Czech University of Life Sciences Prague Ms. Eliška Rolfova, Ministry of the Environment of the Czech Republic,	Collapse of commodity forest: Since 2017 the largest bark beetle outbreak in commodity forests, Collapse of the wood market and forest owners most heavily impacted. Climate change is one of the causes of this situation, however, an important aspect is transformation of about 70% of the Czech forest from natural broadleaved dominated forest to spruce and pine plantations (officially reported as semi-natural forests) - landscape homogenization and decrease of the resilience of the whole system. Consequences: Bark beetle outbreak with more than 100 mil. m3 Wood price collapse, forest owners collapse Severe impacts on the ecosystem services Severe impact on the public budget with need for subsidies CZ harvested in 2020 3x times of the annual increment – CZ forests are string carbon sources	Living with bark beetles: impacts, outlook and management options – study by European Forest Institute, Authors: Tomáš Hlásny, Paal Krokene, Andrew Liebhold, Claire Montagné-Huck, Jörg Müller, Hua Qin, Kenneth Raffa, Mart-Jan Schelhaas, Rupert Seidl, Miroslav Svoboda, Heli Viiri Published on 04.04.2019 https://efi.int/publications-bank/living-bark-beetles-impacts-outlook-and-management-options	Implementation of REMOTE (Research of Mountain Temperature) primary forest project (Slovakia, Romania, Ukraine, Croatia, Albania, Bulgaria, Bosna and Herzegovina) The REMOTE project is a long-term international collaboration based on a network of permanent sample plots in the forests of central, eastern, and southeastern Europe. https://www.remoteforests.org/index.php	Need to differentiate between managed forest, which is much more vulnerable to climate change effects and natural forest not impacted or much less impacted. - Strong pressure to harvest all affected sites (despite no economical or ecological reasons) - Strong pressure for plantation style "artificial restoration" - Concept of biological legacies not respected at all	
Hungary Representatives: Ms. Imelda Somodi, Centre for Ecological Research, Mr. Sándor Szalai, Szent Istvan University	Climate extremes: droughts, other damaging factors (heat waves, frost, wind) and in consequence fire, pests and diseases Sustainability of stand forming native tree species – particularly beech	Hungary reported on several studies and research being available in Hungary on vulnerabilities, including on mountain vegetation, forest vulnerabilities, as well as studies simulating biome-biogeochemical cycles and carbon fluxes that are significant for climate change mitigation.	Existing decision support systems: National Adaptation Geo-Information System (NAGiS), including forestry, soil, agriculture and ecology layers (https://nater.mbfsz.gov.hu/en) AgroClimate Decision Support System (http://agrarklima2.nyme.hu/dtr/inde	**Climate change mitigation – CO2 sequestrations - > afforestation**: The forest biome reaches its edge within Hungary, larger portions of the country rather belong to forest steppe Lowlands might move towards steppe, but even foothills and lower elevations might be carrying forest steppe potential -	Bede-Fazekas Á, Czúcz B, Somodi I. 2017 Vulnerability of natural landscapes to climate change – a case study of Hungary Időjárás / Quarterly J Hun Met Service 121: 4 393-414. Czimber K. & Gálos B. 2016: A new decision support system to analyse the impacts of climate change on the Hungarian forestry and agricultural

