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ADAPTNOW

# NATURE BASED SOLUTIONS

Topic Brief

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# 1. INTRODUCTION

Short description of the project: ADAPTNOW: ADAPTation Capacity Strengthening for Highly Affected and Exposed Territories in the Alps NOW will work on strengthening the adaptive capacity of HAET by implementing and evaluating the available climate adaptation and risk mitigation management tools and practices, assessing the Climate Adaptation Plans and developing Climate Services to support the territories and their local public authorities. Ultimately, ADAPTNOW aims at making risk and adaptation planning more integrated, collaborative and inclusive. This will be reached through a more dynamic, agile and participatory planning process in which all local stakeholders need to be involved.

Project website: <https://www.alpine-space.eu/project/adaptnow/>

## Introduction to the Topic Briefs

In the face of increasing climate risks and environmental challenges, municipalities and regional stakeholders need effective strategies to enhance resilience, protect communities, and ensure sustainable development. **Nature-based Solutions (NbS)** have emerged as a key approach, offering cost-effective and multifunctional benefits for climate adaptation and disaster risk reduction. However, implementing these solutions at the local level requires clear guidance, practical knowledge, and an understanding of best practices.

This series of **topic briefs** has been developed to support municipalities, policymakers, and other stakeholders in integrating Nature Based Solutions, Integrated Planning and Financing Tools, Community Engagement and Communication, and Extreme, Compound and Cascading events solutions into local planning and risk management strategies. Each brief provides concise, evidence-based insights, highlighting their relevance, benefits, and practical applications in different contexts. The objective is to bridge the gap between scientific research and real-world implementation, ensuring that decision-makers have access to actionable knowledge.

The topic briefs can be used in multiple ways:

- **Strategic Planning** – Municipalities can leverage these resources to inform urban planning, infrastructure development, and climate adaptation strategies.
- **Policy Development** – Policymakers can integrate these principles into local and regional policies to enhance ecosystem resilience and reduce disaster risks.
- **Stakeholder Engagement** – The briefs serve as a tool for raising awareness and fostering collaboration among government agencies, private sector actors, and local communities.
- **Project Design & Funding** – Practitioners can use the insights to design projects that align with funding opportunities and international sustainability frameworks.

By providing concrete examples, case studies, and key recommendations, these topic briefs empower local actors to take informed action, ultimately contributing to more resilient and sustainable territories.

You may find the other Topic Briefs in the EUSALP [CAPA Platform](#).

## 2.THEMATIC WORKSHOP ON NATURE BASED SOLUTIONS

### 1.1 DESCRIPTION OF THE CONCEPT

A transnational peer to peer thematic internal workshop on Nature Based Solutions (NbS) has been organized. The 3 mains objective of this workshop were:

1. To have an introduction to the topic with the definition of the key terms and concepts associated.
2. Presentation of NbS initiatives known by or in which project partners are/have been involved.
3. Critical analysis on NbS used and summarizing the feedbacks from the project partners.

The workshop has been conducted in 3 steps:

- Step 1: Presentations by each concerned project partners with a focus on the replicability on the NbS presented on other sites.
- Step 2: Exchanges on the effectiveness applicability, to the initiatives presented in step 1, of the IUCN concepts and criteria about NbS.
- Step 3: Use of all the material collected during the workshop for drafting the following brief topic about NbS.

A total of 13 showcases of NbS were presented during the first step of the workshop process, providing perspectives (Step 2 and 3) for the project partners. These examples covered a very broad spectrum of the possibilities offered by NbS. These are the following 13 examples:

1. Draining pavements to increase soil permeability and mitigate the risk of flooding due to heavy rain, Savona. Within the framework of INTERREG Maritime project ADAPT, a draining pavement in the courtyard of a school and one in the paths of a city park were installed.
2. Promotion of adaptation measures against the effects of heat waves in urban areas, Genova. Pilot action of the “CLIMACTIONS” project: redesign of an urban area using trees and plant able to contrast extreme heat and air pollution.
3. Promotion of adaptation measures against the effects of heat waves in urban areas, Parco del Ponte and Cerchio Rosso, Genova. Creation of botanical gardens with resilient hydraulic system to absorb and collect rain and waste water. Within the framework of the National Operative Programme (ongoing)
4. Demonstration of key climate and water-related challenges in a central and densely populated district characterized by disorganized post-war urbanization, Genova’s Lagaccio district. Within the framework of the H2020 Unalab Project.
5. Study of drainage systems, pavements and rainwater collection and outflow net on buildings and soil in public spaces, Genova. Within the framework of project “CLOUDBURST” (ongoing).
6. The Territorial Sylvicultural Plan initiative (TSP) is a strategic document intended for forest managers, which sets out the management methods approved as sustainable and meeting the challenges of the forest's multifunctional role, in environmental, heritage and economic terms. Any forest owner can therefore take a virtuous approach and be helped to do so across France. The example used was the TSP of the Grenoble Alpes Métropole.

