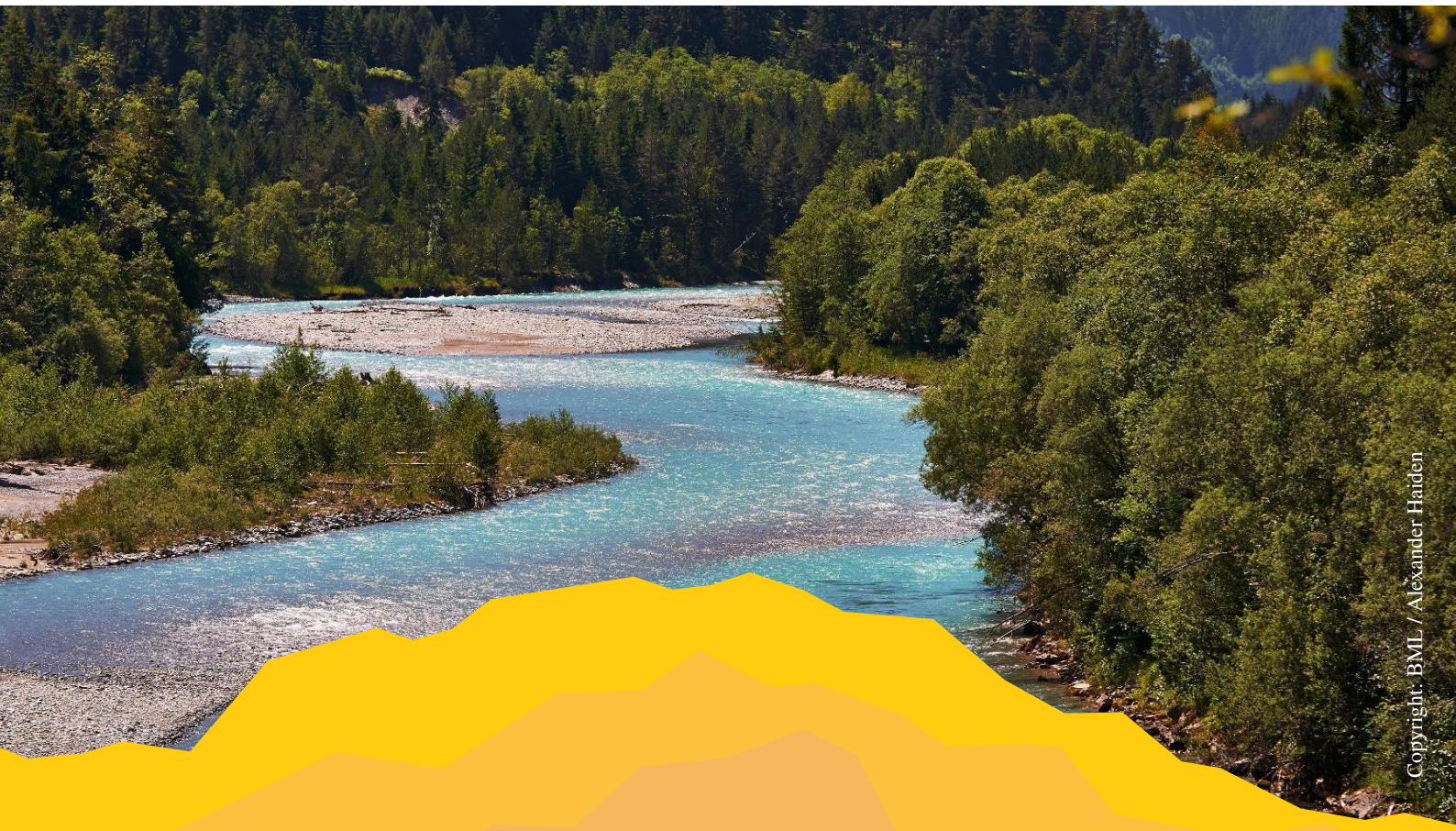
NATURE-BASED SOLUTIONS IN THE CONTEXT OF NATURAL HAZARDS

Policy brief



Copyright: BML / Alexander Haiden

Natural Hazard Working Group of the Alpine Convention (PLANALP)

