

Ecological Connectivity and Nature- Based Solutions in The Carpathian Region

ABSTRACT

Research on the potential socio-economic and environmental impacts of implementing Nature-based Solutions to enhance ecological connectivity in the Carpathian region.

Acknowledgments:

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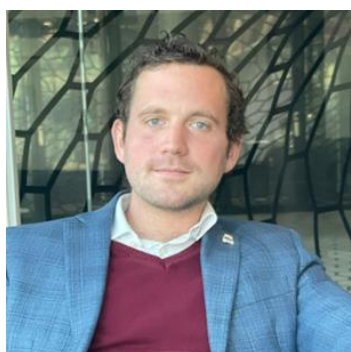


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List of Abbreviations:

ARP - Applied Research Project

COP - Conference of Parties

DNP - Djerdap National Park

ERDF - European Regional Development Fund

ESA - Environmental Services Assessment

GHGs - Greenhouse Gasses

IGNP - Iron Gates Natural Park

IUCN - International Union for the Conservation of Nature

NbS - Nature-based Solutions

PAs - Protected Areas

Ramsar - Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat

SDGs - Sustainable Development Goals

ToC - Theory of Change

UN - United Nations

UNEA - United Nations Environment Assembly

UNEP - United Nations Environmental Program

WWF - World Wild Fund for Nature

Executive Summary:

This report was commissioned by UNEP with the purpose of identifying the socio-economic benefits of applying Nature-based Solutions to enhance ecological connectivity in the Carpathian region. The findings of the 2014 BioREGIO project in the pilot area of the Djerdap National Park (Serbia) and the Iron Gates Natural Park (Romania), as well as interviews with local experts and secondary research of existing reports, were used as a case study to derive a Theory of Change (ToC). This ToC serves both as the theoretical framework and as a final output of the project. It focuses on the conservation and restoration of wetland and forest ecosystems to highlight how increasing ecological connectivity through nature-based solutions (NbS) fosters socio-economic benefits in the Carpathians. This report provides a comprehensive analysis of how nature can be used to restore and repair itself while benefitting society in terms of health, social well-being, and economic opportunities.

The first part of the research consisted in assessing how the causes of ecosystem fragmentation and biodiversity loss has evolved since 2014 in the case study area. One of the main findings of the BioREGIO project was that the threats to forest ecosystems such as invasive species, illegal logging, clear-cutting, single-stock plantations, uncontrolled increased tree cover, and fragmentation caused by roads, were still threats in 2022. Similarly, the threats identified by said pilot project in 2014, including flooding caused by hydroelectric dams, eutrophication, water contamination by plastic waste and fuel, land degradation caused by both air and water pollution, changes to sedimentation and erosion processes, disruptions to water flow and levels, and invasive plant and animal species were still threatening wetland ecosystems in the pilot area in 2022.

These threats to wetland and forest ecosystems were found to be triggered by anthropogenic factors. Among the identified threats to forest ecosystems, the primary root causes were found to be poor forest management practices, mining, urban development, insufficient monitoring of habitat health, and a lack of economic opportunity that pushes locals to resort to illegal tree cutting. In wetland ecosystems, root causes of ecosystem fragmentation and biodiversity loss were also directly prompted by anthropogenic activities such as unsuitable agricultural practices, improper waste management, mining waste dumping, adverse effects caused by hydroelectric plants, and the introduction of invasive species both accidental and deliberate. However, an indirect effect of anthropogenic activity which translates into a natural phenomenon in the form of climate change also threatens the existence of wetland ecosystems with changes in water levels linked to upstream flooding or prolonged droughts, changes in water temperature, and more.

The report found that ecosystem fragmentation translates into the loss of supporting, provisioning, regulating, and cultural ecosystem services offered by the area, which can have devastating socio-economic consequences for the local and Pan-European region. The loss of supporting ecosystem services has socio-economic consequences. Indeed, it would not only mean the disappearance of native and endemic plant and animal species, but it would also affect agriculture with the degradation of soil formation and nutrient cycling capacities. Moreover, wetland and forest ecosystems provide provisioning services that are essential to human survival such as water and agricultural goods for human consumption. Additionally, the provision of timber, agricultural goods, and hydroelectric power enable local communities to generate revenue. Moreover, fragmentation and biodiversity loss

threaten cultural ecosystem services such as ecotourism or the appeal of historical tourist attractions such as medieval monuments, which also generate revenues for local communities. Lastly, the loss of biodiversity and fragmentation of wetland and forest ecosystems would intensify the release of carbon that had been sequestered in the past by those habitats while simultaneously decreasing those same carbon sequestration capacities of the Carpathian region.

Research findings show that national governments, municipalities, and private actors can counteract the effects of ecosystem fragmentation by tackling the root causes of ecosystem degradation through an array of NbS. In 2014, one of the key findings of BioREGIO was that wetlands can be restored and preserved through NbS such as installations of water treatment facilities, restoration of proper hydrological regimes and river dynamics, floodplain recovery, changes to agricultural practices, and the introduction of buffer zones. NbS for forest ecosystems restoration and conservation included banning illegal logging through economic schemes directed at the population, species' introduction, replication of natural distributions for tree plantation, creation of ecological corridors, and implementation of financial tools aimed specifically at biodiversity conservation.

The research showed that in the pilot areas located in both Romania and Serbia, these NbS were not implemented and that the main barriers to such implementations of these NbS were legal, cognitive, and economic. Indeed, lack of legislation and transboundary agreements prevented the tackling of the threats to ecosystems and the facilitation of NbS employment. The lack of funds also explained the absence of implementation of the NbS. Finally, a lack of knowledge about the socio-economic impact of these solutions explained the deficiency of investment in NbS by both the private and public sector.

However, this investigation also demonstrates that although these NbS were not implemented in the pilot area, other areas have derived socio-economic benefits from the implementation of NbS. The main socio-economic benefits of implementing these NbS resulted in flood disaster risk prevention and reductions of monetary losses caused by flood damage, climate change mitigation through the increase of carbon storage capacities, creation of employment opportunities, improved health benefits through the improvement of water quality, and more.

The Theory of Change derived from the research of this report concluded that to **achieve the enhancement of ecological connectivity** as a long-term impact, the following outcomes need to be met: international cooperation for the implementation of Nature-based Solutions, continuous and proper monitoring of biodiversity, increased financing for ecosystem restoration and conservation, and improved sustainable management. The report generated some policy recommendations for each outcome.

The main policy recommendations for the realization of these outcomes were the following:

- Increasing knowledge production and quantification of the socio-economic benefits of Nature-based Solutions through ecosystem service assessments and more
- Introduction of transboundary agreements in terms of knowledge sharing, legislation, and funding in the Carpathian Convention, etc.
- Creation of financial tools to fund these solutions: establishment of markets with offset mechanisms.

Introduction:

With each passing year, climate change progressively dominates the national and international political agendas worldwide with more gravity, and understandably so. It is imperative that competent, collective action is taken to minimize the acceleration of climate change and mitigate its effects. Nevertheless, several other environmental matters are also simultaneously worsening. Amongst them, biodiversity conservation is routinely disregarded as a major problem. Biodiversity degradation can lead to major negative consequences not just for the plant and animal species in danger, but also humanity as a whole. To combat degradation, ecological connectivity remains as a key element.

Ecological connectivity is characterized by the degree to which landscapes and seascapes allow species to move freely and ecological processes to function unimpeded (UNEP, 2014). Ecological connectivity is crucial for the proper conservation of biodiversity in any ecosystem. By connecting different populations and enabling processes to influence a wider area, problems associated with fragmentation are minimized. Strategies designed to increase ecological connectivity are therefore crucial to prevent environmental degradation.

No region is more ecologically fragmented than the Pan-European region (UNEP, 2021). Located in Central and Southeastern Europe, the Carpathians Mountains remain as one of the main biodiversity hotspots in the continent, with the region still possessing massive ecological importance. The Carpathians are home to a myriad of plant and animal species. For instance, two-thirds of the European populations of large carnivores, including bears, lynxes, and wolves, can be found here, as well numerous endemic species such as the beluga sturgeon, now on the edge of extinction (Egerer, 2020). The Carpathians is also the second largest forested area in the Pan-European region with over 100,000 km² of semi/natural forest. Additionally, the Carpathians contain the largest expanse of old-growth forests in Europe and one-third of European plant species can be found in the region (Secretariat of the Carpathian Convention, 2022).

However, the preservation of the Carpathians is threatened by economic development, climate change, and ecosystem fragmentation. Ecosystem Fragmentation is the dissection and reduction of the habitat area available to a given species caused directly by habitat loss or indirectly by habitat isolation (Iuell et al., 2021). The conservation and restoration of the various Carpathian ecosystems is a crucial endeavor that requires a comprehensive and well-thought-out approach from its many stakeholders, from the national governments of the constituent states to the local management entities, to the individual inhabitants of the region.

Climate change and economic development are intrinsically linked to ecosystem fragmentation. As the region has seen substantial human development over the course of the last several decades, reconciling economic growth with biodiversity preservation, ecosystem restoration, and ecological connectivity has become a challenge. The negligence of these dilemmas is extremely problematic, as

ecosystem fragmentation represents a major threat for the survival of countless species, and even crucial human activities such as agriculture and fishing are coming considerably under threat. To address these issues, the implementation of Nature-based Solutions (NbS) is absolutely paramount.

On the 2nd of March 2022, the 5th United Nations Environment Assembly (UNEA) adopted a universal definition of Nature-based Solutions. UNEA defines NbS as actions to ‘protect, conserve, restore, sustainably use, and manage natural or modified terrestrial, freshwater, coastal, and marine ecosystems which address social, economic, and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services, resilience, and biodiversity benefits (UNEA, 2022). UNEA recognises that NbS for biodiversity conservation play an essential role in the overall global effort to achieve the Sustainable Development Goals (SDGs) and climate change mitigation.

This resolution marks a turning point as over the past decades, mainstream environmental discourses have focused on curbing climate change primarily through reducing CO₂ emissions while overlooking biodiversity restoration and conservation. In the wake of the recent adoption of this concept as a universally accepted climate change mitigation strategy, this applied research project will focus on studying the extent to which **the implementation of Nature-based Solutions in one of the most important biodiversity hotspots of the Pan-European region, the Carpathians, can generate socio-economic benefits.**

Several types of ecosystems can be found in the Carpathians. However, two of the most important ones in relation to biodiversity conservation and ecosystem services are old-growth forests and wetlands. Although not the most extensive ecosystems in the area, they disproportionately provide innumerable benefits to the region. Both ecosystems are especially important as highly efficient carbon sinks.

Old-growth or virgin forests may be defined as a climax forest that has never been disturbed by anthropological activities or are essentially free from disturbances. Old-growth forests can be classified as per the age and disturbance criteria (EEA Glossary, 2022). When determining which type of ecosystem is most crucial for conservation, forests tend to come to mind first. This is especially true in regions like the Carpathians, where the importance of forests is already well established. Nonetheless, not all forests are created equal. While restored forests or forests with notable human development can still provide many benefits through ecosystem services, old-growth forests provide services that no other ecosystem can provide. These are strongholds for biodiversity and are especially vulnerable to ecosystem degradation and fragmentation.

Although wetlands provide a massive number of highly beneficial services, they are often overlooked when it comes to conservation efforts. Shedding light on the current state of wetlands across the Carpathians and highlighting the countless benefits that they provide is crucial for biodiversity conservation. Wetlands, just like old-growth forests, are also biodiversity hotspots, yet they remain

largely ignored during restoration and conservation efforts (Hajdukiewicz et al., 2018). In particular, submontane drainages are the most under-protected and under-evaluated (Kajtoch et al., 2013). Although wetlands make up a small portion of the global surface area, they retain a disproportionate amount of the terrestrially stored carbon (UNEP Freshwater, 2022). This is just one of the many reasons why wetlands need to be properly accounted for in conservation efforts.

The health of a multitude of ecosystem services rests on the preservation of the area. Ecosystem services are the benefits contingent to a natural environment and a healthy ecosystem. (Bolund, P. & Sven H. 1999). These services can be provided by agroecosystems, forests, grasslands, and aquatic ecosystems, among others. They have a massive impact not only regionally, but globally, aiding in a multitude of relevant issues, from local flood mitigation to carbon sequestration. By quantifying ecosystem services in terms of socio-economic benefits, they can be better valued and can form an integral part of sustainable development and conservation.