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Country	which are the most pressing vulnerabilities of forests and their ecosystem services to climate change?	which scientific studies (concluded or underway) have identified and assessed those current and future vulnerabilities?	which responses to identified climate impacts and risks are already being implemented?	what are the main challenges, but also opportunities, when dealing with current and future climate variability in forest ecosystems?	Related publications
Ms. Borbala Galos, University of Sopron	Sustainability of closed forests Sustainability of original habitats in Natura 2000 areas at the edge of the forest biome		x-eng.html), adaptive species choice & yield estimates NARIC FRI GeoPortal (http://www.ertigis.hu/index.php/en/) Remote sensing based Forest health Monitoring System (http://193.224.22.151/TEMRE.php), 2nd National Climate Change Strategy Renewable Energy Action Plan	potential cover of closed forests decrease – afforestation might not be sustainable, maintenance of closed forests not feasible - loss of the ecosystem services of forests Growing tree mortality - Forests can turn into net carbon emitters Carbon sequestration might be more effective in grasslands/wetlands where forests are not sustainable **Adaptation:** Increasing aridity – adaptive selection of species/target habitat for planting/restoration Speed of climate change faster than the speed of the adaptation capacity of forests - estimating the future of current forests **Adapting management to more open forests** **Supporting natural dynamics** rather than conserving the current situation in protected/Natura 2000 areas	sectors. Scandinavian Journal of Forest Research DOI:10.1080/02827581.2016.1212088 Csóka G. & Hirka A. 2011: Alien and invasive forest insects in Hungary (A review). Biotic Risks and Climate Changes in Forest. Berichte Freiburger Forstliche Forschung 89: 54–60. Führer E., Horváth L., Jagodics A., Machon A. & Szabados I. 2011: Application of a new aridity index in Hungarian forestry practice. Időjárás 115: 205–216 Gálos B., Führer E., Czimber K., Gulyás K., Bidló A., Hänsler A., Jacob D. & Mátyás Cs. 2015. Climatic threats determining future adaptive forest management – a case study of Zala County. Időjárás 119(4): 425-441 Lepesi N, Bede-Fazekas Á, Czúcz B, Somodi I. 2017 Adaptive capacity of climate sensitive habitats to climate change in Hungary. Időjárás / Quarterly J Hun Met Service 121: 415-436. Mátyás C., Berki I., Bidló A., Csóka G., Czimber K., Führer E., Gálos B., Gribovszki Z., Illés G., Hirka A., Somogyi Z. 2018. Sustainability of Forest Cover under Climate Change on the Temperate-Continental Xeric Limits. Forests, 9(8):489; doi: 10.3390/f9080489

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					Móricz N., Garamszegi B., Rasztovits E., Bidló A., Horváth A., Jagicza A., Illés G., Vekerdy Z., Somogyi Z. and Gálos B. 2018. Recent Drought-Induced Vitality Decline of Black Pine (Pinus nigra Arn.) in South-West Hungary – Is This Drought-Resistant Species under Threat by Climate Change? Forests, 9(7):414; doi:10.3390/f9070414 Rasztovits, E., Berki, I., Mátyás, Cs., Czimber, K., Pötzelsberger, E., and Móricz, N., 2014: The incorporation of extreme drought events improves models for beech persistence at its distribution limit. Annals For. Sci. 71, 201–210 Somodi I, Molnár Zs Czúcz B, Bede-Fazekas Á, Bölöni J, Pásztor L, Laborczi A, Zimmermann NE. 2017 Implementation and application of multiple potential natural vegetation models – a case study of Hungary. J Veg Sci 28: 1260-1269. Somogyi Z. 2016: Projected effects of climate change on the carbon stocks of European beech (Fagus sylvatica L.) forests in Zala County, Hungary. Lesnícky časopis - Forestry Journal 62: 3-14
Poland **Representatives:**	A new situation for which owners and managers are not fully prepared (pests, droughts, floods, changing expectations of forests). Monitoring and trends observed are important	**International project "Biodiversity and Climate Change**, A Risk Analysis (BACCARA)", 7. Framework Program, 2009-2012.	Programme for the Beskydy Mountains (2003) - support for spruce forest disaster management in the Beskydy Mountains and their reconstruction (State Forests and Forestry Faculty in Cracow) - example	Permanent forest monitoring need, exchange of knowledge science - practice, education of forest managers. Involving local communities in discussions	Related publications: Rabasa S. G., Granda E., Benavides R. Kunstler G., Espelta J.M., Ogaya R., Peñuelas J., Scherer-Lorenzen M., Gil W., Grodzki W., Ambrozy S., Bergh J.,