Mandate 2021-2022

ALPENKONVENTION
CONVENTION ALPINE
ALPSKA KONVENCIJA
CONVENZIONE DELLE ALPI

IMPRINT

This report is a result of the Natural Hazards Working Group under the Swiss Presidency 2021-2022. The members of the Working Group are:

Chair: Florian Rudolf-Miklau (Bundesministerium für Land- und Forstwirtschaft, Regionen und Wasserwirtschaft – Austrian Federal Ministry of Agriculture, Forestry, Regions and Water Management)

National delegates:

- **Austria:** Kilian Heil, Katharina Rieder (Bundesministerium für Land- und Forstwirtschaft, Regionen und Wasserwirtschaft – Austrian Federal Ministry of Agriculture, Forestry, Regions and Water Management), Felix Weingraber (Land Oberösterreich – Office of Upper Austrian Government)
- **France:** Catherine Calmet, Ariane Stephan (Ministère de l'Ecologie – Ministry of Ecology), Alison Evans (Office National des Forêts – National Forestry Office)
- **Germany:** Jan Ulrich Job, Lena Großmann (Bayerisches Landesamt für Umwelt – Bavarian Environment Agency), Wolfgang Rieger, Andreas Lindenmaier, Christian Wanger (Bayerisches Staatsministerium für Umwelt und Verbraucherschutz – Bavarian State Ministry of the Environment and Consumer Protection)
- **Italy:** Tommaso Bastiani (Eurac Research; Ministero dell'Ambiente e della Tutela del Territorio e del Mare − Eurac Research; Italian Ministry for the Environment and for the Protection of Land and Sea), Jean-Pierre Fosson (Fondazione Montagna sicura; Regione Autonoma Valle d'Aosta, Assessorato opere pubbliche, territorio e edilizia residenziale pubblica − Safe Mountain Foundation, Aosta Valley Autonomous Region, Department for Public works, territory and public residential constructions), Willigis Gallmetzer (Centro funzionale provinciale dell'Agenzia per la Protezione Civile, Provincia Autonoma di Bolzano − Landeswarnzentrum der Agentur für BevölkeruNbSschutz, Autonome Provinz Bozen − Provincial warning centre of the Civil Protection Agency, Autonomous Province of Bolzano/Bozen), Rolando Pozzani (Associazione ALTALMA)
- **Liechtenstein:** Stephan Wohlwend (Amt für Bevölkerungsschutz − Office for Civil Protection)
- **Monaco:** Astrid Claudel-Rusin (Gouvernement Princier de Monaco – Office of Monaco Government)
- **Slovenia:** Milena Dobnik Jeraj, Lea Pavrič (Uprava Republike Slovenije za zaščito in reševanje − Administration of the Republic of Slovenia for Civil Protection and Disaster Relief), Jože Papež (Hidrotehnik d.o.o., − Hidrotehnik, Water Management Organisation),
- **Switzerland:** Josef Eberli, Carolin Schärpf (Bundesamt für Umwelt – Switzerland Federal Office for the Environment)

Observers:

- Daniel Bieri, Veronika Schulz (Club Arc Alpin)
- Nicolas Chesnel (Interreg Alpine Space Programme)
- Ansgar Fellendorf (UNEP – United Nations Environment Programme)
- Massimo Pecci, Christian Rohr (ISCAR - International Scientific Committee on Alpine Research)
- Ann-Kristin Winkler (WWF Austria)

Permanent Secretariat of the Alpine Convention:

Živa Novljan (Permanent Secretariat of the Alpine Convention)

TABLE OF CONTENTS

1 INTRODUCTION

The concept of Nature-based Solutions (short: NbS) in natural hazard management is common but the understanding and approaches of NbS vary. Therefore, the Natural Hazard Working Group of the Alpine Convention (short: PLANALP) decided to tackle this topic in its mandate 2021 – 2022.

PLANALP was established in 2004 to develop common strategies designed to prevent natural hazards in the Alpine region as well as to deliberate on adaptation strategies.

This policy brief is dealing with the concept of Nature-based Solutions in the context of natural hazard management. It provides a common understanding and identifies NbS for the reduction of risks and prevention of major disasters related to the main natural hazards in the Alps. Furthermore, the policy brief contains an overview of the benefits, limitations and implementation issues of NbS. The policy brief presents a basis for experts in the field of natural hazard management as well as decision maker.