Methodology:

This Applied Research Project aims to analyze how enhancing ecological connectivity through nature-based solutions can generate socio-economic benefits in the Carpathian region. The project objectives include:

- Assessing the importance and contributions of the emergence of concepts such as nature-based solutions and ecological connectivity within the historical baseline of biodiversity conservation in the Carpathian region
- Deconstructing the socio-political institutional barriers to ecological connectivity
- Evaluating the impact of past development projects that used nature-based solutions and current gaps in the solution landscape
- Determining the common criteria of successful projects to find guidelines for the identification of future project opportunities

The main research question of this research project is: How does increasing ecological connectivity through nature-based solutions foster socio-economic benefits in the Carpathian region?

Theoretical Framework:

For the duration of the project we utilized the Theory of Change as defined by our partner UNEP. Their definition posits,

“A Theory of Change is a method used for planning a project, describing the participation that will be needed by different actors and for evaluating the project’s performance. It articulates long lasting intended impact and then maps backward to identify the preconditions necessary to achieve this impact(s). It is a comprehensive description and illustration of how and why a desired change is expected to happen in a context. A Theory of Change also allows for unintended positive and/or negative effects to be depicted.”

Utilizing the Theory of Change as our central framework allows for a clear presentation of our findings within an easily understandable and a clearly formatted framework. This also permits the dissemination of our findings to be made in a coherent and concise manner that can be presented to stakeholders and other interested parties.

Case Study Area:

This research project will assess the impact of a project implemented in the pilot area of Iron Gates Natural Park (IGNP) and Djerdap National Park (DNP) in 2014. This specific area serves as the ideal

case study for assessment. While both parks are comprised of the same ecosystems, IGNP is in Romania and DNP in Serbia. This provides the opportunity to analyze the differences in conservation and management practices in two different states, one EU and one non-EU. This study can also highlight the importance of cross-country collaboration for ecosystem conservation.

Investigation Methods:

In order to determine the success of implementing program recommendations begun under the BioREGIO project, we contacted a range of scientists and policy professionals involved in the development of the project and research for interviews. The substantial response rate for interviews provided us with meaningful access to expert opinions on the ongoing impacts of BioREGIO. We took as our starting point the significant literature and technical outputs developed during the duration of the BioREGIO project and formulated questions based on our preliminary research in order to best determine whether recommendations and best practices had been implemented.

We also looked beyond the context of the work done by BioREGIO to academic literature provided by ongoing research. This was supplemented by our attendance at two working group meetings facilitated by UNEP. The presentations and conversations at the Carpathian Convention workgroup for forest management in Levice, Slovakia and the Convention for Wetlands held in Geneva, Switzerland provided the foundation for our technical understanding of the problems facing each ecosystem in the research area.

PART 1

THE THEORY OF
CHANGE

BIOREGIO



Part 1: Theory of Change of the BioREGIO Project

The BioREGIO project was the fruit of the collaboration between UNEP and the EU's South East Europe Transnational Cooperation Programme. Additionally, 16 other partners participated in the project including international, national, and local authorities and organizations and scientific institutions. All seven Carpathian Ministries of the Environment oversaw the project in the capacity of observers. The project was co-funded by the European Union and the European Regional Development Fund (ERDF), it had an overall budget of €2,202,888.77. The European Union provided €200,000.00 provided to the Republic of Serbia for their partnership in this project. The project started in 2011 and ended in 2014.

The multi-actor collective aimed to contribute to the protection and development of the Carpathian Mountain region. The project built on the existing framework of the Carpathian Convention and its Biodiversity Protocol to improve the management of natural resources in the region and to promote sustainable development. The overall desired impact of the project was to promote nature-based solutions to address ecosystem fragmentation in the Carpathian area. Impacts are long-lasting results arising directly or indirectly from a project, impacts are intended and positive changes and must relate to UNEP's mandate (UNEP, 2021).

This report evaluates the theory of change of the project, how the outputs contributed to the desired outcomes of the project. According to UNEP, the outputs of a project are availability (for intended beneficiaries/users) of new products and services and/or gains in knowledge, abilities and awareness of individuals or within institutions. For example, access by the intended user to a report; new knowledge held by a workshop participant at the end of a training event; heightened awareness of a serious risk among targeted decision-makers. Outputs are viewed from the perspective of the intended beneficiary or user of the output rather than the provider (2021). The outcomes of a project are characterized by the use (i.e., uptake, adoption, application) of an output by intended beneficiaries, observed as a change in institutions, behaviors, attitudes, or conditions.

Furthermore, this report will analyze the necessary preconditions to translate outcome to impact through the determination of drivers and assumptions of this theory of change. As defined by UNEP, we understand drivers to be “a significant external factor that, if present, is expected to contribute to the realization of the intended results of a project. Drivers can be influenced by the project and its partners.” **Likewise**, assumptions are understood to be, “significant external factors or conditions that need to be present for the realization of the intended results but is beyond the influence of the project and its partners. Assumptions are often positively formulated risks (UNEP, 2021).”

Figure 1: Theory of Change

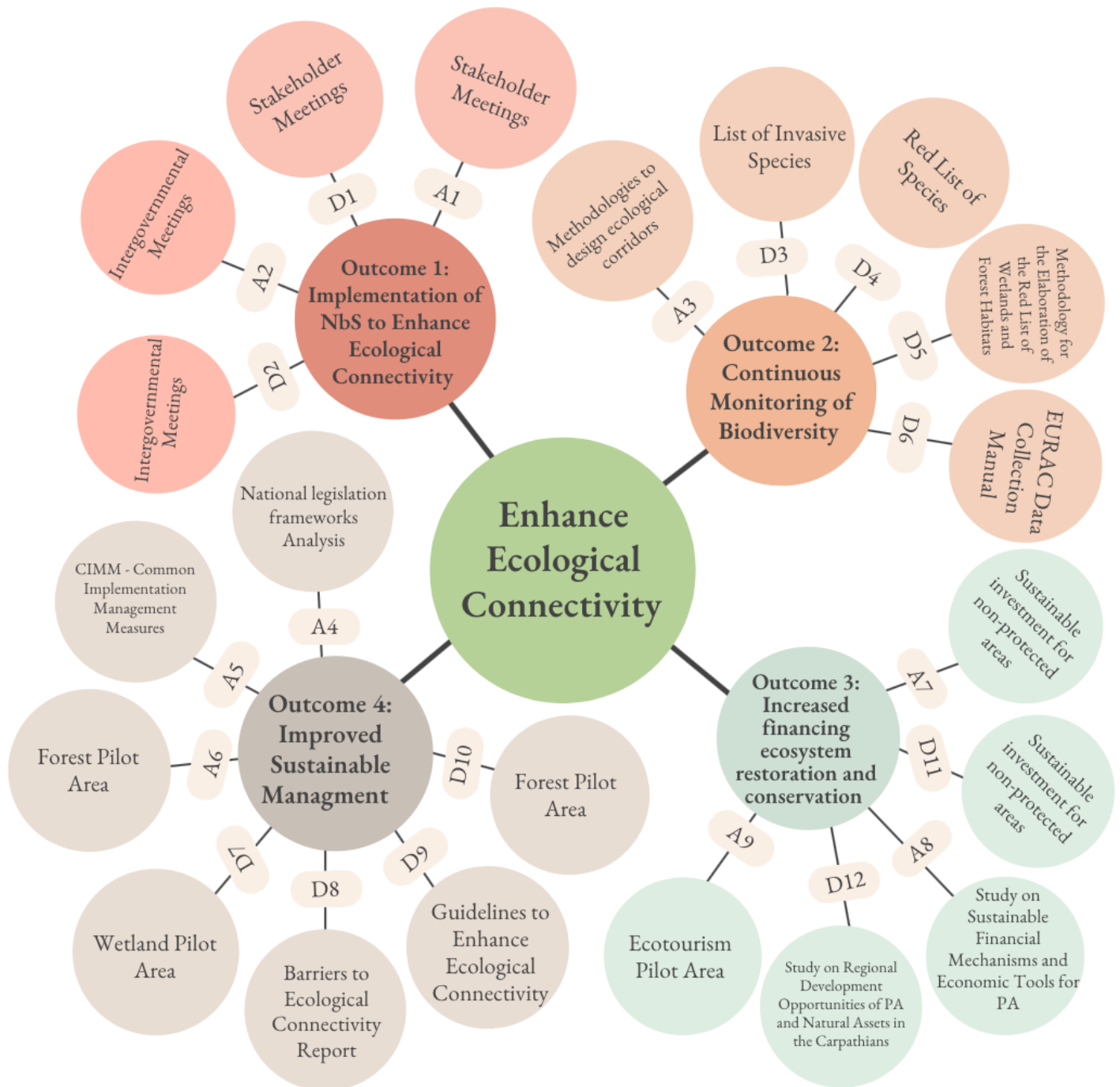


Table 1: Drivers and Assumptions

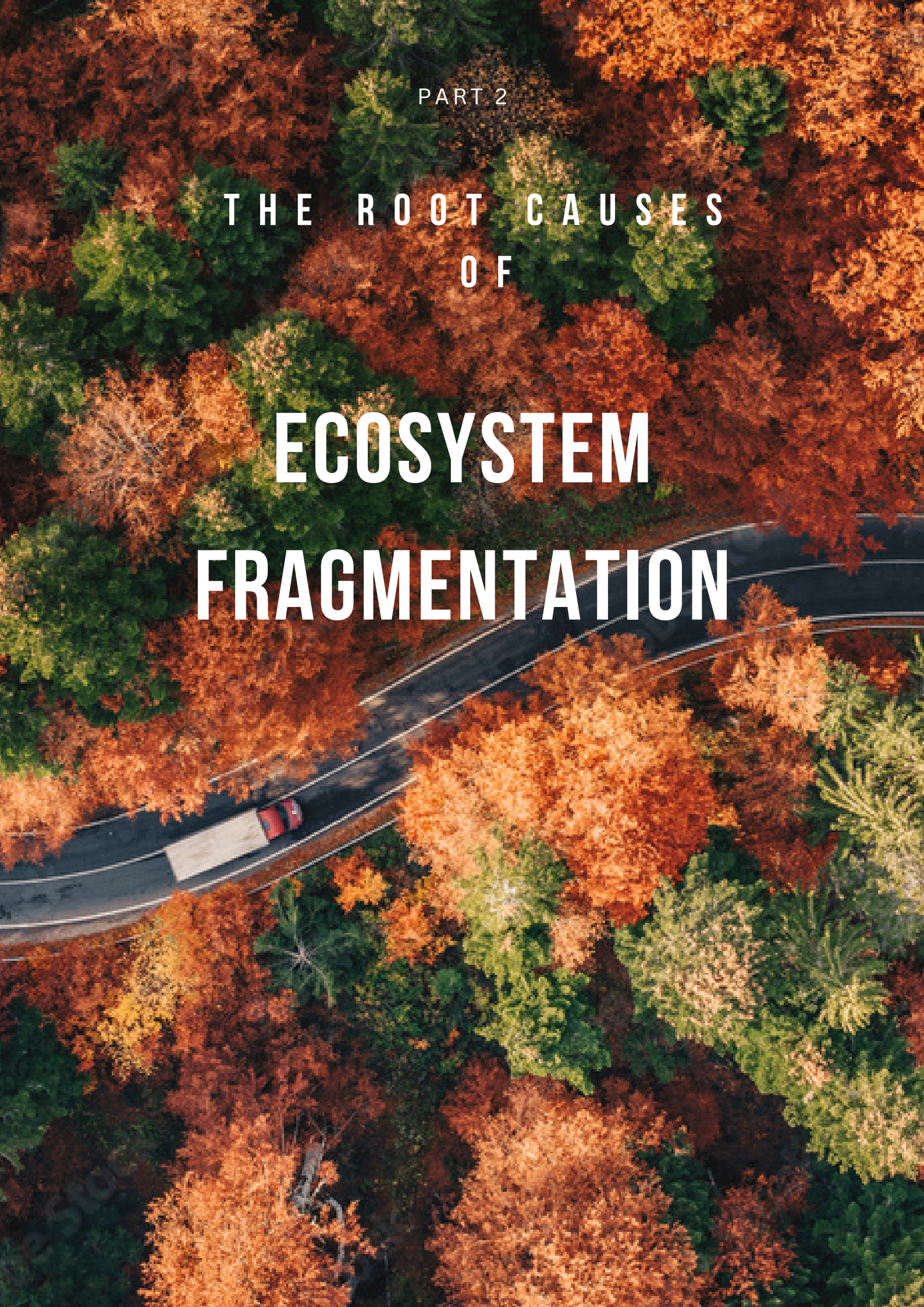
Assumptions	Code	Status in Serbia	Status in Romania	Carpathian Convention
➔ Recognition of the value of wetland and forest ecosystems as climate mitigation strategies	A1 Outcome 1	Absent from legislation	Absent from legislation	Ecological corridors are in the Carpathian Convention; however, they are not labelled as Nature-based Solutions
➔ Availability of finance for NbS Implementation	A2 Outcome 1	Lack of funding	Lack of funding	N/A
➔ Sufficient expertise on ecosystems	A3 Outcome 2	Not enough expertise overall, including a more significant lack of expertise in certain areas, especially wetlands management	Not enough expertise overall, including a more significant lack of expertise in certain areas, especially wetlands management	Recommends to: establish working groups/networks of experts to coordinate activities related to knowledge sharing of environmental expertise
➔ Transboundary mining waste management policies	A4 Outcome 2	None existent	None existent	N/A
➔ Transboundary common implementation measures for park management	A5 Outcome 3	None existent	None existent	N/A
➔ Economic Stability for Local Populations	A6 Outcome 3	Carpathian region is an economically marginalised region	Carpathian region is an economically marginalised region	N/A
➔ Multi-stakeholder approach to funding and willingness of private sector to invest	A7 Outcome 4	Government funding and the EU funds most of PA	Government funding funds most PA and EU contributions	N/A
➔ Existence of financial markets	A8 Outcome 4	The EU Emissions Trading System operates in Romania	The EU Emissions Trading System operates in Serbia	Article 12 of the Carpathian Convention asks the Parties to apply specific impact assessment tools to ensure that the environmental, social, and economic benefits and costs of the planned actions are taken into consideration, and that the most balanced and least harmful option is found.