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Mr. Bożydar Neroj, Bureau for Forest Management and Geodesy **Mr. Wojciech Grodzki, Forest Research Institute;** **Ms. Małgorzata Czyżewska, Directorate General of the State Forest**		**CLIMO project** – Climate-Smart Forestry in Mountain Regions (Oct. 2016 – Oct.2020 – bring s together international scientists, experts and young scholars to develop Climate-Smart Forestry concept for the European mountain regions. https://www.youtube.com/watch?v=qouZ-AUavlQ	of forest management under disaster pressure		Hódar J.A., Zamora R., Valladares F. 2013. Disparity in elevational shifts of European trees in response to recent climate warming. Global Change Biology 19: 2490–2499. DOI: 10.1111/gcb.12220 Ambroży S., Grodzki W. 2013. Biodiversity And Climate Change, A Risk Analysis (BACCARA). Carpathian Case – goals and assumptions. J. Kozak et al. (eds.), The Carpathians: Integrating Nature and Society Towards Sustainability, Environmental Science and Engineering, Springer-Verlag Berlin Heidelberg: 425-428. DOI: 10.1007/978-3-642-12725-0_29 Grodzki W., Ambroży S., Gil W. 2013. The growth and biodiversity of spruce stands in variable climate conditions (Radziejowa Case Study). Folia Forestalia Polonica, Series A – Forestry, 55(3): 146-156. DOI: 10.2478/ffp-2013-00016. **Tatra NP publications**: Detection and definition of the altitudinal distribution of 2 bark beetle species not recorded earlier in the Tatra Mts. Altitudinal transects 1000-1400 m a.s.l. Grodzki W. 2020. On the vertical distribution of Ips duplicatus, I. cembrae and some bark- and longhorn beetles (Col.: Curculionidae,

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					Scolytinae; Col.: Cerambycidae) in the Tatra National Park in Poland. Folia Forestalia Polonica Series A – Forestry, Vol. 62 (2): 68–77. DOI: 10.2478/ffp-2020-0008 The upward spreading of the studied insects as a possible effect of climate change and the resulting environmental conditions favourable for those organisms.
Romania **Representative:** **Mr. Laurentiu Radu, Ministry of Environment, Waters and Forest** **Ms. Liliana Virtopeanu, Ministry of Environment, Waters and Forest of Romania**	Extreme weather events such as: - Strong winds and wind gusts - Massive snowfalls - Heavy rains - Extreme heat and drought		Romania has a Climate Change Adaptation Strategy and action plan, adopted in 2016, tacking both climate change adaptation and mitigation action. Ongoing revision of the Strategy. The RRP also contains several measures that contribute to green transition such as afforestation programmes respectively: - Investments in new areas that will be occupied by forests, including urban forests - Investments in the restoration and natural regeneration of degraded forest ecosystems, including forest habitats that are part of the Natura 2000 network - Investments in nurseries and modern technologies for seedling production - Investments in modern technologies for extracting wood affected by destabilizing factors	Lack of funding and lack of human resources	

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			- Investments in integrated systems to reduce the risks generated by torrential floods in basins exposed to such phenomena. Romania implemented several projects in the field of water management for reduction of flood risks and early warming as well. Furthermore, projects on afforestation, reforestation and regeneration of forest have been also implemented.		
Serbia					
Slovakia **Representative:** **Libor Ulrych, PhD., State Nature Conservancy of Slovak Republic**	Spruce forests: extremes of weather disasters, bark beetle, management or natural regeneration? Oak forests: seed years, germination, impact of invasive plants Scotch pine forests on sandy sites: drying during long summer periods without precipitation, premature dying, invasive plants attack		Geomorphology for easy solutions and solve erosion of forest soil. Process of plant interception is important, higher by broadleaves species, but much more important is interception by soil. Interception by soil needs no disturbance of plant cover, no clear cuts (including management called sheltwerwood cutting, usually starting large scale tree falls by windstorms following by barkbeetle massive invasion). Especially such plant cover rich on mosses, lichens protect soil and save very high ability of water interception from precipitation. Introducing zones: Well established zones of large areas with the same type of use/unuse. It means the highest type of protection is the zone of untouched forest, around this zone is a zone with lower type of protection allowing some management and timber production,	Appropriate management: nature based management or natural processes? Invasive plants – introduction of suitable species, is it necessary to use non-native species in adaptation for climate change? Timber or human surviving: Forests have many ecosystem services, but sometimes in countries of Carpathians the priority lies on timber production. Need to change priorities in times of climate change to such services like preserving water catchments, biodiversity, microclima, etc. Question on geographical scope as considering climatic changes, Carpathians are connected with the Pannonian basin because of water course and sources; the dividing line is very hard to establish Valuation, prioritisation and state accounting for ecosystem services	

