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

INTRODUCTION

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 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.

Following the Special Session and Workshop, a **dedicated informal subgroup** of the Working Group on Climate Change and the Working Group on Sustainable Forest Management has been established with experts nominated by the Focal Points of the Carpathian Convention (ANNEX 1: Nominated experts supporting the assessment), 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". On **16 November 2021 a first expert group meeting** took place online that further discussed key impacts and risks as forest ecosystems are facing as well as adaptation responses in the Carpathian region. Further a draft structure for 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;

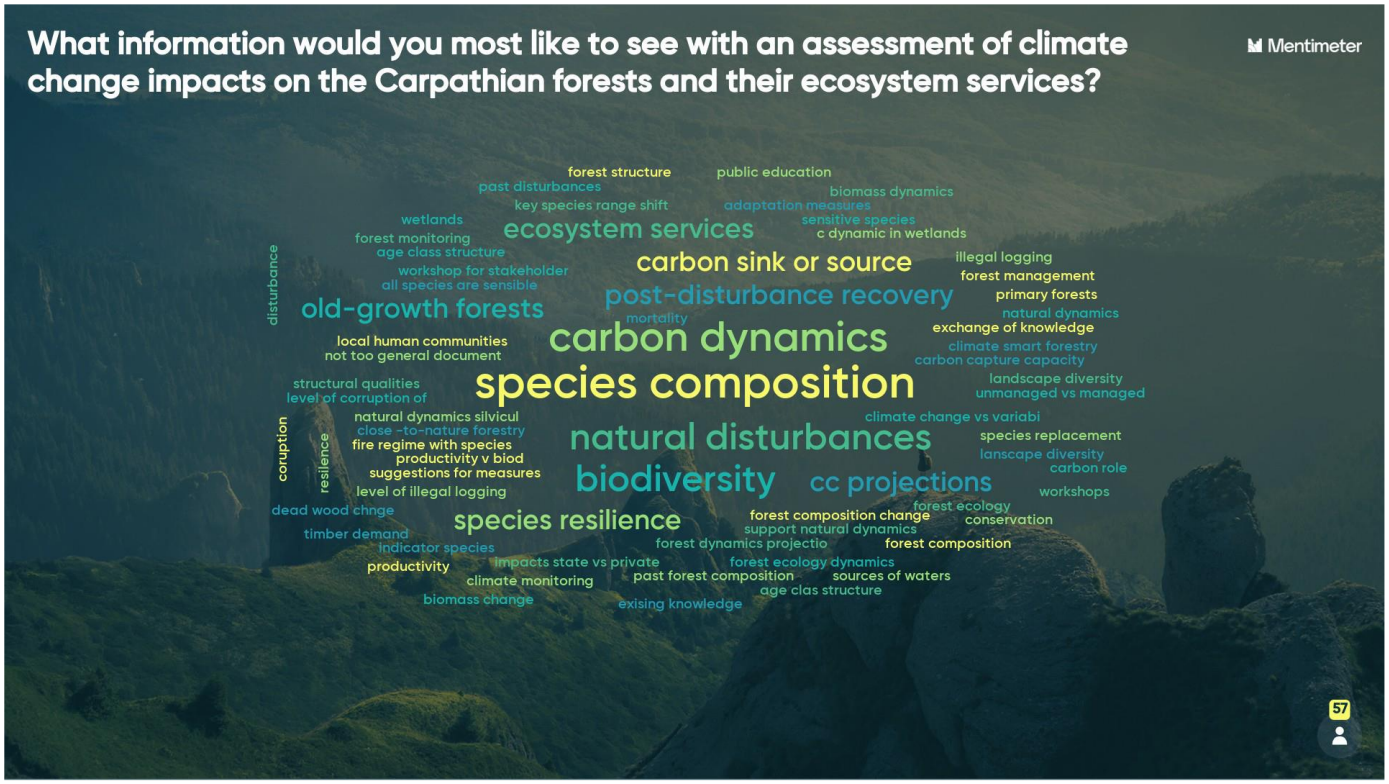
DECISION COP6/18 Climate Change Article 12bis of the Carpathian Convention

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.