Driver	Code	Status in Serbia	Status in Romania	Carpathian Convention
Existence of knowledge production on NbS	D1 Outcome 1	Lack of knowledge	Lack of knowledge	No mention
Collaboration between PA, IOs, and private companies to implement NbS	D2 Outcome 1	Some projects have a multi-stakeholder approach but parks lack this approach	Some projects have a multi-stakeholder approach but parks lack this approach	No mention
Application of an Ecosystem Services Assessment	D3 Outcome 2	Measured by Ramsar, but carbon sequestration capacities are not quantified & analysis is vague	In the park: carbon sequestration capacities not quantified For policy: National Ecosystems Assessment (NEA) exist at a national level	Article 12 of the Carpathian Convention asks the Parties to apply specific impact assessment tools to ensure that the environmental, social, and economic benefits and costs of the planned actions are taken into consideration, and that the most balanced and least harmful option is found.
Evaluation of root causes of ecosystem fragmentation	D4 Outcome 2	Lack of detailed analyses: we needed to rely on interviews	Lack of detailed analyses: we needed to rely on interviews	First List of Invasive Alien Species was created for further consultation and development in order to assess current and potential future threats to local biodiversity and ecosystems of the Carpathians caused by introduction or release of invasive alien species
Constant monitoring of endangered and invasive species	D5 Outcome 2	Implementation: None (Goran, interview)	Implementation: yes (but quite limited) but not for wetlands as there is a lack of expertise in IGBP (Amalia interview)	Parties are also requested to pursue policies by using continuous monitoring, assessment and reporting methods.
Transboundary Monitoring practices for ecosystem services	D6 Outcome 2	No transboundary agreement, but the park is part of Ramsar	No transboundary agreement In the process of becoming a part of Ramsar	Systems and information certainly exist in all countries. In order to combine and harmonize them, transboundary cooperation, the exchange of information and mutual assistance by all parties involved is needed
Mismanagement practices such as illegal logging are stopped	D7 Outcome 3	N/A	N/A	N/A
Mismanagement practices such as clear-cutting are stopped	D8 Outcome 3	N/A	N/A	N/A
Application of an Ecosystem Services Assessment	D9 Outcome 3	N/A	N/A	N/A

PART 2

THE ROOT CAUSES
OF

ECOSYSTEM FRAGMENTATION



Part 2: Root Causes of Ecological Fragmentation

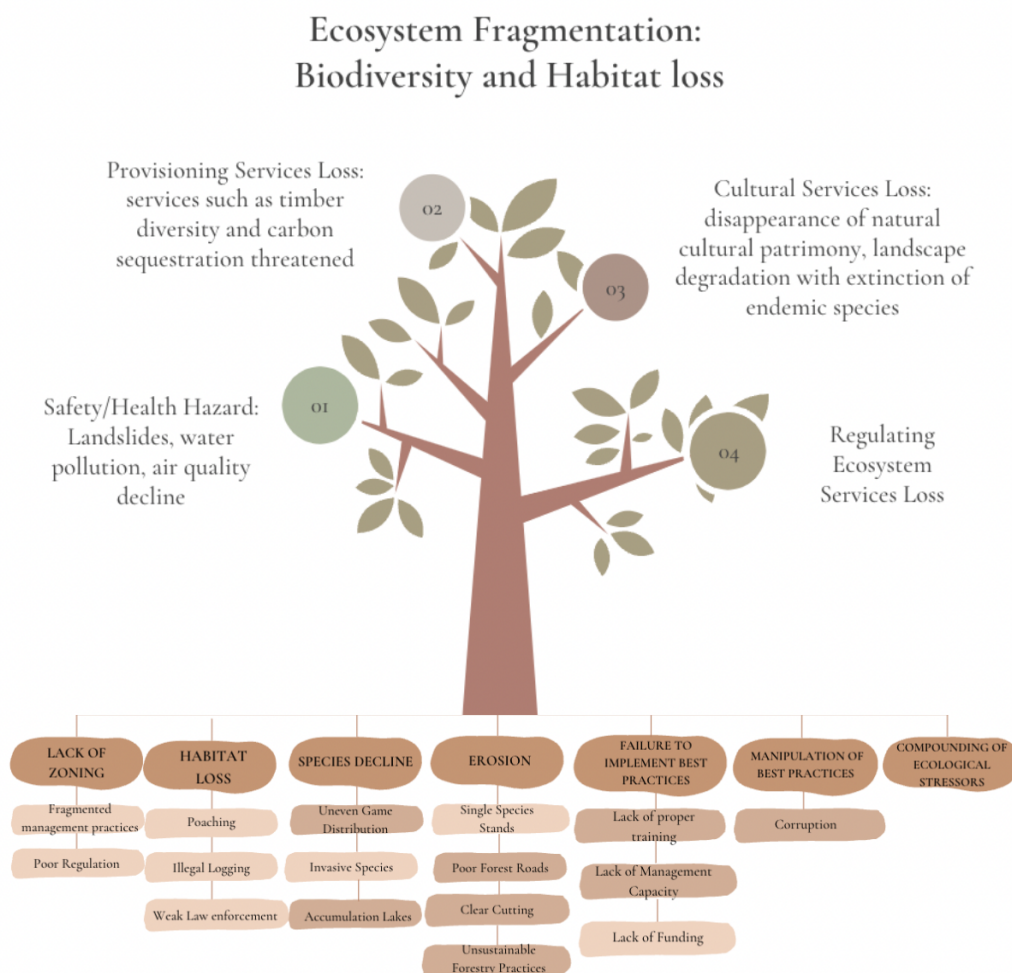


Figure 2: Root causes of Forest Ecosystems Fragmentation

Identifying the root causes of ecosystem degradation and fragmentation is an essential step before improving ecological connectivity can be done. This report will evaluate whether the threats identified by BioREGIO in 2014 are still the degrading and fragmenting forest and wetland ecosystems in 2022.

The current threats forests are facing in the Carpathians fall largely under the heading of management. While overall forest cover in the region has been expanding, threats to old-growth and virgin forests are still widespread with the potential for irreversible damage and sustained decline of intact forest systems. Legally, **clear cutting and illegal logging** are particularly influential threats with limited efforts being made in some areas to address these concerns. Even within protected areas, forest **management practices** are often highly similar to that of **managed for-profit forests** with

insufficient regard for biodiversity conservation and the maintenance of long-term ecosystem services (CIMM, 2014, Keeton, 2022).

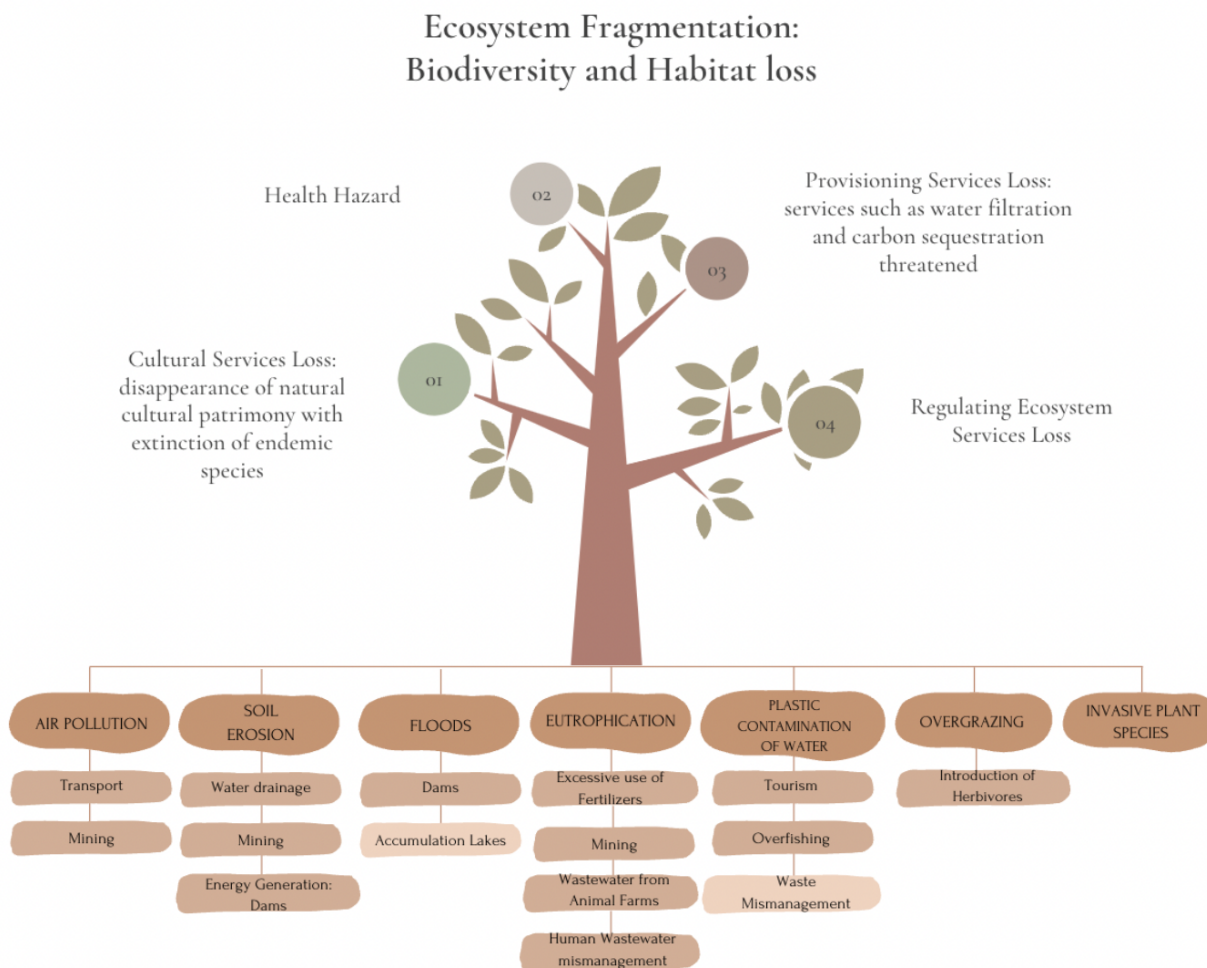
A lack of clear national regulatory regimes and a dearth of funding for supporting forest management and the implementation of best practices also stands as an obstacle to proper forest protection and sustainable forestry implementation. Forestry related subsidy programs also have a mixed history with some funding going towards projects and forestry stands that have exacerbated existing problems. Insufficient funding for forest rangers also means that monitoring of illegal practices and monitoring of correct implementation of best practices is limited and often poorly distributed geographically (CIMM, 2014).