Whenever mentioned in this document, NbS are always in the context of natural hazard management.

2 CHARACTERISATION OF NATURE-BASED SOLUTIONS

2.1 General definitions of Nature-based Solutions

By the European Commission:

Solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions.[1]

By the International Union for Conservation of Nature (IUCN):

Nature-based Solutions are actions to protect, sustainably manage and restore natural and modified ecosystems in ways that address societal challenges effectively and adaptively, to provide both human well-being and biodiversity benefits. They are underpinned by benefits that flow from healthy ecosystems and target major challenges like climate change, disaster risk reduction, food and water security, health and are critical to economic development.[2]

By the Nature-Based Solutions Initiative:

Nature-based solutions (NbS) involve working with nature to address societal challenges, providing benefits for both human well-being and biodiversity. Specifically, they are actions that involve the protection, restoration or management of natural and semi-natural ecosystems; the sustainable management of aquatic systems and working lands such as croplands or timberlands; or the creation of novel ecosystems in and around cities. They are actions that are underpinned biodiversity and are designed and implemented with the full engagement and consent of local communities and Indigenous Peoples.[3]

2.2 Delimitation of Nature-based Solutions

NbS, according to the understanding of the Natural Hazards Working Group of the Alpine Convention, are actions that work with and enhance nature to restore or create a protective function for society from the impacts of natural hazards. NbS are based on and use the power of nature as infrastructure to provide natural services, to benefit society and environment. Such interventions must be designed to mitigate identified real or anticipated social and environmental challenges, for instance natural hazards that are

1 European Union, 2021
2 IUCN, 2022
3 Nature-based solutions initiative, 2022

exacerbated by climate change. At the same time, NBS can have many co-benefits for instance for local biodiversity or increasing the capacity to store carbon.

Important in this context is that NbS in natural hazard management require special cultivation and cannot be constrained by means to increase biodiversity. Special cultivation includes points such as the suitability of only certain plant species, the implementation of specific planting rules regarding distance, size, rooting depth, etc. and the necessity of maintenance measures (e.g. removal of dead wood/plants as they represent a potential source of danger as driftwood). However biodiversity should be considered in the planning of initiatives and efforts to improve biodiversity should be forced whenever possible.

NbS and nature conservation are not the same. In order to avoid natural hazards, serious intervention in nature is sometimes necessary - also in the form of NbS (e.g. biotechnical measures like soil bioengineering) to achieve the desired level of protection for the affected population and the settlement area. Nature conservation and interventions to protect people and their habitat must be carefully assessed.

The focus of NbS in PLANALP is on:

- Reducing sources of natural hazards (by revegetation or restoration)
- Measures that mitigate the impact of natural hazards (e.g. protective forest against avalanches or rock fall)
- Measures to keep drains clear
- Providing natural retention, spreading or development areas (e.g. keeping/creating floodplains or decrease of the amount and speed of surface run-off with different kinds of plants)
- Measures supporting the natural retention function of landscapes and river systems
- Improvement of infiltration ability or storage capacity of soils
- Increasing the roughness of land surface (e.g. protective forest management) or watercourses and floodplains
- Measures that reduce erosion (e.g. in riverbanks and river bottom)

Measures that are only focused on improving the environment, increasing the biodiversity or tackle climate change adaptation without mitigating natural hazards are not regarded as NbS in the context of PLANALP. Furthermore, PLANALP does not define measures as NbS that derive from nature but do not use an ecosystem to generate services.

2.2.1 Features of NbS in the context of natural hazard management

NbS are a crosscutting area in which many different factors have to be taken into account, such as biology, climate or land use. Creating and using synergies with other topics is important. The application of NbS should be done in such a way that the affected population is protected from natural hazards, economic benefits accrue and at the same time biological and cultural diversity and the ability of ecosystems to evolve over time is maintained.

