

ASSESSMENT OF CLIMATE CHANGE RISKS AND IMPACTS ON CARPATHIAN FOREST ECOSYSTEMS AND THEIR SERVICES

SCOPE AND DRAFT TABLE OF CONTENTS

BACKGROUND

The Carpathian Convention Conference of the Parties at its 6th meeting ([COP6](#), 2020) through its decisions¹ 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 took place 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**. All presentations delivered during the workshop as well as the final Workshop Report can be accessed via the [Carpathian Convention website](#).

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 allows for establishing an dedicated expert group 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”. Nominated experts have been providing valuable input and background information to the special session and workshop at the Forum Carpaticum which provide the basis for the scope and potential topics to be covered by the assessment.

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

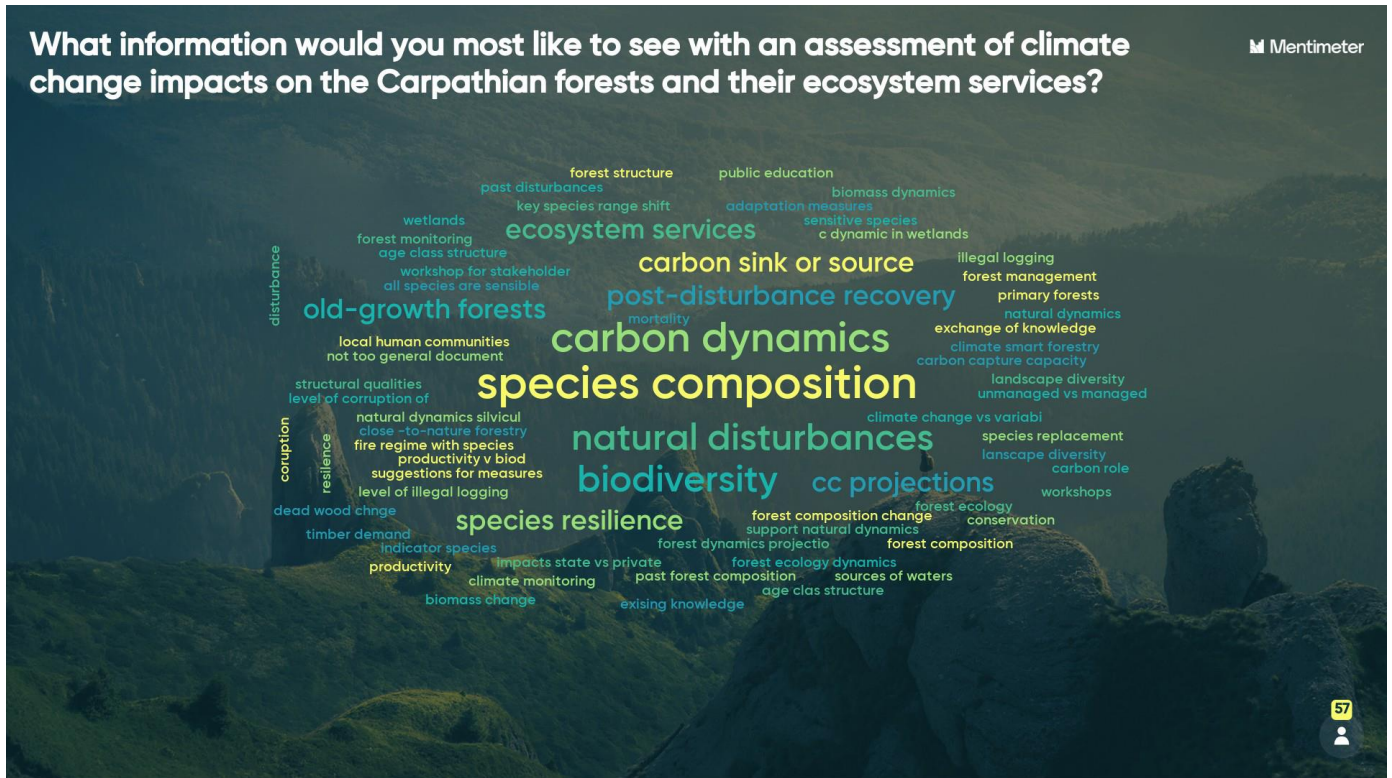
Para 5. Appreciates the strengthened cooperation between the WG Forest and the WG Climate Change and WG Biodiversity, facilitating the implementation of Article 14 of the Forest Protocol, welcomes the idea of collecting information from the Parties with the goal of assessing the impacts of climate change 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.