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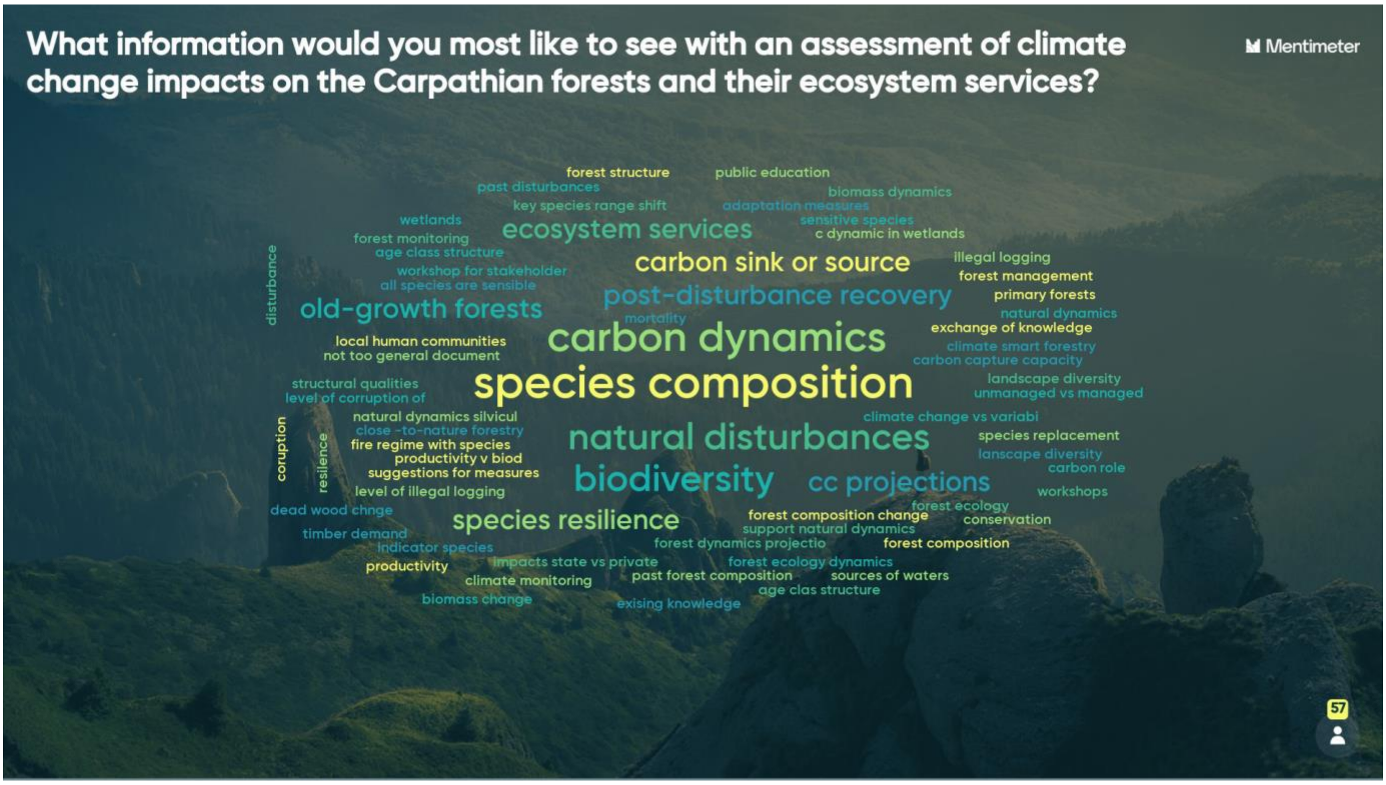
			usually preparing to become , or include in zone of untouched forests. Then it continues with a zone of nature based managed forests with high nature value including well balanced ecosystem services - it means timber production, recreation of people, water supply, etc. The last zone is a zone where priority lies on timber production		
Ukraine **Representatives:** **Ms. Liubov Poliakova, Head of International Cooperation, Science and Public Relation Division State Forest Resources Agency of Ukraine** **Mr. Volodymyr Korzhov, Deputy Head of Ukrainian Scientific Institute of Mountain Forestry** **Ms. Liubov Poliakova, Head of International Cooperation, Science and Public Relation Division State Forest Resources Agency of Ukraine**	Lowering level of ground waters Rapid changes in temperatures Floods	Draft strategy of adaptation of forest to climate change	Introduction of close to nature forestry (2 documents: the Road Map for introduction of close to nature forestry in plain areas and the Road Map for introduction of close to nature forestry in mountain area, several workshops and training on this topic) Implementation of international project Introduction of watershed management (pilot action ongoing, possibility to share experiences with other Carpathian regions) Implementation of a large Slovak – Ukrainian infrastructure project where among other measures for flood prevention are being implemented, as well as building new forest road.		