Healthy ecosystems are the basis for NbS, at the same time NbS can contribute to the improvement of ecosystems, e.g. the development of floodplains leads to a better condition of rivers as pollutants have

more space to weather. Ecosystems are vulnerable to climate change, especially in connection with natural hazards. *Climate change comes with significant changes in temperature and precipitation pattern that might threaten the functionality of ecosystems, which means that specific care has to be given to enhance the resilience of the ecosystems themselves. Invasive alien species or pests are as destabilizing factors as anthropogenic pollution and unsustainable use of the natural resources.*[4] *Therefore, it is important to constantly evaluate the effects of NbS and if needed adopt the measures. Protective forests, for instance, need to be composed of different tree species that can endure the change in temperature and precipitation.*[5]

Due to the strong link between climate change and natural hazards management, the compatibility with the Climate Action Plan 2.0 and its implementation pathways in different sectors have to be ensured.

Another important connection of NbS is with land use. NbS must always be adapted to the site specific types of land use, as these require different measures and have different effects, for example:

- Agriculture: conservation soil tillage, transverse cultivation of land in hillside situations, extensive agriculture, dismantling drainage systems, grassed waterways, riparian strips → effects: improved water balance, erosion protection, reduction of pollutant and particle output (from agricultural areas), groundwater recharge, improved (soil) biodiversity
- Forestry: site-specific afforestation, restoration of forests, dismantling of roads and paths → effects: better infiltration and interception, increased roughness (floods/heavy rain), greater resistance, soil stabilization (erosion protection, landslides/rock fall/avalanches)
- Urban areas: infiltration ponds, green roofs, multifunctional areas, soil unsealing → effects: increased storage of water, cooling effects, recreational areas, drought/climate change adaption
- Rivers and floodplains: development of rivers and floodplains, afforestation of floodplain forests, restoration of rivers (meandering, widening, shallowing river banks,…), dike relocation → effects: reducing slope and velocity of watercourses, improved water balance, climate change adaption, improved river morphology, improved biodiversity, recreational areas
- Peatlands and wetlands: for instance, have a very high water storage capacity. They absorb water in peak seasons, reducing flood risk, and can release water in times of shortage. Vegetation cover of various types - depending on soil structure, inclination and other factors – can help to stabilize slopes and reduce the occurrence or amplitude of landslides or avalanches. Similarly, diversified crops on agricultural land do contribute to soil stability, as do more water-efficient irrigation techniques, and reduce the risk of total harvest lost in case of floods or droughts.

4 Permanent Secretariat of the Alpine Convention, 2019

5 Permanent Secretariat of the Alpine Convention, 2019

3 BENEFITS AND LIMITATIONS

In addition to a common understanding, it is also crucial to know the advantages and disadvantages of Nature-based Solutions in order to be able to implement them effectively.

The benefits and limitations of NbS depend on the function and impact they have on each natural hazard process. In order to achieve synergy effects/co-benefits with NbS, it has to be clarified which societal challenges are addressed, which ecosystems can be used and how this ecosystem has to be managed. The main limitation of protective measures is the exceeding of their functional capacity. Thus, NbS often cannot replace technical measures, but are implemented in a combination with other measures (e.g. technical measures, temporary measures, planning measures).

When designing NbS projects, diverse and complex interpretations present challenges for designing and implementing natural hazard/risk management schemes, which contain a combination of green and grey protective infrastructures. In the majority of cases by solely implementing NbS (as green infrastructure measures) cannot solve the problems of reducing risks e.g. floods, torrents, erosion, landslides, rockfall, snow avalanches to a desired extent.

Likewise, some grey measures, in fact, enable the establishment of an existing NbS (green infrastructure). In some circumstances - especially in very demanding Alpine conditions and torrential catchments - proper located and adapted protection measures maintain, preserve or even establish basic conditions for conception, implementation and development of NbS. In some cases, NbS take over the protective function on their own after years, without the need for technical support. For example, a protective forest may initially need some additional technical and bioengineered measures for the desired level of protection, but after about 50 years the forest has reached its full protective function and then no longer needs support structures.