SCOPE AND POTENTIAL TOPICS TO BE COVERED BY THE ASSESSMENT

The following topics have been highlighted at the Forum Carpaticum’s Workshop with the use of Mentimeter 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?”:



The subsequent exchange and discussion highlighted in essence the following areas of concern:

Impacts / Risks	Mitigation and adaptation measures/responses
<ul style="list-style-type: none"> 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 unmanaged²; 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 	<ul style="list-style-type: none"> 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

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

Impacts / Risks	Mitigation and adaptation measures/responses
<p>subspecies that react to climate factors in different ways (also leading to varying economic effects)</p> <ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • Concept of biological legacies; expand use of retention forestry practices. Move away from salvage logging in beetle and windthrow areas • Land use transition due to extensive agricultural land abandonment (ALA) resulting in increasing forest areas in the Carpathians offers a variety of chances that should be considered and utilized • Need for long-term monitoring
Further suggestion	
<ul style="list-style-type: none"> • Process knowledge gathered into a “toolbox” for climate smart forestry approaches 	

After further refinement, we condensed the proposed list of assessment topics to the following as a **basis for discussion at the expert workshop on 16 November 2021 (online)**:

Topic	Impacts / Risks (sample)	Response prospects
Forest growth and productivity	<ul style="list-style-type: none"> • Effects of temperature increase, variations in precipitation • CO₂ fertilization effects: short term vs long term; interactions with stressors • Effects of altered disturbance regimes • Effects of drought 	<ul style="list-style-type: none"> • Adaptive silviculture • Expanded use of exotic species (pros and cons)
Biomass and Carbon Stocks	<ul style="list-style-type: none"> • Carbon stored in terrestrial ecosystems is vulnerable to loss back into the atmosphere. Key mechanisms include an increase in fire frequency due to climate change and the sensitivity of ecosystem respiration to rising temperatures. • Changing/reduced carbon uptake and carbon dynamics (sequestration, storage, and fluxes) 	<ul style="list-style-type: none"> • Improved forest management/carbon forestry • Afforestation/reforestation • Avoided land-use conversion • Core area protection/rewilding • Managing land use, fire, and other disturbances and non-climatic stressors
Tree mortality	<ul style="list-style-type: none"> • Interaction between mortality and disturbance risks³ • Drought impacts on mortality 	<ul style="list-style-type: none"> • Adaptation management of fire, pests, and pathogens (variable approaches and opinions) • Restoration of site endemic species • Restoration of landscape heterogeneity
Changes in species range, habitat shifts and abundance	<ul style="list-style-type: none"> • Extinction risk for species with intrinsically low dispersal rate, and species in isolated habitats such as mountain tops • Impacts on keystone and flagship species and the composition of forest communities • Habitat shifts through interaction of climatic factors and anthropogenic pressures 	<ul style="list-style-type: none"> • Reduction of habitat modification and fragmentation, pollution, over-exploitation, and invasive species • Protected area expansion, assisted dispersal and migration, ex situ conservation
Invasion by non-native species	<ul style="list-style-type: none"> • Disruptions of species interactions and altering climatic factors increases the vulnerability of ecosystems to invasion by 	<ul style="list-style-type: none"> • Forest management practices that reduce susceptibility to invasive species, largely

³ Attributed in some cases to direct climate effects (higher risk of extreme events and forest fires) and indirect effects due to insect outbreaks, drought, and disease processes, etc. Dead trees further increase the risk of forest fires.