ANNEX 2: Draft table of contents for the assessment) has been presented that would be filled with more in-depth information through a **subsequent survey** (ANNEX 3: Survey).
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 the covered by the assessment.

SCOPE AND 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 several areas of concern that have been condensed to the following proposed list of topics that have been further discussed at the expert workshop on 16 November 2021 (online):

Table 1. Key topics, impacts, and responses addressed by the survey

Topic	Impacts / Risks (sample)	Response prospects
Forest growth and productivity	• 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	• Adaptive silviculture • Expanded use of exotic species (pros and cons)
Biomass and Carbon Stocks	• Carbon stored in terrestrial ecosystems is vulnerable to loss back into the atmosphere. Key mechanisms include an	• Improved forest management/carbon forestry • Afforestation/reforestation

Topic	Impacts / Risks (sample)	Response prospects
	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)	• Avoided land-use conversion • Core area protection/rewilding • Managing land use, fire, and other disturbances and non-climatic stressors
Tree mortality	• Interaction between mortality and disturbance risks[2] • Drought impacts on mortality	• 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	• 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	• 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	• Disruptions of species interactions and altering climatic factors increases the vulnerability of ecosystems to invasion by non-native (alien) species. In the extreme this can result in biome shifts, with consequent changes in the spectrum of ecosystem services provided	• Forest management practices that reduce susceptibility to invasive species, largely based on reducing other stresses (except from climate) and control measures
Forest ecosystem services	• 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	• 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	• 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	• 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

[2] 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
	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	

SURVEY

With reference to gather more detailed and highly valued inputs towards identifying and discussing most relevant topics to address when jointly developing the Assessment of climate change risks and impacts on the Carpathian forest ecosystems and their services, survey has been elaborated by the Secretariat together with Dr. William Keeton (ANNEX 3: Survey). This survey contained questions along with the presented structure for the assessment to be filled in by nominated experts, also consulting with national colleagues to gather further contributions.

Survey responses were received by the Secretariat in the first half of 2022, paving the way for an initial analysis and synthesis conducted over the summer. Preliminary findings (see below) were supported by a review of previous European-scale and regional-scale scientific assessments, interviews with leading research groups with on-going projects in the Carpathians, and a literature review using a key word search in Web of Science. The latter focused exclusively on peer-reviewed papers published in English language scientific journals.

PRELIMINARY SYNTHESIS AND FINDINGS

Methods

We coded the questionnaire responses to indicate the number of times particular risks, impacts, and adaptation responses were mentioned. This was performed individually for each topic and then as a cross-cutting synthesis (or meta-analysis) across all the topics. The triangulation method allowed us to identify the top priorities (i.e., greatest concerns) shared among the respondents. When synthesized this way, survey responses were unequivocal with respect to the issues of central concern to national experts throughout the Carpathian region. The significance of these issues was validated by our literature review: the priority risks identified in survey results aligned closely with the topics of most active investigation within recently published and on-going forest science research.

Table 2. Ranked preliminary findings identified through the meta-analysis of survey responses

SYNTHESIS OF RISKS AND IMPACTS	**Primary Risks Identified**	**Convergence/Divergence of Views Regarding Impacts**
Top ranked	Disturbances	Reduced carbon storage, growth increment, and climate regulation. Accelerated shifts in species distributions. Accelerated spread of invasive species
Second ranked	Drought	Forest decline, dieback, and reduced productvity. Shifts in species distributions, exacerbation of insect and fire risks, and diminished ecosystem services
Third ranked and other	Flooding, invasive species, land use pressure	Interations across a range of ecosystem services and habitat provisioning, including carbon sequestration, hyrdologic regulation, and wood production as well as biodiversity
ADAPTATION SYNTHESIS	**Theme**	**Convergence/Divergence of Views Regarding Impacts**
Top ranked	Forest restoration	High agreement on need for restoration and climate-adapted regeneration practices
Second ranked	Sustainable management, including broader use of close to nature silviculture and continuous cover forestry	High agreement on need for broader use of sustainable forest management practices including ecological silviculture
Third ranked and other	Landscape heterogeneity to increase resilience to disturbance and drought	High agreement on need to address altered disturbance regimes, promote future-adapted forest composition, increase landscape heterogeneity and complexity, and reduce spread of invasive species