There has been a paradigm change: Formerly NbS were seen only as minor addition to the technical measures, whereas now the technical measures complement the use of NbS. There are four ways of implementing NbS:

1. NbS performs its function by itself
2. Technical solution complements the NbS
3. NbS supplement the technical solution
4. In case only a technical solution is considered effective, nature-based measures are set to mitigate the unwanted effects on the environment

3.1 Benefits

The basic advantage is the mitigation of the impact of natural hazards in combination with synergetic effects/co-benefits, e.g. improvement of water balance, groundwater recharge, cooling effects, improvement of ecosystems and biodiversity, development of recreational areas.

An active management of NbS is important and leads to a general reduction of potential risks. A good example for this is protective forest. It protects settlement areas from natural risks like avalanches or rockfall. In addition, to its protective function the forest also has positive effects on the climate through e.g. binding CO_2 or cooling effects and represents an important recreational area for humans.

NbS approaches have been recognized as flexible, cost-effective and broadly applicable tools for reducing the impacts of climate change, and as important strategies to complete structural measures in natural hazard management and lead to low-regret measures. They are not only able to equally respond to various hazards that might occur, but can adapt to changes in hazard dynamics over a longer time period. They allow for multifunctional uses (agriculture, recreation) and do not bear the risk of simply transferring the risk to another area, e.g. to downstream communities. Additionally, ecosystem services support resilience of local settlements through the protection and purification of drinking water reserves and similar.[6]

NbS present a more sustainable solution and they often have a higher level of acceptance in the public. It is also easier to respond to changing environmental or climatic conditions by tailoring NBS to these changes. In the case of technical measures, their impact on natural hazard processes cannot be so easily adjusted afterwards to changed environmental conditions.

3.2 Limitations

For the use of NbS, it is important to know the limitations of their impact on natural hazard processes. Their effectiveness strongly depends on topography, geology, soil as well as land use and is often decreasing with increasing catchment size. Another important factor is that NbS need to be constantly managed to ensure that they full fill their protective function. Furthermore, it is more complicated to predict the effectiveness of NbS as they highly depend on external conditions, which modelling approaches does not reflect. This also makes it difficult to quantify the outcomes.

Time is also an important factor. It takes some time to achieve the desired protection level (especially with protective forest, which is only in full function after 20–30 years), during which temporary measures are needed.

As the Alps are characterized by often narrow valleys and many different user interests, a specific challenge for implementing ecological measures lies in designating enough space for it – the best effectivity can be reached by a coherent approach on landscape level, e.g. a watershed or catchment area. This also needs an enhanced preparatory dialogue, especially with land owners and mayors responsible for land use designation and construction permits. NbS often offer the possibility to use the area for additional purposes (e.g. recreation, agriculture) after completion. While technical constructions require often a smaller area, but due to their use/the type of construction (e.g. torrent control construction) the area cannot be used for other purposes too. Especially in agglomeration areas, it can be difficult to obtain the required space.

Although in general the public prefers NbS to technical solutions, there still exists certain prejudices or mistrusts regarding the effectiveness of NbS.

Another important point is that NbS have to face barriers in legislation and administration practice, which must be eliminated for a successful implementation. When designing a Nature-based Solution intervention, it's an important step to identify relevant policies and plans (including e.g. relevant regulations, subsidies, tenure policies etc.), which can support or hinder the intervention.

6 Permanent Secretariat of the Alpine Convention, 2019

Climate change has a greater impact on NbS than on technical solutions, making it difficult to predict the effectiveness of NbS.

An assessment of NbS from different points of view is necessary because solutions can also fail in their impact on natural hazard processes or cause other risks (e.g. storm events, driftwood, which can cause blockage of bridges). Of course, this applies for all measures, including also technical measures.

To combine NbS and technical solutions it is important that the various groups/experts work together (exchange of knowledge/experience). Through the collaboration of experts in different fields it is possible to build up capacities/know how, gain more knowledge on what works and also acquire trust in the protection functions of NbS.

4 COST AND FINANCING OF NATURE-BASED SOLUTIONS

On one hand depending on the type of NbS the measures may initially entail higher investment costs but provide higher and multiple long-term benefits or reduced costs over the investment's lifetime. Therefore, it is crucial to make a holistic cost comparison between investments in grey and green infrastructures. An important basic tool is the cost-benefit-analysis. In order to obtain a realistic picture, all long-term effects and maintenance costs must be included, regardless of the protection measure. Especially the maintaining costs are often not integrated in the calculation.