7. Large scale mapping of French protective forest against rockfalls danger. Based on a modelling approach, this regional map provides information about 1) the place where forest stands potentially have a protective effect against rockfalls risk and 2) a first input about the efficiency of this protection according to distance travelled by boulders in forested areas. This map serves for defining where to conduct high resolution expertise and to use the French protective forest management guidelines.
8. The 3 French protective forest management handbooks for developing protective forest sustainable management according to the Pyrenees, and the Northern and Southern French Alps conditions.
9. The Climesence application for evaluating the consequences of different IPCC scenarios on tree species future distribution for improving Nature based Strategies based on forestry.
10. The possibilities offered by the current French Risk Prevention Policy for integrating protective forest in natural risk Prevention Plan via the creation of “Green zones”.
11. Climate resilient tree species project, 10 regions in Alpine Space, IT, AT, DE, CH. The objectives are 1) to plant 500 climate-resilient trees in each of the ARGE-Alp region, which are above 1000m and “climate resilient and 2) to adapt alpine forests to climate change (Approximately 40,000 ha of Tyrolean Forest are classified as „climate-sensitive forest areas “, which are those forests located in dry areas below 1000 m above sea level). These are the priority for rejuvenation and conversion into mixed forests. The long-term goal of the “Climate-Smart Tyrolean Mountain Forests” action group is to adapt Tyrolean forests for climate change. Furthermore, they aim to raise social awareness particularly to the consequences of climate change on protective forests and the environment).
12. The RIE Index in Bolzano. Numerical index of environmental quality indicating the effect of building intervention with respect to the permeability of soil and greenery. The objectives are to decrease impermeability of soil, mitigate impact of heavy rains, contribute to CA to heatwaves and reduce high temperature. The R.I.E. procedure applies to all building and urban transformation interventions within production areas subject to building permits. In the case of building measures involving the sealing of large areas, an ecological balance must be created through green roofs, engineering-biological technologies and through greening and planting. It’s a certificate.
13. NbS for adapting of smaller streams to high water and heavy rains in Slovenia. Implementation by the Municipality of Selnica ob Dravi.

## 2.1 WHAT ARE THE CONCLUSIONS OF THE WORKSHOP?

Coming out from the exchanges within the workshop and with the support of a bibliographic review a synthetic drafting about Nature-based Solutions (NbS) has been set up and can be used for knowledge awareness.

NbS are defined as actions that leverage natural or modified ecosystems to address societal challenges in a way that is effective and adaptable, while providing benefits for both human well-being and biodiversity (IUCN French Committee, 2019; Sowińska Świerkosz & García, 2022). The idea of working with nature is central to NbS, to create resilient systems that support sustainable development. Protecting biodiversity is a critical societal challenge, as it underpins human development and economic activities. By utilizing natural features—such as forests, wetlands, and coastal ecosystems—NbS seek to integrate this “biodiversity” priority with other societal challenges, such as climate change adaptation and mitigation, disaster risk

reduction, biodiversity conservation, securing water supplies, fostering socio-economic development and improving human well-being (Rey et al., 2019; Young et al., 2019; Accastello et al., 2019; Alva, 2022). These solutions focus on preserving, restoring, and sustainably managing ecosystems, making them versatile approaches for achieving both environmental and socio-economic benefits.

The NbS concept was first raised during the 2009 United Nations Framework Convention on Climate Change Conference of the Parties, and in 2013 it was incorporated into the Global Program of the International Union for Conservation of Nature (IUCN) (Eggermont et al., 2015). NbS gained further international recognition following COP21 in 2015 and the 2016 World Conservation Congress, especially for their contribution to sustainable development goals, including good health and well-being, clean water and sanitation, life on land and below water, and climate action.

NbS can be applied in three primary ways, individually or in combination across regional actions (IUCN French Committee, 2019): (i) preserving functional and ecologically intact ecosystems; (ii) managing ecosystems sustainably for human use; and (iii) restoring degraded ecosystems or creating new ones. NbS is closely connected to ecological restoration, ecological engineering, and blue/green infrastructure, with a strong emphasis on the preservation and conservation of natural processes (Poratelli et al., 2020; Ommer et al., 2022).

However, effective implementation of NbS requires comprehensive planning that considers local conditions, scales, and stakeholder involvement. Potential trade-offs, such as between conservation goals and economic demands, must be managed through integrated risk management approaches that account for the socio-economic contexts of affected communities. Engaging local stakeholders, enhancing public awareness, and fostering governance frameworks that promote collaboration are all essential to the success of NbS.

As the need for sustainable solutions grows, NbS offer a promising path forward, aligning human development with ecological health, and supporting a more resilient future for both nature and society.

The International Union for Conservation of Nature (IUCN) developed a framework of eight key principles to guide the implementation and effectiveness of NbS. These are the following eight criteria (IUCN, 2020):

1. Address societal challenges: NbS should target and provide solutions to specific societal challenges, such as climate change, disaster risk reduction, food security, water security, and human health.
2. Design at scale: NbS should be implemented at an appropriate scale to achieve the desired outcomes. This includes considering the ecological, spatial, and temporal scale, as well as local and regional needs.
3. Biodiversity net gain: NbS should not only protect biodiversity but should also lead to measurable biodiversity gains over time, enhancing ecosystem health and resilience.
4. Economic viability: NbS must be economically feasible and capable of sustaining themselves over time. This includes considering cost-effectiveness, funding sources, and potential for long-term economic benefits.
5. Inclusive governance: Effective NbS require inclusive, transparent, and participatory governance that involves all relevant stakeholders, including local communities, governments, and the private sector.
6. Equitable and fair: NbS should promote social equity, rights, and fairness, ensuring benefits are shared and accessible to all, particularly marginalized and vulnerable communities.