Finally, a lack of capacity building among forest management officials and practitioners is an obstacle, as the wrong practices are often prioritized or warped to fit special interests. This is particularly true of old-growth and virgin forests. This has become an impediment to bettering the understanding of the importance of old-growth and virgin forest systems in regulating broader ecosystems and preserving local and regional biodiversity and connectivity (CIMM, 2014, Keeton, 2022).

Table 3: Threats to forest ecosystems

IN 2014	IN 2022	ROOT CAUSES
Invasive species	Still a threat	Poor monitoring and lack of prevention
Illegal logging	Still a threat	Lack economic opportunity for local populations
Clear-cutting	Still a threat	Forestry mismanagement practices
Single stock plantations	Still a threat	Forestry mismanagement practices
Increased tree cover (uncontrolled)	Still a threat	Forestry mismanagement practices
Roads (fragmentation)	Still a threat	Urban development

Figure 3: Root causes of Forest Ecosystems Fragmentation



According to BioREGIO’s report, in 2014, the main threats to biodiversity were both natural and anthropological. Anthropogenic threats to biodiversity include activities such as tourism, mining, agriculture, energy production, and transportation. The previously mentioned activities have led to numerous negative outcomes, such as flooding, droughts, eutrophication, water contamination, soil erosion, and sedimentation. All these processes or events can greatly disturb existing ecosystems and imperial human welfare. Natural threats to biodiversity are linked to climate change and invasive species introductions, which in turn is linked to anthropogenic activities as well.

Water Contamination:

The first general category of root causes of wetland degradation is related to water itself. Issues with contamination and management are often the most complicated ones to correct, although these are also the ones that normally attract the most attention. According to the 2014 UNEP BioREGIO,

there are two main issues related directly to water: water contamination from organic waste and fertilizers, and water flow disturbances and sedimentation and erosion.

In the area, agricultural activities have caused both drainage and eutrophication as unsustainable use of fertilizers coupled with the increase of waste from animal sources have led to strong input of nutrients in an aquatic environment that stimulates algae growth (BioREGIO, 2014: 69). Bioaccumulation of toxins (or the increase in concentration of a chemical in a biological organism over time) affects more than just the food chain (UNEP 2014, 67). It can also have dangerous effects on activities such as recreational fishing (UNEP 2014, 67). Contamination from organic waste such as manure and fertilizers both organic and inorganic can have devastating impacts on all types of flora and fauna found in wetland habitats.

Mismanagement of sewage has also been causing water contamination with the dumping of wastewater directly into the Danube (BioREGIO, 2014: 81). Transport on the Danube River as well as toxic fumes from road transportation have likewise been associated with water contamination. An increase of plastic water contamination has been monitored because of touristic activities (BioREGIO, 2014: 67). Today, water contamination due to waste mismanagement in the Danube remains one of the main threats to wetland ecosystems (Dumbrava, 2022).

The heavy metal extraction of the Moldova Nouă copper mine and Majdanpek gold mine caused water contamination as well as land degradation and air pollution (BioREGIO, 2014: 76). In Romania, mining and metallurgy date back to over 2000 years. However, what was once perceived as a traditional and cultural economic activity has become a major threat to public health over the years. Although the mine in Moldova Nouă closed in 2006 (Cuprumold Mining SA, 2022), mining is still contaminating water sources in both Serbia and Romania (Sekulic, 2022).

Although not mentioned in detail in the BioREGIO project, which simply refers to ‘mining activities’, the abandonment of the Bosneag pond, a tailing pond, was and still is a major threat to biodiversity and wetland ecosystems. A tailing pond is a man made dam or pond that stores residues from the mining process, including tailings. If abandoned, the pond could flood and contaminate neighboring water sources. It is extremely important that these infrastructures are maintained properly as mining waste contains high levels of heavy metals which can be harmful to the environment and human health. If abandoned, the tailing ponds could dry and the toxic mining residues can turn into dust and pollute the air. If the tailing ponds flood, then the contaminated tailings will contaminate other water sources such as the Danube in the case of the Bosneag pond. Nevertheless, the Bosneag tailing pond has been contaminating the subterranean water sources of the park for over 60 years. The abandonment of the Bosneag pond was extremely problematic since it represented 102 hectares of copper and zinc tailing extracted from Moldova Noua mines. To this day, the Bosneag pond represents a public health and safety hazard.

I. Hydroelectric Plants:

In the Serbian Djerdap National Park pilot area, wetland management developments such as the construction of accumulation lakes or water reservoirs caused floods that led to the reduction of endemic plant species such as the Boiler tulip and *Crocus banaticus* (BioREGIO, 2014: 10). A series of hydroelectric dams straddling both sides of the border also led to changes in water levels, contributing to the increase of flooding upstream of the dams and droughts downstream, negatively affecting biodiversity and wetland habitats as a whole (BioREGIO, 2014: 24). Water temperature changes have also been attributed to the construction of the dams (BioREGIO, 2014: 82). These can greatly alter the living conditions for freshwater species on both sides of the dam. Changes in water levels caused by dams have also had an impact on nesting birds habitats and sedimentation patterns, thus causing both degradation in bird species populations through ecosystem fragmentation and increased soil deposition (BioREGIO, 2014: 77). Studies from 2010 also reported that the construction of the hydroelectric dams caused the fragmentation of sturgeon populations in the park (Schneider, 2010). This is still an issue in 2022, according to WWF Serbia representative (Sekulic, 2022).

II. Climate Change - Floods to Droughts:

During the summer of 2022, water level issues were characterized by droughts caused by climate change. In July, water levels of the Danube were one-third of what they should be during that time of the year (Chirileasa, 2022). In Romania, 700 towns had to reduce their water supplies, the drought affected the Iron Gates hydropower stations, which were operating at lower capacities, fishing, and over 240,000 hectares of agricultural crops (Greenpeace, 2022).

III. Invasive Species:

Finally, natural causes of biodiversity loss include invasions of non-native plant and animal species. Monotypic plant communities altered habitats structures, productivity, food chains, and nutrient cycles (BioREGIO, 2014: 59). Moreover, the deliberate introduction of large herbivores caused biodiversity loss as the newly introduced non-native species overgrazed.

Table 3 - Threats to Wetland Ecosystems:

IN 2014	IN 2022	ROOT CAUSES
Hydroelectric dams => Disappearance of Native Plants	Still a threat	<ul style="list-style-type: none"> • Upstream flooding • Changes in water temperature • Changes in sediment deposition levels
Hydroelectric Dams => Fragmentation Animal Habitats	Still a threat	<ul style="list-style-type: none"> • Hydroelectric dams serve as barriers between different segments of the river • Upstream flooding • Water level changes
Eutrophication	Still a threat	<ul style="list-style-type: none"> • Overuse of fertilizers • Improper management of agricultural animal waste • Improper waste water management
Water Contamination by Plastic and Fuel	Still a threat	<ul style="list-style-type: none"> • Economic development and urbanization • Increased tourism • Increased road traffic
Land Degradation/(Air and Water Pollution)	Still a threat	<ul style="list-style-type: none"> • Mining activities • Tailing Ponds/dumps
Changes to Sedimentation and Erosion Patterns Changes to Water flow and Water levels)	Still a threat	<ul style="list-style-type: none"> • Hydroelectric plants
Invasive Plant and Animal Species	Still a threat	<ul style="list-style-type: none"> • Accidental and deliberate introductions • Eutrophication

PART 3

THE CONSEQUENCES
OF





ECOSYSTEM DEGRADATION



Part 3: Consequences of Biodiversity and Ecosystem Degradation and Fragmentation

There are consequences to ecosystem fragmentation and degradation that surpass strictly environmental damage and affect human wellbeing and economic activity. In order to understand the true repercussions of biodiversity loss and ecosystem degradation, it is important to comprehend the ecosystem services provided by those ecosystems. Biodiversity loss, habitat destruction, and ecosystem fragmentation lead to the disappearance of ecosystem services and the emergence of biological and health threats.

Table 4: The Consequences of Ecosystem Service Degradation

Supporting 	Provisioning 	Regulating 	Cultural 
Type of Ecosystem Services Offered in Iron Gates and Djerdap Region			
<ul style="list-style-type: none"> • Nutrient Cycling • Soil Formation • Native habitat for: <ul style="list-style-type: none"> ◦ 5,000 species of invertebrates ◦ 14 species of amphibians ◦ 17 species of reptiles ◦ 205 species of birds ◦ 34 species of mammals 	<ul style="list-style-type: none"> • Wetlands: water (both for consumption and for energy), food (small-scale fishing) • Forest Ecosystems: timber and other agro-forestry products, food (hunting and agricultural) 	<ul style="list-style-type: none"> • Carbon sequestration (both wetland and forest ecosystems) • Pollination by wild insects (both wetland and forest ecosystems) • Water filtration (wetlands) • Waste decomposition 	<ul style="list-style-type: none"> • Cultural heritage sights of regional and national importance (more than 20 listed) • Scientific work and education • Wetlands: fishing, tourism • Forest: tourism, hunting, historical sites
Consequences of Ecosystem Service Degradation			
Loss of endemic species	<ul style="list-style-type: none"> • Health hazards through water contamination • Loss of economic activities such as fishing, agriculture 	<ul style="list-style-type: none"> • Increase flooding risks • Increase landslide risks • Acceleration of climate change • Decreased biodiversity and environmental resilience 	Loss of recreational activities Loss of cultural patrimony

I. The Consequences of Losing Supporting Services:

Supporting services are the processes that allow the planet to sustain basic life forms (National Wildlife Federation, 2022). Crucial processes such as nutrient recycling cycles and photosynthesis serve as the basis for entire ecosystems and help maintain healthy biodiversity levels (Food and Agriculture of the United Nations, 2022). The pilot area studied is considered a biodiversity hotspot, and BioREGIO scientists found that the Serbian and Romanian parks host a myriad of different plant and animal species. In IGNP alone, over 5,000 species of invertebrates, 14 species of amphibians, 17 species of reptiles, 205 species of birds, and 34 species of mammals, including large and medium carnivores, were categorized (BioREGIO, 2014: 23). Many of these have protected status. Additionally, 1,668 plant species were inventoried, with 242 (14.5%) of these being included in the Red List of Higher Plants in Romania (BioREGIO, 2014: 21). These species are part of a collection of complex and endangered ecosystems. In 2008, the International Union for the Conservation of Nature (IUCN) began developing a Red List of Ecosystems to assess the vulnerability status of ecosystems worldwide. By analyzing a multitude of factors, experts determined the likelihood that the environment would collapse within the next 50-100 years (South East Europe and BioREGIO Carpathians, 2014).

As a consequence of ecosystem fragmentation, the existence of these ecosystems is threatened. The study found that across the Carpathians, 65% of all ecosystems categorized were either “critically endangered”, “endangered”, or “vulnerable” to collapse, 27% were “near-threatened”, and only around 8% were “least concern” or “ecologically satisfactory” (South East Europe and BioREGIO Carpathians, 2014). In Romania, the situation was worse, with the respective numbers being 72% “endangered” or similar, 25% “near threatened”, and only 3% “ecologically satisfactory” (South East Europe and BioREGIO Carpathians, 2014).

II. The Consequences of Losing Regulating Ecosystem Services:

Regulating services are benefits provided by ecosystem processes that moderate natural phenomena such as water filtration or pollination of crops by wild insects (National Wildlife Federation, 2022). The regulating systems provided by wetlands in the DNP and IGNP area are characterized by hydrological transfer and flood control, biochemical transfer, nitrogen and carbon cycling, filtering, cleaning, and retention of nutrients (UNEP, 2014: 36). According to RAMSAR (2022), the importance of the Djerdap site hydrological regimes as a regulating service is high with features such as groundwater recharge and discharge.