Finding: Altered disturbance regimes

The most frequently mentioned risk to all key topics (forest growth, biomass, tree mortality, etc.) was the effects of climate change on natural disturbances, particularly forest fires, bark beetle outbreaks, and windstorms. This ~~R~~risk is related to the alteration of disturbance regimes, including the already occurring trends of increased disturbance frequency and intensity. There is an interaction with the land-use history of Carpathian countries, which has made forests more vulnerable to climate exacerbated disturbances. The identified risks closely match the leading topic within current forest science research in Europe. Both national experts and scientific literature suggest a variety of adaptation responses, including forest management to increase compositional heterogeneity across landscapes, restoration of mixed-species and beech forest where these were historically endemic, and management for forest structures that are less susceptible to disturbances. Climate change effects on disturbance regimes are also the primary focus of an on-going pan-European climate vulnerability assessment (FoRISK) undertaken by Forest Europe with support from the European Forest Institute.

Finding: Drought risks to forest resources and services

The second most frequently mentioned risk – a topic clearly of great concern given recent climate trends – was drought. This is perceived by national experts to pose grave consequences for forest growth and productivity, regional tree mortality rates, biodiversity, and future shifts in species composition. The connection to forest-derived water resources and other ecosystem services, such as carbon storage, is also clear. Responses varied in terms of suggested adaptation strategies, but frequently stressed the need for greater attention to regeneration practices (both natural and artificial) that favour future-adapted and

drought tolerant species. There is some debate among both national experts and within the scientific literature of the extent to which exotic tree species should be included within this mix. Many respondents suggested broader use of close-to-nature silvicultural practices to make forests more drought-resistant. This is supported by recent scientific literature, which has shown continuous cover, selection systems, and retention forestry practices to perform well at buffering microclimate below complex forest canopies.

Finding: Flood risks, invasive species, land-use pressures, and the need for restoration

No single theme emerged with a clear tertiary ranking. Rather, responses varied with respect to a variety of additional risks and impacts identified by national experts. These included flood risks and their connection to forest cover and management; spread of invasive insect pests, tree pathogens, and noxious plants; and concerns over increased land-use pressures on forest ecosystems. Respondents had different views on some issues, such as restoration of older forests, the carbon sequestration and storage value of older forests, and whether forest management intensity should be increased or decreased. In some cases, the views expressed in survey responses matched the findings of scientific studies, for instance those relating to flooding and invasive species. In other instances, respondent views sometimes diverged from the developing consensus within the scientific literature, for example on the carbon value of older forests. However, the literature review showed the same degree of debate on the topic of optimal forest management intensity, suggesting that the survey respondents are not alone in having reached widely different conclusions. There was general support for forest restoration, reforestation, and conversion cutting to restore endemic species composition and to create more heterogeneous landscapes.

NEXT STEPS

The following next steps are suggested until December 2022:

- 8TH MEETING OF THE WORKING GROUP ON SUSTAINABLE FOREST MANAGEMENT October 2022:
  The Carpathian Convention Secretariat together with Prof. William Keeton will present the preliminary findings for the draft and discuss open issues and gaps
- October until December 2022: Drafting chapters for the assessment and possibly further information gathering (through follow-up interviews and exchange with scientific network experts)
- Mid/End of December 2022: First draft of the assessment available to be sent out to nominated experts for review

ANNEX 1: NOMINATED EXPERTS SUPPORTING THE ASSESSMENT

Expert Group for the development of the assessment of the climate change risks and impacts on the Carpathian forest ecosystems and their services