Discussion

The country presentations were followed by an interactive exchange and discussion about scope and approach for the assessment. For the opening, Mentimeter was used to generate a word cloud on the question "What information would you most like to see with an assessment of climate change impacts on the Carpathian forests and their ecosystem services that would be most beneficial for your country/work?". Results from participants´ responses can be seen in the picture below.



The subsequent exchange and discussion on the scope and potential issues to be covered by the assessment highlighted in essence the following areas:

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 CO_2)
- Change in dead wood dynamics (recruitment and loading; differences between managed and unmanaged[2]; 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:

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

- 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

One additional input has been received after the Workshop from Poland highlighting the important interaction is a long-term land use transition that affects many mountain areas, and the Carpathians in particular. The trend of increasing forest areas in the Carpathians continues due to extensive agricultural land abandonment (ALA) that in some Carpathian regions may contribute to massive secondary forest succession (SFS). Without any intervention, SFS in near future will translate into significant increase of forested area[3] (Kolecka et al. 2017, Price et al. 2017, Kolecka, Kozak 2019). Though ALA is a well-studied and easily observable phenomenon, it is, however, rarely included in discussions related to forest management. The land use transition (or more precisely, forest transition) related to ALA provides, in the context of climate crisis, a variety of chances that should be considered and utilized.

Next steps

The following next steps were suggested until December 2021:

- July 2021: The Carpathian Convention Secretariat together with Prof. William Keeton will provide a draft Workshop Report and invite all participants for their written feedback and additions
- July/August 2021: Together with sending the Draft Workshop Report, nominated experts and participants are invited to provide additional references to existing studies/reports/assessment/strategies, good practice examples and any further information that can be relevant for the assessment
- September 2021: The Carpathian Convention Secretariat together with Prof. William Keeton will undertake an analysis of the data/information collection and draft a table of contents for the assessment
- End of September 2021 (date tbd): 1rst meeting of the informal subgroup of the Working Group on Climate Change and the Working Group on Sustainable Forest Management to discuss the data/information analysis and agree on the table of contents (i.e., scope and issues to be covered by the assessment)
- September until November 2021: Drafting chapters for the assessment and possibly further information gathering (according to the agreed scope)
- November/December 2021 (date tbd): 2nd meeting of the informal subgroup
- End of December 2021: First draft of the assessment available

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[3] Kolecka N., Kozak J., 2019, Wall-to-wall parcel-level mapping of agricultural land abandonment in the Polish Carpathians. Land, 2019 vol. 8 no. 9

Kolecka N., Kozak J., Kaim D., Dobosz M., Ostafin K., Ostapowicz K., Wężyk, P., Price B., 2017, Understanding farmland abandonment in the Polish Carpathians. Applied Geography 88, 62-72

Price B., Kaim D., Szwagrzyk M., Ostapowicz K., Kolecka N., Schmatz D.R., Wypych A., Kozak J., 2017, Legacies, socio-economic and biophysical processes and drivers: the case of future forest cover expansion in the Polish Carpathians and Swiss Alps. Regional Environmental Change 17, 2279–2291. DOI 10.1007/s10113-016-1079-z

Session on Forest ecosystem and resource vulnerabilities to climate charge in the Carpathian Mountain Region - Abstracts

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.

Effect of management interventions after windstorm on ectomycorrhizal fungal community

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[1]Department of Carbon Storage in the Landscape, Global Change Research Institute CAS, Česk Budějovice, Czech Republic
[2]Department of Forest Protection and Wildlife Management, Faculty of Forestry and Wood Technology, Mendel University in Brno, Brno, Czech Republic
[3]Department of Botany, Faculty of Science, University of South Bohemia, Česk   Budějovice, Czech Republic
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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 92 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.

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 od 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 singl erisk (e.g. avoidance of beetle outbreak), forest management needs to aim forest resilience.

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.

Soil biological activity changes as a result of windthrow in the Javorov 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 JavorovValley 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 -D-celobiosidase and xylanase activity occured, but in three-years old windthrown the activity of the enzymes reached the rate occurred in forest soils (-D-celobiosidase, xylanase) or exceeded it (-glucosidase, N-acetylo-β-D-glucosaminidase). Both nitrogen mineralization and nitrification potential were higher in the soils of a 3-yearold 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.

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 33 became dominant at all research plots. The highest abundance we wegistred at NEX, where carbon source may be decayind stumps.

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

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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.

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