Topic	Impacts / Risks (sample)	Response prospects
	<p>non-native (alien) species. In the extreme this can result in biome shifts, with consequent changes in the spectrum of ecosystem services provided</p>	<p>based on reducing other stresses (except from climate) and control measures</p>
Forest ecosystem services	<ul style="list-style-type: none"> • Alteration of critical services, such as carbons sequestration and storage, hydrologic regulation, habitat provisioning • Further ecosystem services potentially impacted include provisioning services (bioenergy, water), regulating services such as climate regulation, pollination, pest and disease control, and flood control, supporting services such as primary production (timber) and cultural services, including recreation and aesthetic and spiritual benefits 	<ul style="list-style-type: none"> • Adaptive forest management to build resilience of at-risk ecosystems by identifying the full set of drivers of change and most important areas and resources for protection and restoration • Foster inclusion of climate change considerations into the management of protected areas (incl. Natura2000) and core area restoration • Socio-economic inclusive approaches that may also have community and cultural benefits (Ecosystem-based Adaptation)
Forest – water interactions, including hydrologic regulation and riparian dynamics	<ul style="list-style-type: none"> • Altered hydrology regimes due to climate change will have impacts on forests and the watershed services they provide and affect water quality, aquatic habitats and species and soil resources • Large-scale disturbances, such as fire, bark beetle outbreaks and defoliating insects, will reduce water uptake by trees, reduce infiltration by the soils, causing an increase in runoff, increases and potentially severe erosion and chemical loading • Warmer temperature may accelerate the rate of nutrient cycling in some systems, promoting increased forest growth and elevated nitrogen levels in streams 	<ul style="list-style-type: none"> • Better integrate water-related ecosystem services supply into climate-smart forest management objectives • Broader adoption of riparian buffer standards • Improved forest road planning, design, and regulation

DRAFT TABLE OF CONTENTS

The following draft table of contents suggests single sections and chapters including a possible approach for information gathering and sharing responsibilities for drafting, contributing, and reviewing text. The **core chapters 2** (KNOWLEDGE BASE on CLIMATE CHANGE RISKS and IMPACTS on CARPATHIAN FOREST ECOSYSTEMS and their services) and **3** (PRACTICAL EXAMPLES / CASE STUDIES) will **in content mostly rely on feedback to a survey asking nominated colleagues from the dedicated expert group to fill out a factsheet template** (to be prepared by the CC Secretariat) for their respective country and coordinating input with relevant national experts. The drafting responsibility for those chapters therefore mainly relates to screening the information submitted with the survey template and elaborating an overview summary from a regional Carpathian perspective.

Section / Chapter	Remarks	Suggested number of pages	Approach	Responsibility		
				Drafting	Contributing	Review
Preface	Testimonials e.g., from Carpathian Convention NFPs, other mountain regions, Senior Management UNEP, EC	1	<ul style="list-style-type: none"> Identify and select key stakeholders Conduct short interviews for collecting testimonials / viewpoints 	UNEP		William Keeton
Acknowledgements	Expert group; WG Climate Change and WG Forest, any other contributors	0,5	<ul style="list-style-type: none"> Draft acknowledging all contributors to the assessment 	UNEP		
Key messages		0,5	<ul style="list-style-type: none"> Highlight key findings and conclusions (final stage) 	UNEP	William Keeton	Expert group; WG Climate Change; WG Forest; NFPs
Executive summary		1	<ul style="list-style-type: none"> Summarize assessment and recommendations (final stage) 	UNEP	William Keeton	Expert group; WG Climate Change; WG Forest; NFPs
1 INTRODUCTION						
1.1 Rational and aim	Starting point, why this assessment, objectives	0,5	<ul style="list-style-type: none"> Draft brief introduction on background and objectives 	UNEP	William Keeton	Expert group
1.2 Approach and scope	Approach and topics covered	1	<ul style="list-style-type: none"> Agree on approach (factsheets / survey) and proposed scope with expert group 	UNEP	William Keeton	Expert group