Below experts were nominated by the Carpathian Convention Parties based on the CC NOTIFICATION 2021 - 7 – Requesting nomination of experts to be involved in the climate change assessment / special session at the Forum Carpaticum 2022 /WG Climate Change + WG Forest

Country	Name of nominated expert and organization	Email address
Czech Republic	Mr. Miroslav Svoboda, Ph.D., Czech University of Life Sciences Prague	svobodam@fld.czu.cz
	Ms. Eliška Rolfova, Ministry of the Environment of the Czech Republic	Eliska.Rolfova@mzp.cz
	Mr. Radek Pokorný, Mendel University in Brno	radek.pokorny@mendelu.cz
Hungary	Ms. Borbala Galos, University of Sopron.	galos.borbala@uni-sopron.hu
	Ms. Imelda Somodi, Centre for Ecological Research,	somodi.imelda@ecolres.hu
Poland	Mr. Bożydar Neroj, Bureau for Forest Management and Geodesy	bozydar.neroj@zarzad.buligl.pl
	Mr. Wojciech Grodzki, Forest Research Institute	w.grodzki@ibles.waw.pl;
	Ms. Małgorzata Czyżewska, Directorate General of the State Forest of Poland.	malgorzata.czyzewska@lasy.gov.pl
Romania:	Mr. Laurentiu Radu, Ministry of Environment, Waters and Forest,	laurențiu.radu@mmediu.ro;
	Ms. Liliana Virtopeanu, Ministry of Environment, Waters and Forest of Romania.	liliana.virtopeanu@mmediu.ro
	Mr. Borz Stelian Alexandru, Transilvania University of Brasov, Department of Forest Engineering	stelian.borz@unitbv.ro
	Mr. Păcurar Victor Dan, Transilvania University of Brasov	vdpacurar@unitbv.ro,
	Mr. Sorin Cheval, National Meteorological Administration of Romania	sorin.cheval@meteoromania.ro;
	Mr. Popa Ionel, Forest Research and Management Institute, Romania	popaicas@gmail.com;
Slovakia:	Mr. Libor Ulrych, State Nature Conservancy of Slovak Republic	libor.ulrych@sopsr.sk;
Serbia:	Ms. Ilija Dordevic, Institute of forestry, Department for spatial planning, GIS and forest policy, Assistant director for international cooperation	ilija.djordjevic@forest.org.rs
Ukraine:	Ms. Liubov Poliakova, Head of International Cooperation, Science and Public Relation Division, State Forest Resources Agency	lpolyakova@ukr.net
	Mr. Volodymyr Korzhov, Deputy Head of Ukrainian Scientific Institute of Mountain Forestry.	vl.korzhov@ukr.net
Coordinators:	Mr. William Keeton, University of Vermont and Member of the Science for the Carpathians	William.Keeton@uvm.edu;
	Ms. Sabine McCallum, Senior Strategic Advisor and Climate Change Expert – UNEP-SCC	sabine.mccallum@un.org;
	Ms. Klaudia Kuras, Carpathian Convention Coordination Expert, UNEP-SCC	klaudia.kuras@un.org;

ANNEX 2: DRAFT TABLE OF CONTENTS FOR THE ASSESSMENT

The following draft table of contents suggests single sections and chapters including the suggested 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 your feedback to the survey** for each 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	• 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	• Draft acknowledging all contributors to the assessment	UNEP		
Key messages		0,5	• Highlight key findings and conclusions (final stage)	UNEP	William Keeton	Expert group; WG Climate Change; WG Forest; NFPs
Executive summary		1	• 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	• Draft brief introduction on background and objectives	UNEP	William Keeton	Expert group

Section / Chapter	Remarks	Suggested number of pages	Approach	Responsibility		
				Drafting	Contributing	Review
1.2 Approach and scope	Approach and topics covered	1	• Agree on approach (factsheets / survey) and proposed scope with expert group	UNEP	William Keeton	Expert group
1.3 Structure of the assessment	Briefly introducing structure and content	0,5	• 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	• 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	• Compile and structure references gathered so far • Prepare and undertake survey with Expert group to fill out a fact sheet template[3] 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	• 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		• Desk research on current initiatives within and beyond the Carpathian region	William Keeton	UNEP	Expert group