Accelerating Climate Change by Losing Carbon Sequestration:

Forests landscapes, particularly old-growth (older and diverse stands) and virgin (completely or largely untouched) forests, throughout the Carpathian region provide essential ecosystem services which are coming increasingly under threat. Virgin and old-growth forests are particularly valuable for their contribution to carbon retention and uptake. Mostly or completely undisturbed forest ecosystems with

ecological balance and cohesive systems are the most effective forest ecosystem in sequestering and storing carbon long term. High biodiversity forests are also more resilient to natural disturbances and are more likely to naturally adapt to changes in climate and nutrient conditions than managed or single species stands (Konôpka et al, 2019). Encroachment on virgin forests, which contain high volumes of carbon, also threaten to speed the advance of climate change while depriving forest management of valuable tools for best practices within managed areas.

While concrete data on the effects of invasive species on carbon sequestration in the Carpathian Mountains is not available, research conducted across a range of ecosystems indicates that invasive species, particularly invasive plant and insect varieties, can have profound effects on an ecosystem's carbon cycle. This is particularly true of aquatic plants and their effects on wetland forests. A pilot study conducted in wetland forests in Hawaii found that the removal of invasive aquatic plants dramatically increased native plant expansion and overall carbon uptake. More research on the role invasive species play in the various carbon cycles across ecosystem diversity could be beneficial for further incentivizing the maintenance of natural ecosystems and the funding of invasive species eradication. (Poland, et al 2021)

Carbon sequestration is arguably the most important ecosystem service provided by wetland ecosystems. In fact, wetlands have higher carbon storing capacities than any other terrestrial ecosystem (UNEP Freshwater, 2022). Although wetlands make up only 6% of the global surface area, they retain more than 20% of the terrestrially stored carbon (UNEP Freshwater, 2022). This is why the loss of wetland ecosystems not only prevents higher levels of carbon sequestration, it also discharges extensive amounts of carbon into the atmosphere.

Losing Soil Properties such as Water Retention:

Wetlands also provide water retention and flood prevention capabilities that can aid massively during periods of heavy precipitation (Keeton & Crow, 2009), (which in recent years have become more damaging and common). Additionally, erosion may lead to issues such as hazardous impacts on water-side infrastructure and alterations to riparian habitats (UNEP 2014, 77). The recovery of natural forest habitats in previously agricultural or managed areas also results in better outcomes for landscape management and safety with corresponding decreases in soil erosion, landslides, water pollution, and species disturbance related to carbon release (Malek et al, 2018).

III. The Consequences of Losing Provisioning Services:

Threats to wetland ecosystems also affect provisioning services. According to the National Wildlife Federation and Millennium Ecosystem Assessment (a major UN-sponsored effort), provisioning services include any kind of tangible resource that can be extracted out of an environment (National Wildlife Federation, 2022). The IGP and DNP area provide a variety of provisioning services such

as timber, fish, grains, water, copper, zinc, and gold, as well as energy since there are hydroelectric plants in the area. In Iron Gates, 24.6% of the park is agricultural land with 285 km² of coverage.

Losing provisioning services would affect economic activities such as fishing, electricity production, logging, and more. According to Eurostat, the gross value of forestry in Romania was reported to be 521 million euros in 2005 and 898 million euros in 2010 (NEPA et al, 2017).

Water contamination affects provisioning services such as clean water for human consumption. In August 2022, a study assessed water quality in the regional Banat area's mining sites, such as Ciudanovita, Lisava, Moldova Nouă, and Anina (Murarescu et al, 2022). The assessment concluded that the heavy metal contamination of sources of drinking water, both surface and subterranean, are concerning. High heavy metal contamination dramatically increases the risk of diseases in the renal, respiratory, and cardiovascular systems, and the possibility of developing cancer. This contamination is particularly dangerous for the normal development of children. The levels of lead, copper, chromium, and nickel found in the water samples were higher than national standards allow for, as well as World Health Organization's specifications for water intended for human consumption. Moreover, the study determined that the levels of toxicity were particularly high in the Banat region neighboring Serbia. Despite high toxicity levels, the water was considered safe for adults in terms of cancer risks from a non-cumulative perspective. Nevertheless, these concentrations present a threat to adults if accumulated with other sources of heavy metal. Toxicity levels demonstrated higher risks for children for the development of cancer as target hazard quotients were found to be three times higher for children due to the levels of cadmium and lead in the water.

Additionally, provisioning services such as clean air can be affected by tailing ponds. Sites such as the Tausani and Bosneag tailing ponds generate dust that pollute the air of several localities in Romania, including Moldova Ceche, Moldova Nouă, Macesti, and Pojejena, as well as the following localities in Serbia: Vinci, Pozezeno, Ram, Stara Palanka and Veliko Gradiste (Burlacu et al, 2022).

IV. The Consequences of Losing Cultural Services:

Cultural services are non-material benefits that contribute to the development and cultural advancement of people (such as recreational activities or cultural heritage traditions) (National Wildlife Federation, 2022). Recreational fishing, water sports, and hunting are some of the benefits provided by wetland ecosystems.

The Djerdap Park's spiritual and cultural heritage has high historical and archaeological importance, scientific and educational. Archaeological historical sites such as the "Lepenski Vir" (7,000-6,000 BC) and Vlasac from the Mesolithic period, as well as cultural goods from the Roman period, are part of the cultural identity of the national park (Ramsar, 2020).

Culturally, old-growth and virgin forests in the Carpathians serve as some of the last core habitats for large carnivores in Europe. These species hold a high degree of cultural significance for local and regional peoples and their cultures.

Losing these cultural services that the area offers would translate into a loss of revenue for local populations, since activities such as hunting, tourism and fishing would be affected.

PART 4

MEASURING
BIOREGIO'S
IMPACT

**NATURE-BASED
SOLUTIONS
IMPLEMENTATION**

DECERBALUS REX
DRACAN FECIT

Part 4: Measuring the impact of BioREGIO on Nature-based Solutions Implementation

Since the main objective of the BioREGIO project was to promote multi-stakeholder cooperation in the implementation of NbS for conservation and restoration as well as economic development purposes, this report evaluates whether the NbS proposed by BioREGIO were implemented as well as the barriers to their implementation.

Furthermore, the project was an advocacy endeavor to promote NbS, which is why we have examined other NbS projects that have been implemented in the region as well as opportunities. The main takeaways of the research aimed at identifying how these NbS solve the threats previously mentioned and what the socio-economic benefits of these NbS are.

NbS can be implemented simultaneously in order to mitigate or even completely reverse these problems already mentioned previously. To a varying degree of success, these NbS have already been put into action in various wetland habitats in diverse regions, including some in the Carpathians. In the following paragraphs, distinct kinds of root causes that affect wetland and forest ecosystems will be coupled to specific NbS that can be employed to counter them as well as their socio-economic benefits.

NbS for Water Contamination:

In 2014, in an effort to combat water contamination, BioREGIO recommended that water treatment facilities be constructed to significantly reduce household waste that ends up in natural water systems (BioREGIO, 2014:70). Strict requirements with possible financial penalties for farmers to build proper storing capacity for fertilizers and waste (UNEP 2014, 81) can also greatly curtail water contamination. While representatives of IGNP ensure that there are water treatment plants installed in the park, these solutions need to be implemented across the whole Danube area to increase efficiency. The United Nations Economic Commission for Europe reported that only 81.99% of Romanians had access to drinking water in 2020, thus indicating that there is still progress to be made regarding reaching access to clean water (2021, xxxix).

Regarding the heavy-metal pollution caused by the Bosneag tailing pond, official representatives of the park report that solutions have been provided to regulate the humidity of the pond in order to prevent the tailings from turning into dust and contaminating the air (Dumbrava, 2022). However, this solution does not prevent the infiltration of heavy metals into subterranean water sources. The National Institute of Research and Development in Environmental Protection proposed other NbS to ‘green the tailings ponds’ by covering the pond with a gravel layer and installing a drainage system. The drained water would then be collected in a tank which would store it for treatment before dumping it into the Danube (Burlacu et al, 2017).

The socio-economic benefits of NbS for the treatment of contaminated water encompass health improvements for local communities and any community depending on the Danube. In order to prevent future costs associated with preventable health treatment, it is crucial to improve the water contamination situation.

NbS for Water Flow Disturbance:

As for water flow disturbances and sedimentation and erosion problems, there are a variety of specific problems that can affect wetlands. The disturbance of sedimentation levels can lead to problems ranging from channeling to the establishment of invasive species (UNEP 2014, 84). Meanwhile, erosion may lead to issues such as hazardous impacts on water-side infrastructure and alterations to riparian habitats (UNEP 2014, 77). Most NbS that tackle these problems fall under the restoration of hydrological regimes and river dynamics. These are key for the long-term persistence of wetland ecosystems, and solutions like restoration of catchment areas often include the construction of small-scale infrastructure, like small dams made to reflow former peatland (UNEP 2014, 84). Although these strategies are quite effective, they may run into financial limitation issues. In the IRGN and DNP area, none of these NbS have been implemented so far. While these projects tend to require more funding and specialized supervision (thus complicating the feasibility in the region), they are vital for long-term restoration of wetland ecosystems (UNEP 2014, 84).

One pilot project that did utilize the restoration of hydrological regimes is the Garla Mare-Vrata Wetland. The project is a cross-sectoral partnership between WWF-Romania (which carried out the project), the Coca-Cola Foundation (which funded the project with 4.4 million US Dollars), and the International Commission for the Protection of the Danube (which provided oversight) (WWF, 2022). Beginning in 2020, the partnership restored 400 hectares of floodplain by reconnecting the riparian ponds to the Danube. The newly designated Natura 2000 site was designed according to EU and Romanian legislation in order to protect a number of endangered species (WWF, 2022). The wetland is now home to over 80 species of fauna and flora, but its benefits go much beyond biodiversity. The risk of flooding in the area is now vastly reduced, as an additional 5 million m³ of water can be stored in the wetland (WWF, 2022). Moreover, the project is already becoming an attractive spot for fishing and ecotourism, improving the local economy. This pilot area showcases how proper NbS projects can be applied across the region to develop a variety of benefits.

While floodplain restoration of the lower Danube Green Corridor was estimated to cost €183 million, it is a worthwhile investment as it generates significant economic benefits in the long run. Socio-economic benefits of such restoration projects include annual earnings through ecosystem services including water purification, flood control, groundwater replenishment, reservoirs of biodiversity, sediment and nutrient replenishment, recreation and tourism, and more (Mansourian et al., 2019). In fact, a study estimated the benefits of restoring floodplains to an expected annual earning through

ecosystem service of €111.8 million per year, as each hectare provides €500 per year in ecosystem services, helping to diversify the livelihoods of local people (Mansourian et al., 2019).

NbS for Pollution:

Pollution stemming directly from tourism and agriculture can be minimized through the establishment of buffer zones, which distance the protected areas from human activity and can work suitably for wetlands close to intense agriculture (UNEP, 2014:82). Although a fairly easy and inexpensive solution to implement, both IGNP and DNP have not established any buffer zones. This is particularly an issue in IGNP, where more substantial agricultural activity lies adjacent to the protected areas (Dumbrava, 2022).

Agricultural pollution can likewise be minimized through policy solutions. Cross-compliance rules can oblige farmers to respect set standards like limits on fertilizers while simultaneously rewarding those who do with single area payments (UNEP, 2014:86). Strategies like payments from rural development programs to farmers and compensatory measures that oblige the compensation of habitat loss can be quite beneficial (for example, compensation for habitat loss can go directly into restoration projects) (UNEP, 2014:86). Finally, the implementation of conservation and restoration projects on wetlands can come directly from European operational programs that provide funding schemes (UNEP, 2014:86). As for the lack of inter-sectoral communication, the utilization of joint projects with broad partnerships is imperative (UNEP, 2014:85). It is key that all of these solutions are examined carefully and that they are put into action simultaneously so that restoration and protection efforts can work as efficiently and expeditiously as possible.