Section / Chapter	Remarks	Suggested number of pages	Approach	Responsibility		
				Drafting	Contributing	Review
1.3 Structure of the assessment	Briefly introducing structure and content	0,5	<ul style="list-style-type: none"> Agree on structure and proposed sections with Expert group Provide brief overview on structure and content of the assessment 	UNEP		William Keeton
1.4 Gaps and barriers	Gaps and barriers regarding information gathering and analysis	0,5	<ul style="list-style-type: none"> TBD at a later stage if at all needed / useful 	UNEP	William Keeton	Expert group
2 KNOWLEDGE BASE on CLIMATE CHANGE RISKS and IMPACTS on CARPATHIAN FOREST ECOSYSTEMS and their services						
2.1 Key risks and impacts	Along identified topics	10	<ul style="list-style-type: none"> Compile and structure references gathered so far Prepare and undertake survey with Expert group to fill out a fact sheet template⁴ per CC country Summarize key risks and impacts across the Carpathian region 	William Keeton	UNEP Expert group	UNEP Expert group
2.2 Response prospects	Related to climate risks and impacts addressed	10	<ul style="list-style-type: none"> Prepare and undertake survey with Expert group to fill out a fact sheet template per CC country Summarize most common response prospects in the Carpathians to identified risks and impacts (focus on adaptation) 	UNEP	William Keeton Expert group	Expert group
2.3 Key initiatives	Linking to ongoing initiatives		<ul style="list-style-type: none"> Desk research on current initiatives within and beyond the Carpathian region Select and highlight key initiatives relevant to key risks/impacts identified as well as to response prospects 	William Keeton	UNEP	Expert group

⁴ The proposed survey asking nominated experts to fill out a factsheet template for their respective country would include information gathering for chapters 2 and 3.

Section / Chapter	Remarks	Suggested number of pages	Approach	Responsibility		
				Drafting	Contributing	Review
2.4 Opportunities and pathways	Unused potentials and opportunities for effective responses / pathways (ecosystem restoration; NbS/EbA)	3	<ul style="list-style-type: none"> Gap analysis of unused potentials based on literature and knowledge/experience in other mountain regions Outline possible approaches and pathways focusing on inclusive ecosystem restoration using NbS/EbA 	UNEP	William Keeton	Expert group
2.5 Limitation and barriers to overcome	Potentially linking to policy frameworks, shortcomings with implementation and financing, Cross-border cooperation, etc.	2	<ul style="list-style-type: none"> Prepare and undertake survey with Expert group to fill out a fact sheet template per CC country Make use of policy analysis undertaken by the WG Climate Change (if available) Summarize and highlight most common limitation and barriers to overcome 	UNEP	William Keeton WG Climate Change	Expert group
2.6 Knowledge gaps and research needs	Further information and research needs	2	<ul style="list-style-type: none"> Based on information gathered and analyzed, identify knowledge gaps and further research needs for better informed decision making 	William Keeton	UNEP	Expert group
3 PRACTICAL EXAMPLES / CASE STUDIES						
3.1 Selected promising approaches with upscaling potential	Highlight case studies from the region with upscaling potential	10	<ul style="list-style-type: none"> Prepare and undertake survey with Expert group to fill out a fact sheet template per CC country Use similar methodology to collect and select promising approaches /case studies as for the Adaptation at Altitude programme⁵ Present a selection of inspiring case studies (one per CC country?) 	UNEP	Expert group	William Keeton

⁵ <https://adaptationaltitude.org/adaptation-at-altitude-solutions-portal-guidance> resp. simplified approach used for East Africa and South Caucasus (under UNEP responsibility)

Section / Chapter	Remarks	Suggested number of pages	Approach	Responsibility		
				Drafting	Contributing	Review
4 CONCLUSIONS / RECOMMENDATIONS	Conclusions and recommended way forward	3	<ul style="list-style-type: none"> Discuss findings of the assessment with Expert group at dedicated meeting (date tbd) and draw main conclusions Summarize main conclusions and draft recommendations 	UNEP	William Keeton	Expert group; WG Climate Change; WG Forest; NFPs
Abbreviations		1		UNEP		
References		5-10		UNEP	Expert group	William Keeton
ANNEX	Factsheets for each CC country Further tbd	?		UNEP	Expert group	William Keeton