On the other hand, in terms of costs effectiveness, it turns out that some NbS often have a better economic efficiency than technical measures. If the present protection level by protective forests had to be replaced by technical measures, this would be more than 100 times as expensive. For example in Austria *a comparison of the costs for the conservation measures of the protective forest with those of rehabilitation measures (rejuvenation) and with technical measures resulted in a ratio of 1:15:146. This means that the use of € 1000 for the conservation of a protective forest replaces € 146,000 of technical protection measures that are necessary when the protection forest can no longer fulfil its function.* In case of rehabilitation measures, € 15,000 replaces € 146,000 of technical protection measures.[7]

A risk assessment should also be part of the economic assessment and cost-benefit analysis, because every protection system can fail. Hence, a risk assessment for failure of function should be an integral part.

Important for the implementation of NbS is also the funding system as well as incentives for NbS. Only with access to sufficient funds or incentives will people systematically think of NbS. Financing of NbS in the Alpine countries is structured and executed very differently, depending on the type of NbS and the national regulations.

Regarding protective forests, financing is well established in Austria, Italy, Liechtenstein, Switzerland and partly in Slovenia where support and funding for forest owners are provided. Furthermore, obligations by law for forest owners exist (in Austria, partially Italy, Liechtenstein, Switzerland and Slovenia) and compensation is provided by the federal state. In France, on the other hand, it is difficult to finance protective forests that affect private forest ownership.

Another example for financing NbS is the wastewater tax from sewage treatment plants applied in Bavaria (Germany), which is used for the ecological share of measures.

In South Tyrol, levies from hydropower-plant-operators are used in a targeted manner for environmental compensation measures along the affected rivers, for risk reduction measures or for measures that combine risk reduction and the improvement of the ecological status.

7 Rechnungshof, 2015

There are also types of NbS, which are not financed - especially in the field of spatial planning. In some Alpine countries, it is nearly impossible to create flood retention areas. Because often the first step would be to restrict or change land use, but municipalities usually do not have the financial means for that. Frequently there is a lack of a cost transfer system between landowners and beneficiaries. Hence, it should be mandatory to consider NbS in planning processes. Public and EU funds should be used to promote NbS also through available funding for combined measures. In Switzerland for example, projects that combine flood protection and river revitalisation receive additional funding. In South Tyrol, the funds from priority axis 4 of the ERDF program demand that risk reduction measures are always combined or at least complemented with NbS.

5 CONCLUSION

NbS are a cross-cutting area in which many different factors and stakeholders have to be taken into account. Hence, the implementation of NbS needs an inclusive governance approach. Cooperation of different sectors on horizontal and vertical level (different levels of administration) and the inclusion of all relevant stakeholders are necessary already in the planning phase.

Since a main challenge of NbS is their consumption of land, which often also affect private land ownerships, it is imperative to include the public from the beginning of the planning process. As precondition the general acceptance for NbS needs to be increased and prejudices eliminated. Communication plays a crucial role in dealing with this, thus communication strategies are required. It is important to explain the advantages but also the risks of NbS in comparison to technical measures. The multifunctional use of NbS (e.g. other possible uses for recreation/tourism, ecosystem services) needs to be highlighted and must be explored already in the spatial planning phase.

As already mentioned, a better funding system for NbS is needed. An option would be to apply NbS in the context of different funding schemes, like for natural hazard management, climate change adaptation, biodiversity and ecology.

With regards to evaluate NbS, a tool is needed for the assessment of NbS that compares them to technical measures (spatial planning, financial aspect, effectiveness...). Within this tool, all benefits (e.g. sustainability, positive effects on climate, self-renewable, lifetime, social function for society) should be expressed in financial terms.

Furthermore, it needs to be communicated that there is always a residual risk – whether a technical, a nature-based or a combined solution has been applied.

6 KEY MESSAGES AND RECOMMENDATIONS

6.1 Key Messages

1. The focus of Nature-based Solutions in natural hazard management is on reducing the impact sustainability of natural hazards.
2. Nature-based Solutions should include benefits for biodiversity whenever possible.
3. The multiple functions of Nature-based Solutions offer synergetic effects and therefore provide benefits for nature and society.
4. Nature based Solutions require maintenance and sustainable management to keep the level of protection.
5. For best results, Nature-based Solutions need a safety assessment and can be combined with other measures whenever needed to provide the necessary level of protection.
6. Cost and benefit assessments reveal that Nature-based Solutions have certain advantages concerning the sustainability and maintenance costs compared to technical measures.