[3] 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
			• Select and highlight key initiatives relevant to key risks/impacts identified as well as to response prospects			
2.4 Opportunities and pathways	Unused potentials and opportunities for effective responses / pathways (ecosystem restoration; NbS/EbA)	3	• 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	• 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	• 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	• 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 programme[4]	UNEP	Expert group	William Keeton

[4] https://adaptationataltitude.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
			• Present a selection of inspiring case studies (one per CC country?)			
4 CONCLUSIONS / RECOMMENDATIONS	Conclusions and recommended way forward	3	• 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

ANNEX 3: SURVEY

INTRODUCTION

The Carpathian Convention Conference of the Parties at its 6th meeting (COP6, 2020) through its decisions[5] 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.

This survey aims to gather information for developing the **assessment of climate change risks and impacts on Carpathian Forest ecosystems and their services** along a draft table of contents (see Annex) that has been presented and agreed at the 1rst Expert Workshop on 16 November 2021 (online).

There are **4 sections** of the survey:

A: CONTACT and CONTRIBUTORS
B: KNOWLEDGE BASE on CLIMATE CHANGE RISKS and IMPACTS on CARPATHIAN FOREST ECOSYSTEMS and their services
C: PRACTICAL EXAMPLES / CASE STUDIES
D: REFERENCES

The Secretariat of the Carpathian Convention together with Dr. William Keeton, University of Vermont and Member of the Science for the Carpathians, highly appreciates your willingness to contribute to assessment by sharing your insights and expertise through this survey. We would also encourage you to consult with national colleagues for further contributions.

Please return the filled in survey until **28.01.2022**. Many thanks in advance for your valuable inputs!

[5] 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.

SECTION A. CONTACT AND CONTRIBUTORS

* 1. CONTACT DETAILS

Name:
Click or tap here to enter text.

Institution you represent:
Click or tap here to enter text.

Type of institution:
Choose an item.
If you chose Other, please specify below:
Click or tap here to enter text.

Gender:
Choose an item.

Email Address:
Click or tap here to enter text.

* 2. COUNTRY

This survey will ask you a series of questions about a particular country where you operate. We appreciate that you may work in multiple locations, so please indicate one below that you will discuss here.

Please use the dropdown list below to select the country:
Choose an item.

* 3. CONTRIBUTORS

You may want to list colleagues that contributed to filling in this survey and shall be acknowledged:
Name:
Click or tap here to enter text.
Institution
Click or tap here to enter text.

SECTION B. KNOWLEDGE BASE ON CLIMATE CHANGE RISKS AND IMPACTS ON CARPATHIAN FOREST ECOSYSTEMS AND THEIR SERVICES

* 1. KEY RISKS AND IMPACTS

For distinguishing between risk and impacts, we are using the concepts of how the IPCC assesses and communicates to decision-makers:

The 'core' definition of **risk** is "**the potential for adverse consequences**":

- The word "potential" makes clear that uncertainty, or more broadly, incomplete knowledge (as defined in IPCC), is a key element of the concept of risk.
- In IPCC use, risk refers only to negative ("adverse") consequences[6].

The term **impact** is used to describe the consequences of realised risks on natural and human systems, where risks result from the interactions of climate-related hazards (including extreme weather and climate events), exposure, and vulnerability.