NbS for Invasive species:

The deliberate introduction of ruminants can be harmful or beneficial to the environment depending on how it is managed. The introduction of a horse population to a specific wetland in IGNP led to overgrazing of native plant species (UNEP, 2014:63), but the proper management of grazing activity can also prevent quick changes to wetland flora makeup linked to invasive species (UNEP, 2014:83). This can usually be done (alongside with mowing) responsibly through NGOs, but these projects are prone to capacity limits. In IGNP, proper ruminant management projects have not been implemented due to lack of funding. (Dumbrava, 2022).

Mulching, or the cutting down of biomass into small pieces to be left on site, can serve as an active management measure (although this may also lead to eutrophication if done incorrectly) (UNEP, 2014:83). This can serve as an additional measure to control invasive plant species. Other physical solutions include the reduction of trees and shrubs and the manual removal of invasive plant species through things like underwater cutting (UNEP, 2014:84).

NbS for Ecosystem Resilience:

Proper management and conservation of specific parts of an ecosystem can act as a multiplier when increasing ecosystem resilience. One of the most important and well-known NbS strategies in this sub-field is the reintroduction of native species. In Romania, the European bison has already been reintroduced to parts of its former range across three pilot areas outside of IGNP (WWF, 2021). As both an ecosystem engineer and a keystone species, European bison are a vital element in the environment. They not only serve as a source of food for large carnivores, but keep plant growth under control, create habitats for smaller fauna through trampling, and enrich soil through waste (WWF, 2021).

While IGNP and DNP have not implemented a reintroduction project of their own yet, this endeavor has been considered substantially, and the success of the other Romanian reintroduction projects has pushed the initiative forward (Dumbrava, 2022). European bison can provide socio-economic benefits by increasing biodiversity resilience and creating sustainable entrepreneurship opportunities through ecotourism. For these projects to be successful, locals have to sustainably coexist with the wild bison populations. The “Urgent Actions for the Recovery of European Bison Populations in Romania Project”, implemented by *WWF Romania* and *Rewilding Europe*, can provide expertise in IGNP, as they lead the original pilot projects (WWF, 2021).

NbS for Old-Growth Forest Loss:

The primary NbS for old-growth and virgin forest preservation is conservation. Proper protection of untouched or largely untouched forest ecosystems is the only sustainable way to maintain them. However, drawing clear boundaries around old-growth and virgin forests is not sufficient to maintain their ecosystem diversity. In order to assure proper ecosystem preservation, connectivity and buffering must occur. Simply designating forests as protected areas is insufficient for their protection, as stressors at the periphery of forest systems can cause disturbances internal to the system. For example, simply designating a stand as protected and then clear cutting around it will put profound stress on the protected area and will not insulate it from ecosystem degradation. Likewise, having designated protected areas in isolation without proper ecological connection or wildlife corridors can lead to imbalance within the internal dynamics of those isolated systems and can make them more susceptible to outside disturbances. A potential solution to these issues would be to consciously buffer old-growth and virgin forests with managed conservation areas and sustainably managed for-profit forestry areas. This would allow for greater distance of protected areas from outside stressors. Connectivity can be increased via several different solutions, such as better management of forest roads and power line corridors to allow for easier passages of species among protected areas, and the proper management of erosion and landscape fragmentation around protected stands. The remoteness of old-growth and virgin forests remains one of their greatest assets, however increasing human activities makes the formalization of best practices essential for their continued survival and protection, especially in privately owned areas (Keeton, 2022).

The primary socio-economic benefit of old-growth forests is their actual ability to serve as a NbS themselves. Implementation of Cultural Complexity Enhancement (CCE) cutting practices in managed forests relies on old-growth forests to provide natural distribution patterns that can be emulated as discussed in more detail below (Keeton, 2022)

NbS for Enhance Connectivity in Forest Habitats and Single Stock Plantation Reduction:

Old-growth and virgin forests can serve as a NbS for forest restoration in managed and for-profit forests. By replicating natural patterns and distributions within largely untouched systems and by scheduling cuts to minimize the disturbance of those patterns in the forestry industry, proper management can increase both biodiversity and the carbon carrying capacity within managed forests. Old-growth and virgin forests are our best assets, as they are able to reproduce such systems on a large scale (Keeton, 2022). As such, virgin forests can play an essential role in giving forest management officials a blueprint for forest restoration in managed areas. By mapping species distribution and natural adaptive patterns within virgin forests and applying these patterns in managed stands, foresters can better replicate natural systems and increase biodiversity, carbon retention, and opportunities for more sustainable, close-to-nature silviculture (Keeton et al., 2009, Svetozarevic, 2022). Management practices that seek to emulate old-growth and virgin systems also result in higher rates of tree related microhabitats which result in more resilient and adaptive managed stands (Asbeck et al, 2021).

Implementation of best practices in natural forest pattern restoration has the potential to improve overall landscape management, restore cultural significance, enhance flood protection, and dramatically increase carbon sequestration capacity. All this can be accomplished with minimal effects on long term forestry-related profit margins if best practices are implemented. This could allow ecotourism sites and for-profit forests to be better jointly managed (Keeton, 2022).

NbS for Ecosystem Fragmentation Caused by Roads and Infrastructure:

Ecological fragmentation due to roads, particularly forest roads, and other human infrastructure such as power lines, are an obstacle to ecological connectivity. Implementation of best practices in the maintenance of vegetation underlying powerlines in Slovakia has shown great potential for increasing connectivity, especially for small mammals, birds and pollinators. Innovative alternatives to stripping vegetation from under power lines and tapering and adapting vegetation to the particular needs and contexts of the managed area has the potential to be upscaled and implemented both within and at the periphery of managed areas in order to better allow for species passage and dissemination (UNEP, 2021)

Fragmentation due to roads and railways is a major obstacle with few clear solutions. However, certain practices can decrease the potential for increased ecological strain and externalities. Where current roads and railroads exist, it is essential for management to take account of disconnected forest systems

and consciously create buffer zones and connecting corridors to allow for the passage of species. Specifically in relation to forest and dirt road management, attention must be paid to the ways in which poor management contributes to the deterioration of water quality, the increased likelihood of erosion, and the long term need for new roads due to deterioration (Keeton, 2022).

Financial NbS:

The financial situation for protected areas in the Carpathian region is not good, as they are often dependent on public funds. They need more funding sources and more freedom to contract external providers. Studies have found that it is important to not just define the value of ecosystem services, but to also identify stakeholders who would benefit from them. (UNEP 2014).

The majority of funding for protected areas in the Carpathian region comes from public budgets, with a smaller amount coming from tourism and green markets. Private funding sources are very low, resulting in protected areas being very dependent on public funds. The study also found that several parks cannot deliver their expected outcomes even under a basic management scenario. A more diverse portfolio of financial sources could help ensure the sustainability of PAs in the long term perspective.

Furthermore, increasing the funding for infrastructure and facilities, incrementing the autonomy of forest management, and implementing a legal united framework for the general management of the Carpathians are all strategies that should be adopted. All these alternatives could lead to socioeconomic benefits, including better financial management that will increase the job market opportunities for the local community and the incentivizing of ecotourism.

Urban NbS for Climate Change Mitigation:

As previously mentioned, climate change is affecting the ecosystems in drastic ways and threatening the very existence of wetlands. In 2013, Romania exceeded its emission pledge which was met by an EU infringement case (UNECE, 2021). In 2017, Therefore, ecosystem resilience cannot be reduced to implementing NbS at the local level. The places that produce the most emissions such as big cities need to be part of the effort for the conservation of the Carpathians. Solutions such as green infrastructures, which include green roofs and walls, can help reduce cooling energy usage and therefore reduce the emissions emitted to produce energy. Moreover, they sequester carbon in cities and enhance ecological connectivity. Green walls create wind barriers by reducing the speed of wind on the building surface, thus reducing heat transfer (Charoenkit and Yiemwattana, 2016). This acts as a cooling benefit of the cavity insulation when the air between plants on indirect green walls creates thermos insulating matter for non-ventilated cavities (Munoz, 2016). Finally, greenery in cities creates passive carbon sinks through photosynthesis or carbon sequestration (Nowak, 2006). A study performed in Berlin found that based on the temperature surveyed from 3,000 extensive green rooftops since 1998, if 50% of buildings had green rooftops in Berlin during the past 20 years, it would

have had a cooling effect of 1.5 degrees Celsius (Köhler and Kaiser, 2019). Economic benefits of such green infrastructure include its cost-efficient properties since its insulation properties enable savings in energy dedicated to temperature regulating services. Additionally, savings on water drainage can also be achieved since green roofs absorb water and can control 30-90% of stormwater runoff volumes (Foster, Lowe and Winkelman Steve, 2011). Environmental benefits include GHGs reductions through energy savings and carbon sequestration, the reduction of the heat island effect in cities thanks to evaporation and transpiration effects, and greater ecological connectivity.

Table 5: Nature-based Solutions:

Threat to Biodiversity	NbS Recommended by BioREGIO in 2014	Was it Implemented? Why?	Socio-Economic Benefits
Water contamination from agricultural and human waste, pollution, and mining	Water treatment facilities	Not for the Moldova Noua tailing pond Another NbS is used: mechanisms to keep the pond humid and avoid contamination through wind	Health improvement of local populations
Water flow disturbance	<ul style="list-style-type: none"> Restoration of hydrological regimes and river dynamics Floodplain restoration Restoration of catchment areas with small dams to reflood peatlands 	No Not enough commitment and capital	<ul style="list-style-type: none"> Flood disaster risk prevention Prevention of monetary loss due to flood damage Riverside infrastructure damage prevention Sustainable levels of river bank erosion
Pollution due to tourism	Buffer zones to distance human activity from protected areas	No Lack of administrative support	<ul style="list-style-type: none"> Protection of native wildlife Prevention of costs associated with clean-up efforts
Agricultural Pollution	<ul style="list-style-type: none"> Cross-compliance rules to limit fertilizer use Payments for rural development programs Compensatory measures where farmers are obliged to compensate for loss of habitats 	No Lack of commitment, funding, and potential resistance by local farmers	<ul style="list-style-type: none"> Improvements in water quality => related to local water consumption Protection of native wildlife Development of sustainable farming practices
Invasive Species	<ul style="list-style-type: none"> Introduction of certain, limited numbers of ruminants Stop propagation of non-native and invasive tree stands such as black locust 	No Lack of funds for introduction of herbivores	<ul style="list-style-type: none"> Reduction in costs associated with conventional management of invasive species Protection of native wildlife
Illegal Logging	Encourage more sustainable economic activity in the park through businesses like ecotourism	No Legal barriers and funding issues	<ul style="list-style-type: none"> Prevention of further carbon release => climate change mitigation Revenue generation from tourism Creation of employment opportunities for local population
Clear-cutting	The use of close-to-nature silviculture methods	No Poor administrative oversight	<ul style="list-style-type: none"> Decreases levels of habitat degradation Establishes sustainable agro-industry Creation of employment opportunities for local population
Single stock plantations	Use management practices to replicate natural distributions	No Poor implementation of best practices	<ul style="list-style-type: none"> Increases biodiversity Increases carbon storage capacity Facilitates eco-tourism Improves landscapes
Increased tree cover (uncontrolled)	Common implementation measures for Serbia and Romania	No	Protects other, non-forest ecosystems (ex: prairies)
Roads	Ecological corridors	No Lack of political commitment	<ul style="list-style-type: none"> Increased ecological connectivity (protection of native fauna from ecosystem fragmentation) Increased ecosystem resilience
Lack of funding	Financial tools for finance of biodiversity conservation	No Lack of political commitment	<ul style="list-style-type: none"> Expanded capacity to initiate projects Creation of employment opportunities for local population

A vertical photograph of a dense forest. The trees are tall and thin, with a thick canopy of green leaves. The forest floor is covered in a layer of brown leaves and a vibrant green moss. The lighting is soft and natural, creating a serene atmosphere.

PART 5

FINDINGS

POLICY

RECOMMENDATIONS

Part 5: Policy Recommendations

In order to turn outcomes into impact, there are some necessary preconditions that must be fulfilled. In the Theory of Change theoretical framework, they are called ‘assumptions’ and ‘drivers’. As defined in part 1, assumptions are significant external factors or conditions that need to be present for the realization of the intended results but are **beyond the influence** of the project and its partners. Assumptions are often positively formulated risks. According to UNEP, drivers are significant external factors that, if present, are expected to contribute to the realization of the intended results of a project. Drivers **can be influenced** by the project and its partners. This part of the report will determine the policy recommendations to fulfill the drivers and assumptions of the Theory of Change at hand.