6.2 Recommendations for implementation

1. Development of communication strategies to increase general acceptance and foster the implementation
2. Dismantling of barriers in legislation and administration practice
3. Providing governmental funds and incentives
4. Development of modelling and assessment approaches that consider the manifold effects of Nature-based Solutions in different sectors
5. Consider where the use of Nature-based Solutions makes sense, depending on the circumstances
6. Involvement of all relevant stakeholders, especially private land owners, from the beginning
7. Considering Nature-based Solutions at an early stage of the spatial planning process

7 BIBLIOGRAPHY

European Commission, Directorate-General for Research and Innovation (2021). Evaluating the impact of nature-based solutions: a summary for policy makers. Publications Office. Online: https://data.europa.eu/doi/10.2777/2219 [20.02.2022].

European Environment Agency, Castellari, S., Zandersen, M., Davis, M., et al. (2021). Nature-based solutions in Europe policy, knowledge and practice for climate change adaptation and disaster risk reduction. Publications Office. Online: https://data.europa.eu/doi/10.2800/919315 [20.02.2022].

European Union (2021). Nature based-solutions. Online: https://ec.europa.eu/info/research-and-innovation/research-area/environment/nature-based-solutions_en [15.11.2021].

IUCN, International Union for Conservation of Nature (2022). About Nature-based solutions. Online: https://www.iucn.org/theme/nature-based-solutions/about [02.03.2022].

Nature-Based Solutions Initiative (2022). What are Nature-based Solutions. Online: https://www.naturebasedsolutionsinitiative.org/what-are-nature-based-solutions/ [02.03.2022].

Permanent Secretariat of the Alpine Convention (2019). Natural hazard risk governance: Report on the state of the Alps. Online: https://www.alpconv.org/de/startseite/news-publikationen/publikationen-multimedia/detail/7-alpenzustandsbericht-naturgefahren-risiko-governance/ [20.04.2022].

Rechnungshof (2015). Bericht des Rechnungshofes: Schutz- und Bannwälder in Salzburg, Tirol und Vorarlberg. Reihe TIROL 2015/8. GZ 001.507/252-1B1/15. Online: https://www.rechnungshof.gv.at/rh/home/home/Schutz_und_Bannwaelder_in_Salzburg__Tirol_und_Vorarlberg.pdf [26.04.2022].

The Alpine Convention is a pioneer of its kind as the first international treaty dedicated to the protection and sustainable development of an entire mountain range – the Alps. The Convention was signed by the eight Alpine countries (Austria, France, Germany, Italy, Liechtenstein, Monaco, Slovenia and Switzerland) and the European Union, and came into effect in 1995.

The foundations of the Alpine Convention are the Framework Convention and the implementing Protocols and Declarations, which establish guiding principles and a framework for transnational cooperation in key areas of Alpine environments, societies, and economies. Based on these foundations, the Convention works to build partnerships and establish cross-sectoral approaches to address the most pressing challenges in the Alps.

Work is carried out in different formats by the Alpine Convention's various bodies: the biennial Alpine Conference, the work of the Contracting Parties, the Permanent Committee, the Compliance Committee, numerous Thematic Working Bodies, and the Permanent Secretariat. Several Observer organisations also contribute to the implementation of the Convention.

The Alpine Convention is leading the way for sustainable life in the Alps, working to safeguard their unique natural and cultural heritages – now and for the future.

Permanent Secretariat of the Alpine Convention
Herzog-Friedrich-Straße 15
A-6020 Innsbruck
Austria

Branch office
Viale Druso/Drususallee 1
I-39100 Bolzano/Bozen
Italy

ALPENKONVENTION
CONVENTION ALPINE
ALPSKA KONVENCIJA
CONVENZIONE DELLE ALPI

info@alpconv.org
www.alpconv.org

TW: @alpconv
FB: @AlpineConvention