- Impacts may be referred to as consequences or outcomes occurring within a specific time period.
- Impacts can be adverse or beneficial.[7]

From your experience, please indicate the main risks and potential impacts along the identified key topics:

FOREST GROWTH AND PRODUCTIVITY

Key risk	Potential impacts (consequences, outcomes)

BIOMASS AND CARBON STOCKS

Key risk	Potential impacts (consequences, outcomes)

[6] https://www.ipcc.ch/site/assets/uploads/2021/02/Risk-guidance-FINAL_15Feb2021.pdf
[7] https://apps.ipcc.ch/glossary/

Key risk	Potential impacts (consequences, outcomes)

TREE MORTALITY

Key risk	Potential impacts (consequences, outcomes)

CHANGES IN SPECIES RANGE, HABITAT SHIFTS AND ABUNDANCE

Key risk	Potential impacts (consequences, outcomes)

INVASION BY NON-NATIVE SPECIES

Key risk	Potential impacts (consequences, outcomes)

Key risk	Potential impacts (consequences, outcomes)

FOREST ECOSYSTEM SERVICES

Key risk	Potential impacts (consequences, outcomes)

FOREST – WATER INTERACTIONS, INCLUDING HYDROLOGIC REGULATION AND RIPARIAN DYNAMICS

Key risk	Potential impacts (consequences, outcomes)

* 2. ADAPTATION RESPONSES

From the key risks and impacts identified under B.1, please indicate adaptation response options that you aware of and briefly highlight their intended effects for each key topic. Please note that there is an additional possibility to share adaptation response options that are cross-cutting in tackling more than one of the key topics.

FOREST GROWTH AND PRODUCTIVITY

Please indicate adaptation response options addressing the key risks and impacts mentioned above:

Name / Key word	Main Impact/Risk addressed	Brief description	Intended effect	Pros and cons (if any)

BIOMASS AND CARBON STOCKS

Please indicate adaptation response options addressing the key risks and impacts mentioned above:

Name / Key word	Main Impact/Risk addressed	Brief description	Intended effect	Pros and cons (if any)

TREE MORTALITY

Please indicate adaptation response options addressing the key risks and impacts mentioned above:

Name / Key word	Main Impact/Risk addressed	Brief description	Intended effect	Pros and cons (if any)

CHANGES IN SPECIES RANGE, HABITAT SHIFTS AND ABUNDANCE

Please indicate adaptation response options addressing the key risks and impacts mentioned above:

Name / Key word	Main Impact/Risk addressed	Brief description	Intended effect	Pros and cons (if any)

INVASION BY NON-NATIVE SPECIES

Please indicate adaptation response options addressing the key risks and impacts mentioned above:

Name / Key word	Main Impact/Risk addressed	Brief description	Intended effect	Pros and cons (if any)

Name / Key word	Main Impact/Risk addressed	Brief description	Intended effect	Pros and cons (if any)

FOREST ECOSYSTEM SERVICES

Please indicate adaptation response options addressing the key risks and impacts mentioned above:

Name / Key word	Main Impact/Risk addressed	Brief description	Intended effect	Pros and cons (if any)

FOREST – WATER INTERACTIONS, INCLUDING HYDROLOGIC REGULATION AND RIPARIAN DYNAMICS

Name / Key word	Main Impact/Risk addressed	Brief description	Intended effect	Pros and cons (if any)

CROSS-CUTTING

Name / Key word	Impacts / Risks addressed	Brief description	Intended effect	Pros and cons (if any)

ADDITIONAL FOCUSED QUESTIONS DERIVED FROM THE EXPERT DISCUSSION

Please provide your thoughts on the following topics regarding **specific adaptation response options** raised at our first Expert Workshop on 16 November 2021. In case you already covered one or more of these additional questions, please refer to the respective section above.

Planting and management of exotic species.
Should use of exotic, non-European species comprise an element of adaptative management? Where, when, and how?

Click or tap here to enter text.

Role of landscape level planning, including a diversity of forest zonation and management strategies.
What is your view on the role of protected areas vs. active adaptive management?

Click or tap here to enter text.

Expanded use of "close-to-nature" silviculture (e.g., selection harvesting, continuous cover forestry, retention forestry, etc.).
How is the forest sector in your country considering broadening its portfolio of forest management practices to adapt to climate change, including altered disturbance regimes?

Click or tap here to enter text.

Forest road density, design, and location.
How should forest road systems be managed to reduce vulnerabilities to flooding?

Click or tap here to enter text.