I. Incentivizing the Implementation of NbS

Policy Recommendations for Implementation of Nature-Based Solutions

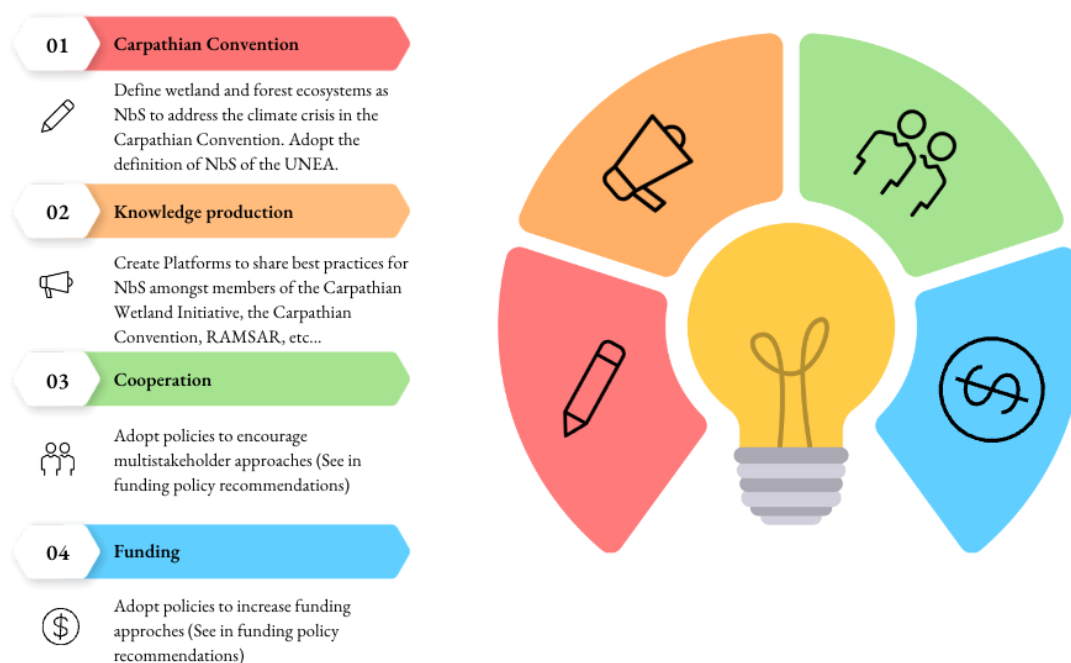


Figure 4: Policy Recommendations for Implementation of Nature-based Solutions

On March 2nd, 2022, the 5th United Nations Environment Assembly (UNEA) adopted a universal definition of Nature-based Solutions (UNEA, 2022). The UNEA defines NbS as actions to ‘protect, conserve, restore, sustainably use, and manage natural or modified terrestrial, freshwater, coastal, and marine ecosystems which address social, economic, and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services, resilience, and

biodiversity benefits.’ (UNEA, 2022). The UNEA recognised that NbS for biodiversity conservation play an essential role in the overall global effort to achieve SDGs and climate change mitigation (UNEA, 2022).

At the 14th Conference of the Contracting Parties (COP14) of the Convention on Wetlands (Ramsar Convention), Spain proposed a resolution on the protection, management, and restoration of wetlands as [Nature-based Solutions] [ecosystem-based approaches] to address the climate crisis (CITE). This resolution was drafted and supported by **the Mediterranean Wetland Initiative (MEDWET), which included 27 delegations.** The resolution would redefine the wetlands themselves as NbS to climate change. This resolution aimed to redefine climate mitigation as biodiversity conservation, the most long-term, cost-effective Nature-based Solutions to regulate carbon emissions, and reduce vulnerability to climate change, as well as to secure both sustainable water and food resources (Ramsar, 2022). In this resolution, Spain requested the Ramsar Secretariat to establish a community of practice on wetland conservation, management, and restoration as a Nature-based Solutions for cooperation among regional initiatives and other stakeholders aiming to provide scientific and technical support as well as facilitating the access to financial resources for interested Contracting Parties (Ramsar, 2022).

However, countries such as Brazil were reluctant to include the term ‘nature-based solution’ in the resolution. The opposition of Brazil to name wetland solutions as NbS to the climate crisis are rooted in fears that national sovereignty on their territory will be undermined by the international dimension of fighting against climate change (Jordan, 2022). Therefore, the resolution that passed did not include the term NbS. Instead, COP14 adopted the following resolution: ‘The protection, conservation, restoration, sustainable use, and management of wetland ecosystems in addressing climate change’ which recognises the definition of NbS adopted by the 5th UNEA assembly, as well as benefits of wetlands restoration for human well-being and the environment (Ramsar, 2022). The main achievement of the revised resolution is to request contracting parties to collaborate and facilitate the creation of a community of practice to restore and fight climate change.

These recent developments point to four important preconditions that are needed to increase the implementation of Nature-based Solutions and enhance ecological connectivity:

- The need for governments and local authorities to recognise the value of wetland and forest ecosystems as climate change mitigation NbS thanks to their carbon sink properties (Assumption 1),
- The existence of knowledge production on NbS (Driver 1)
- The availability of funding for the implementation of NbS (Assumption 2).

Therefore, the first **policy recommendation** to incentivize the implementation of NbS would be to recognize the importance of NbS as defined by the 5th UNEA assembly and define wetland as well as forest ecosystems restoration and conservation as NbS to address the climate change crisis.

It is important to note that, as pointed out by member parties of the Ramsar convention, there are knowledge gaps regarding NbS as they are a new concept. It is also essential to highlight that Nature-based Solutions can be specific to their environment. For instance, green infrastructure measures such as green walls for cooling infrastructures would be more efficient in cool climates such as Germany than in warmer environments such as Qatar. Thus, a policy recommendation to respond to the research gaps in this field would be for members of the Carpathians to share knowledge and outcomes of NbS implementation. The creation of a knowledge platform for members of the Carpathian convention as well as the active participation of the Carpathian Wetland Initiative in Ramsar’s new push to request contracting parties to collaborate and share best practices in the implementation of NbS would be another policy recommendation.

Finally, policies are necessary to ensure funding opportunities, as they, just as multi-stakeholder approaches, are necessary to incentivize and ultimately, enhance the implementation of Nature-based Solutions.

II. Continuous Monitoring of Biodiversity - Filling the Environmental Data Gap:

Policy Recommendations for Continuous Biodiversity

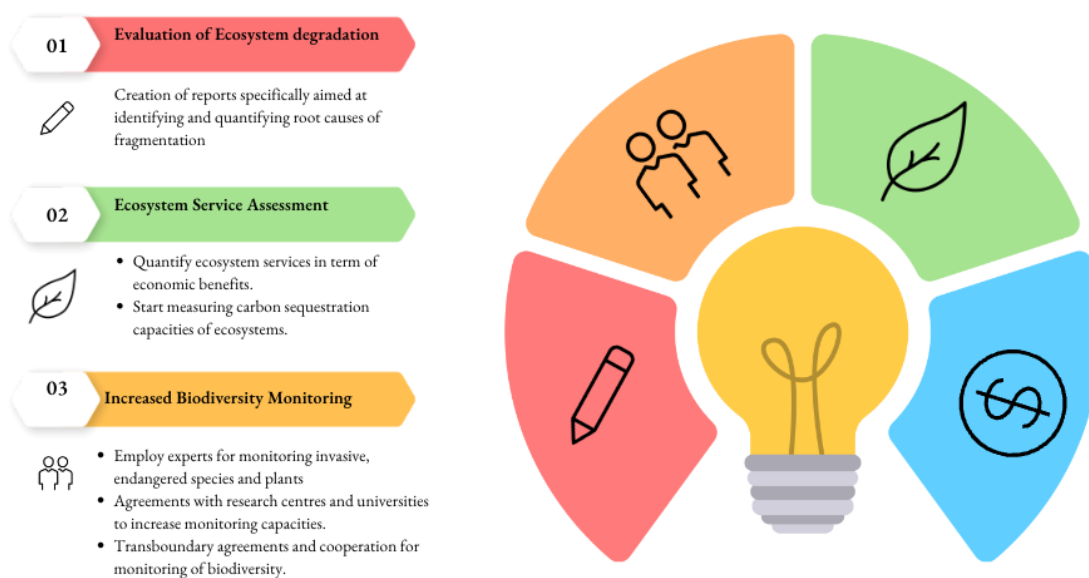


Figure 5: Policy Recommendations for Continuous Biodiversity

Monitoring biodiversity is a crucial part of the *continuous* process of conservation. Monitoring the process of existing projects, invasive species, and economic development requires the collective effort of both park administrators and experts and public officials behind legislation. Nevertheless, a “data

gap” exists between the different entities that influence biodiversity monitoring. In order to resolve the current situation, it is imperative that this gap is closed as much as possible. Many NbS can be implemented specifically to aid with monitoring, and some of the most important ones are directly related to policy.

During our assessment, four drivers and one assumption were identified as crucial elements in the overall outcome that is the monitoring biodiversity. By properly addressing each one, monitoring biodiversity can become a more feasible target. Nevertheless, the present situation in each country showcases the current inadequacy in fulfilling the drivers and assumption. The elements vital for biodiversity monitoring are:

- Driver 1: Application of an Ecosystem Services Assessment
- Driver 2: Evaluations of root causes of ecosystem fragmentation
- Driver 3: Constant monitoring of endangered and invasive species
- Driver 4: Transboundary Monitoring practices for ecosystem services
- Assumption 1: Sufficient expertise on ecosystems

Ecosystem Services Assessments (ESA) are a powerful way to categorize and quantify the available ecosystem services provided by a specific ecosystem. This can aid in the development of economic evaluations of the benefits supplied by said ecosystem. In DNP, although an analysis has been completed by Ramsar, no carbon sequestration measurements have been carried out. The current analysis is also somewhat vague. In Romania, the situation is even more inadequate. Although a National Ecosystems Assessment exists in the legislature at the national level, no major ESA of any kind has been carried out in IGNP, including any carbon sequestration measurements (Dumbrava, 2022). In Article 12 of the Carpathian Convention, meanwhile, Parties are asked to apply specific impact assessment tools to ensure that the environmental, social, and economic benefits and costs of the planned actions are taken into consideration, and that the most balanced and least harmful option is found (Carpathian Convention, 2022).

The evaluations of root causes of ecosystem fragmentation are generally more well-developed than ESAs in both parks but are still somewhat vague. As these evaluations pinpoint the sources of the fragmentation issues, they serve as preventative measures, which can help prevent higher project-related costs for damage mitigation in the long run. For each park, we had to rely on interviews to find information regarding these evaluations. Concurrently, the Carpathian Convention states that the First List of Invasive Alien Species was created for further consultation and development in order to assess current and potential future threats to local biodiversity and ecosystems of the Carpathians caused by introduction or release of invasive alien species. It is key that the park administrations use lists like these to address root problems of fragmentation (Carpathian Convention, 2022).

The constant monitoring of endangered and invasive species is an obvious element that both parks need to address. The DNP currently has no implemented monitoring programs for this purpose

(Sekulic, 2022), while the IGNP presently only has monitoring programs for forest ecosystems, as they do not have the expertise to launch monitoring programs for wetlands (Dumbrava, 2022). The Carpathian Convention, on the other hand, requests that Parties pursue policies of using continuous monitoring, assessment and reporting methods (Carpathian Convention, 2022).

The last driver, transboundary monitoring practices, is the least addressed element of the four. There are currently no transboundary agreements between DNP and IGNP (Dumbrava, 2022), although a small start could be reached by establishing IGNP as a Ramsar site, just like DNP on the Serbian side. Transboundary agreements would greatly facilitate the transfer of knowledge and expertise for an area that could greatly benefit from it. In fact, the Carpathian Convention recommends that working groups/networks of experts are established to coordinate activities related to knowledge sharing (Carpathian Convention, 2022). In fact, the Carpathian Convention advises that since management systems and information already exist in both countries, in order to combine and harmonize them, transboundary cooperation and mutual assistance by all parties involved is absolutely necessary.

Sufficient expertise on ecosystems is the overarching theme that both parks are currently struggling with. Although there is an overall lack of expertise throughout, certain areas have a more significant deficiency, especially wetlands management (Dumbrava, 2022). This is the case for both parks. The Carpathian Convention recommends that working groups/networks of experts are established to coordinate activities related to knowledge sharing (Carpathian Convention, 2022).

To combat the inadequacy presently affecting the drivers and assumption, numerous policy recommendations can be implemented. Many of these are relevant for more than one element. In addition, they can also be used in conjunction with other policy recommendations to better accumulate the benefits:

- Add more legislation related to ecosystem services at both the local and regional level | Specify and economically quantify existing legislation about ecosystem services
- Start quantifying carbon sequestration properties
- Create reports specifically for identifying and quantifying root causes of ecosystem fragmentation | Increase available funds such reports
- Use existing reports from the Carpathian Convention to develop specific monitoring projects in the IGNP-DNP area
- Create transboundary agreements and managements plans | Share assessments and reports
- Standardize management practices in both parks
- Establish working groups/networks of experts to coordinate activities related to knowledge sharing of environmental expertise

III. Increased Financing of Ecosystem Restoration and Conservation - Multi-Stakeholder Funding

Policy Recommendations for Increased Financing

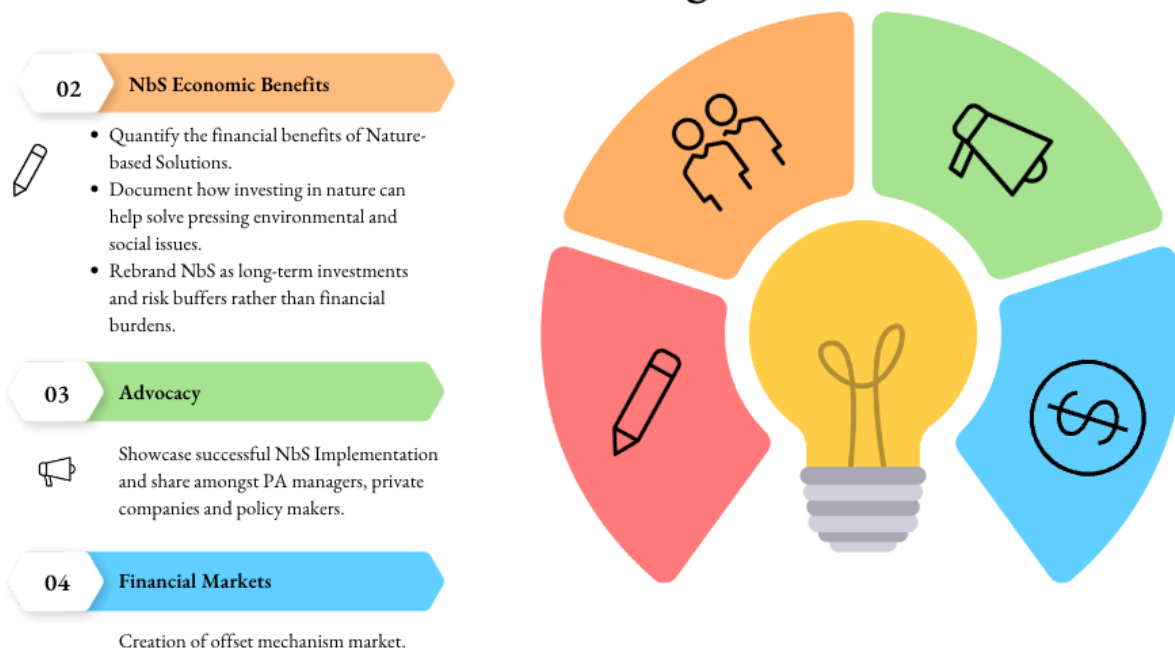


Figure 6: Policy Recommendations for Increased Financing

Literature on the barriers to the implementation of NbS such as green infrastructure comprehends cognitive barriers for policymakers and urban planners who tend to view green solutions as a financial burden rather than a cost-effective investment (Matthews et al., 2015). Recommendations to overcome these barriers include the need for reconceptualizing green infrastructure as a form of ‘capital’ and as ‘risk buffers’ (Matthews et al., 2015).

The agenda for Sustainable Development Goals focuses on economic growth and environmental protection. Inclusive multilateralism is a foreign policy principle that calls for the inclusion of different actors in international decision-making and cooperation. The principle is based on the belief that global problems can only be effectively addressed through multilateral action, and that all countries should have a say in decisions that affect them (Eckersley, R. 2012). Inclusive multilateralism promotes funding and involvement of more actors for large forest and wetland areas that are needed for economic benefits and for the development of the communities. Stakeholders like the states, United Nations with UNEP and the SDGs, NGOs, and local actors now also serve as ‘Development Banks’, with the aim to promote development for the countries financing projects. Following this principle can integrate both economic growth and environmental protection.

There are a few ways to get more funding with NbS:

1. Write grants specifically for NbS. Another way is to work with organizations that are already funding NbS.
2. Work with partners to pilot and scale Nature-based Solutions. Showcase successful projects that demonstrate the potential of Nature-based Solutions to achieve real-world impact.
3. Secure long-term funding for Nature-based Solutions. Advocate for dedicated funding streams to support the implementation of Nature-based Solutions at scale.
4. Advocate for Nature-based Solutions. Make the case to policymakers and the general public that investing in nature is good for the economy, society, and the environment.
5. Develop a comprehensive understanding of the benefits of Nature-based Solutions. Use data and research to demonstrate how investing in nature can help solve pressing environmental and social issues.

IV. Improved Sustainable Management - Collaboration/Cooperation

Policy Recommendations for Improved Sustainable management

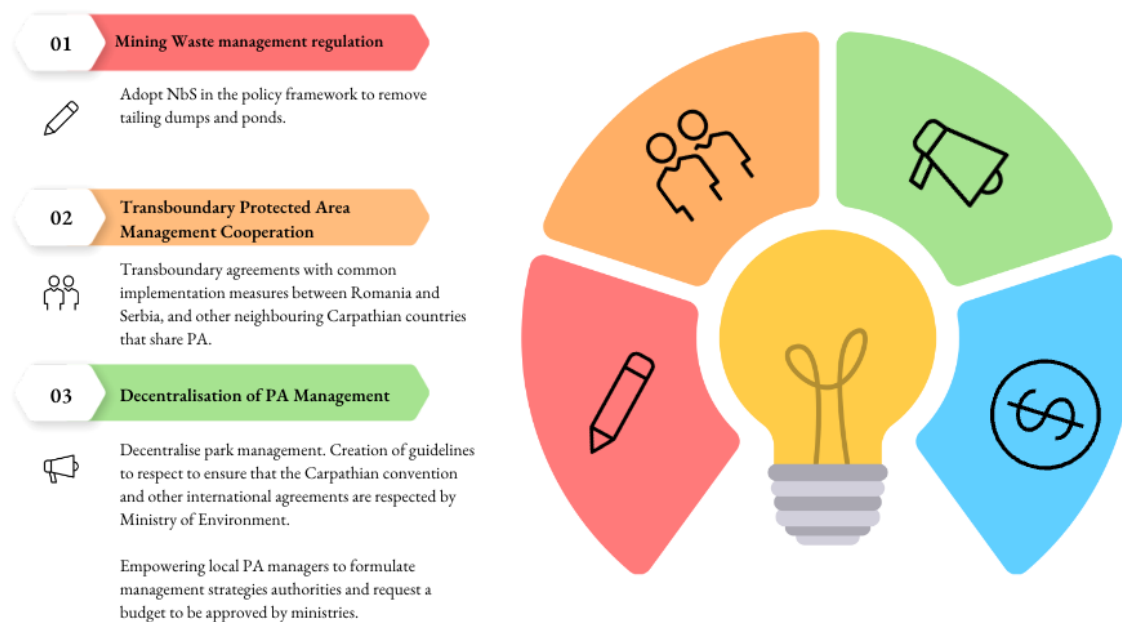


Figure 7: Policy Recommendations for Improved Sustainable Management

In 1987, the World Commission on Environment and Development defined sustainable development as meeting the needs of present generations without compromising the ability of future generations to meet their needs (United Nations, 2022). For sustainable development to be attained, it is important for protected areas to have adequate management plans.

However, in Romania, the mismanagement of protected areas is a systemic issue. In 2020, only 50% of national protected areas had a management strategy (UNECE, 2021). A recent development caused the switch between the management of protected areas from the Ministry of Agriculture to the Ministry of Environment. However, in Serbia, the Ministry of Agriculture still determines the management strategies of DNP. Currently, Romania does not have a national strategy for the forestry sector with objectives, measures, and deadlines. Instead, there is a Forestry Code that mentions the implementation of a certified forest management plan as well as the mapping, identification, and securing of forest biodiversity hotspots (NEPA et al, 2017: 20).

Because of the contiguous nature of managed areas, the development of a comprehensive forestry policy and park management approach should include the decentralizing of management practices from the national level and the facilitation of transboundary management and enforcement practices among park officials and local stakeholders. This would provide for better monitoring and best practice implementation in forest areas. Any such national policy should include the banning of sanitary cuts which are often used as a trojan horse for unnecessary clearcutting. Local managers across transboundary management areas should also receive unified instruction in best practices for forest management and work jointly to facilitate them. UNEP and the Carpathian Convention are uniquely well positioned to play a facilitating role in negotiating such a transboundary management agreement between Romania and Serbia as well as other countries in the region.

Therefore, our policy recommendation would be to **decentralize park management**. The Ministry of Environment can give guidelines to ensure that the Carpathian Convention and other international agreements are respected. However, the park managers are aware of the local situation and the needs of the protected area better than the ministries could be. Consequently, allowing them to formulate plan management strategies in collaboration with neighboring authorities and asking for a budget that could be approved by the ministries would be a good start. Moreover, conservation efforts should not stop at policies to regulate protected areas, as issues such as waste mismanagement, whether human, animal, or mining waste derived tailings affects the whole area, the parks, and the cities.

In 2014, the European Commission sued Romania because of a failure to comply with European Environmental standards of mining waste management as the Bosneag tailing pond was almost completely abandoned. As of 2020, the infringement was still active as Romania had not adopted policies that comply with EU standards nor implemented strategies for mining waste management (UNECE, 2021). Over time, the mining industry has left 30 tailing dumps with 139 tons of tailings. The health of 136 generations local to the area has been affected by water pollution and soil deterioration from mining extraction and practices such as tail dumping (Murarescu et al, 2022). **Since mining waste contamination affects hundreds of hectares of farmland, ecosystems, and the health and safety of generations, it is important that transboundary NbS are adopted in the policy framework to get rid of the tailing dumps and ponds.**

Annex:**Table 6: List of Experts Interviewed**

Expert Interviewed	Position	Country	Date	Interview Style	Interviewer
Doru Banaduc	Former BioREGIO Expert	Romania	3/10/22	Online Interview	Michael King
Amalia Dumbrava	Biologist at Iron Gates Natural Park Administration	Romania	14/11/22	Online Interview	Juan Diego Prado
Osvaldo Jordan	Executive Director at Regional Ramsar Center for the Western Hemisphere	Panama	12/11/22	In-person Interview	Anne-Lise Hadzopoulos & Juan Diego Prado
Jan Kadlecik	Former BioREGIO Expert	Slovakia	9/10/22	Questionnaire	Juan Diego Prado
Anton Kristin	Former BioREGIO Expert	Slovakia	7/10/22	Online Interview	Michael King
Clemens Neuhold	Flood Risk Management Expert at Austrian Federal Ministry of Agriculture, Forestry, Environment, and Water Management	Austria	12/10/22	Online Interview	Juan Diego Prado
Bohdan Prots	Director at Danube Commission	Ukraine	21/10/22	Online Interview	Anne-Lise Hadzopoulos
Peter Puchala	Former BioREGIO Expert	Slovakia	13/10/22	Online Interview	Juan Diego Prado
Goran Sekulic	Policy Officer at WWF	Serbia	14/10/22	Online Interview	Anne-Lise Hadzopoulos
Ivan Svetozarevic	Former BioREGIO Expert	Serbia	17/10/22	Online Interview	Michael King

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