Long-term adaptive forest management objectives.
Should we manage for the historic, current, or future potential vegetation? How is the forest sector in your country approaching these challenging questions?

Click or tap here to enter text.

Public policy, perception, and science.

What are the greatest challenges you face relating to formulating adaptation responses, given the interplay between public perception and public policy that may or may not always be consistent with the science?

Click or tap here to enter text.

Forest harvest rotations.

Is the forest sector in your country considering reducing or increasing forest harvest rotations? Why or why not?

Click or tap here to enter text.

Adaptation to altered natural disturbance regimes.

How is the forest sector in your country adapting to increasing risks of bark beetles, wind, fire, and drought?

Click or tap here to enter text.

Mix of old vs. younger forest stands.

How is the forest sector in your country adjusting the mix of forest ages as adaption to disturbance risk, for the purpose of carbon management, or to conserve biodiversity in the face of climate change?

Click or tap here to enter text.

* 3. FURTHER OPPORTUNITIES AND PATHWAYS

If you are aware of any further unused potentials and opportunities for effective adaptation responses / pathways (e.g., in other countries/mountain regions), please briefly describe:

Click or tap here to enter text.

Please specifically outline possible approaches and pathways you know focusing on inclusive ecosystem restoration using Nature based Solutions (NbS) and Ecosystem based Adaptation (EbA):

Click or tap here to enter text.

* 4. KEY INITIATIVES

Please share ongoing relevant initiatives / larger scale projects in your country / the Carpathian region / elsewhere:

IN YOUR COUNTRY

Name of the initiative /project	Duration of implementation	Brief description	Weblink (if available)	Contact for further information

IN THE CARPATHIAN REGION

Name of the initiative /project	Duration of implementation	Brief description	Weblink (if available)	Contact for further information

ELSEWHERE

Name of the initiative /project	Duration of implementation	Brief description	Weblink (if available)	Contact for further information

Name of the initiative /project	Duration of implementation	Brief description	Weblink (if available)	Contact for further information

* 5. LIMITATION AND BARRIERS TO OVERCOME

From your experience, please highlight the most common limitations and barriers to overcome for developing and implementing effective adaptation responses. These could potentially link to policy frameworks, shortcomings with financing for implementation, cross-border cooperation, etc.

Click or tap here to enter text.

* 6. KNOWLEDGE GAPS AND RESEARCH NEEDS

In your opinion, where do we still have major knowledge gaps and thus research needs toward better informed decision-making for forest ecosystem climate change adaptation?

Please indicate in which areas you see knowledge gaps and research needs and briefly explain why:

Knowledge gap	Research need	Brief explanation

SECTION C. PRACTICAL EXAMPLES / CASE STUDIES

Within this section we aim to collect practical examples that could be showcased as promising approaches with upscaling potential to other countries/regions.

As a general orientation for considering practical examples to share, please reflect the following aspects[8]:

KEY DIMENSIONS TO QUALIFY FOR A MOUNTAIN ADAPTATION SOLUTION

☑ **Relevant**

The solution addresses one or more current or anticipated mountain-specific climate change risks and provides a promising approach to becoming effective[1] in tackling the issue at stake. In this regard, the solution is based on scientific evidence and/or traditional knowledge and practices.

☑ **Practical and feasible**

The solution can be implemented on relevant timescales to address the risks in question, is realistic in terms of resources available (human and financial) and tailored to the actors and their capacities needed for implementation and is sustainable in the longer term (both human capacities and financial resources can realistically be maintained).

☑ **Direct benefits and co-benefits**

The solution promotes ecological, economic and/or social benefits. It shows synergy with and offers co-benefits to climate change mitigation and other sustainable mountain development topics, such as eradication of poverty, averting unemployment, provision of humanitarian aid in case of conflict or disasters, universal health coverage and education, achieving gender equality and empowering women and girls.

☑ **Flexible and robust**

The solution is designed in a way that allows for adjustments and incremental implementation and reiteration depending on the level and degree of climate change, i.e. allows for adaptive management and responds to multiple interests and purposes. Thus, the solution is robust in terms of maintaining its effectiveness under a range of different climatic and socio-economic development scenarios. In doing so, the solution should ideally have built-in mechanisms to enable its monitoring and evaluation of time.

☑ **Replicable and/or scalable**

The solution including its enabling factors has the potential for adjustment, replication or upscaling in other geographic, social or sectorial contexts (even though as such customized and tailored to specific local circumstances).

☑ **Legitimate and coherent**

The solution is politically, culturally, and socially accepted. The solution is not in conflict with other adaptation or sustainable development efforts and coherent with existing or planned policies on local, regional and national level (please note that this does not translate into a requirement that the solution is already integrated in a local, regional or national policy!)

Please share **one or more** promising adaptation approaches from your country that are already in the process of being implemented describing them along the following simple structure. For sharing more than one case study please simply copy the text box below:

[8] These key dimensions are being used under the Adaptation at Altitude programme for gathering and selecting mountain adaptation solutions in South Caucasus and East Africa.

Name of the practical example / case study:
Click or tap here to enter text.

Description:

❖ **The issue**

Short description of the issue to be tackled, which specific related risk/s and impacts are or were being addressed and what the *evidence base /need* for developing this adaptation response in this particular area is.
[responding to the dimension of *Relevance*]

Click or tap here to enter text.

❖ **The solution**

Detailed description of the solution in response to the issue at stake: Short background why the approach has been chosen for addressing the specific mountain-related risk/s and how it has been designed for effective implementation in the geographical location. If applicable, reference shall be made to necessary enabling factors that contribute to the solution´s success such as social inclusion, women empowerment, taking account of the broader socio-economic context, securing political commitment and financing. The description shall also include the time planned for implementing the solution in this area, built-in mechanisms for evaluation and feedback-loops, room for adjustment if needed and the timescale for which the solution is planned to last.
[responding to the dimensions of *Practical and efficient; Flexible and robust*]

Click or tap here to enter text.

❖ **Coverage and Impact**

Brief summary of the main effects adverse which are already evident through implementing the solution, including reference to all areas where the approach provides impacts at the moment of writing the text. A portrait of a beneficiary or a project "owner" will give a more personal aspect to the text. The text can be supported by further elements **such as graphs and photographs to better explain the impact of the solution.**
[responding to the dimensions of *Direct benefits and co-benefits; Legitimate and coherent*]

Click or tap here to enter text.

❖ **Applicability**

Short description about the potential to upscale, replicate or transfer this solution in a different context or continent. In particular, the context specificity but also characteristics of the location are relevant factors for the transferability and scalability of a solution.
These factors include, inter alia, the social and cultural context in which the solution is implemented (e.g. the solution responds to gender-differentiated vulnerabilities, is socially accepted and generally compatible with mountain livelihoods systems), characteristics of beneficiaries of the solutions (e.g. in terms of risk aversion, capacity building towards increasing climate resilience), possibly technology characteristics (e.g. costs, familiarity, perceived usefulness, profitability, co-benefits and/or 'no regrets' potential), the policy environment and other transfer mechanisms such as incentives. Referring to the specific location the solution is being implemented, similar climatic and geophysical factors may also be a precondition for a solution to achieve a similar outcome in a different geographical region.
[responding to the dimension of *Replicable and/or scalable*]

Click or tap here to enter text.

SECTION D. REFERENCES AND ADDITIONAL INFORMATION

* 1. REFERENCES AND FURTHER INFORMATION

Please use this section to share further references and additional information that you see relevant for the assessment (from your country / from the Carpathian region / from elsewhere).

FROM YOUR COUNTRY

Click or tap here to enter text.

FROM THE CARPATHIAN REGION

Click or tap here to enter text.

FROM ELSEWHERE

Click or tap here to enter text.

* 2. FINAL COMMENTS

Please add any other comments or thoughts you would like to share here regarding climate change vulnerabilities and adaptation in forest ecosystems in your country or for your institution.

Click or tap here to enter text.