7. Balance trade-offs: NbS should carefully assess and manage trade-offs to avoid compromising ecosystem integrity, biodiversity, and socio-economic benefits.
8. Adaptive management: NbS must be designed with adaptability and resilience in mind, allowing for adjustments based on monitoring, learning, and changing conditions, especially in response to climate change and evolving socio-economic dynamics.

These eight principles ensure that NbS are applied in a way that provides long-term solutions, fosters resilience, and supports sustainable development in harmony with nature.

Depending on the nature of the ecosystems involved and the engineering approaches used, NbS are classified into three main categories:

1. Blue Nature-based Solutions refer to the use of marine and freshwater ecosystems to address societal challenges. These solutions focus on managing, conserving, and restoring water-based ecosystems such as oceans, coasts, rivers, lakes, and wetlands.
2. Green Nature-based Solutions (refer to the use of terrestrial and land-based ecosystems to address societal challenges these solutions focus on restoring, and sustainably managing “green spaces” such as forests, grasslands, agricultural lands, and urban green spaces. For forest, the term Forest-based Solution is also used. In the Alpine space FbS serve in particular as protective buffers against natural hazards like landslides, floods, and wildfires, especially in vulnerable areas such as mountains and coastal zones.
3. Grey Nature-based Solutions typically refer to the integration of traditional engineering approaches (often referred to as “grey infrastructure”) with blue and/or green NbS. While “grey” generally denotes built infrastructure—such as concrete flood barriers, drainage systems, and levees—Grey NbS involves blending these conventional approaches with natural processes to create more effective and sustainable solutions.

During the workshop, the case of Forest-based Solutions (FbS) proved particularly insightful, highlighting both the importance of NbS and the challenges associated with them in the Alpine Space (including both the adaptation of forest to Climate Change and the use of forest as part of the strategy to develop CC adaptation plans). FbS are of primary importance. Forests can play a critical role in preventing or mitigating natural hazards by reducing their likelihood, frequency, magnitude, or intensity—especially in mountainous (Moos et al., 2018) and coastal areas (Ahmed et al., 2022). These “protective forests” (also known as “protection forests”) help make such regions safer for habitation and serve as effective Ecosystem-based Disaster Risk Reduction (Eco-DRR) solutions (Teich et al., 2022; Nehren et al., 2023). Eco-DRR involves the sustainable management, conservation, and restoration of ecosystems to reduce disaster risks, supporting resilient and sustainable development (Sudmeier-Rieux et al., 2021). Properly managed ecosystems can act as Eco-DRR measures by influencing components of natural hazards and providing essential ecosystem services. These services are crucial for strengthening socio-economic resilience and supporting the livelihoods of communities. The Eco-DRR concept emerged in 2009 and was formally defined in 2013, aligning with forest management practices aimed at safeguarding people and assets from natural hazards, similar to the long-standing approach of multifunctional mountain forest management (Dorren et al., 2004).

As noted, NbS encompass various existing approaches, and Eco-DRR qualifies as NbS when it addresses major societal challenges while benefiting biodiversity (IUCN French Committee, 2019). By integrating protective forests as Eco-DRR measures, it is possible to prevent or mitigate natural hazards, creating resilient landscapes as a primary goal (Nehren et al., 2014). Protective forests, therefore, can be considered a specific form of NbS, focused on hazard prevention and reduction. They can be so classified as “Forest-based

Solutions” (FbS), defined as actions that use or aim to establish forests to preserve healthy ecosystems, restore degraded areas (or create new ones), and improve ecosystem management to address societal challenges, while enhancing both human well-being and biodiversity.

Effective FbS initiatives must be grounded in forest ecosystem functions, implemented at scales appropriate to the societal challenges they address, and strive to balance local and global needs without causing harm to either. They require the involvement of all forestry stakeholders to enable integrated governance and emphasize awareness and education. Additionally, managing protective forests to enhance resilience and protective capacities brings further benefits, such as carbon sequestration, aesthetic value, and support for local communities' livelihoods (Renaud et al., 2016).

The interreg Alpine Space project RocktheAlps has proposed a first SWOT analysis about the main items of protective forest policy within the different countries of the Alpine Space. The following matrix summarizes the current situation. This matrix template can and should be adapted to other NbS in order to establish a current overview of their uses.

		Austria		Germany		France		Italy		Slovenia	
		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Existence of a regulation for risks prevention	National	X			X	X			X	X	
	Regional	X		X			X	X		X	
Existence of a protection forest classification	National	X		X		X			X	X	
	Regional		X	X			X	X		X	
Comprehensive mapping of natural hazards	National	X			X	x		X			X
	Regional	X		X		x		X			X
	Local	X		X		x		X			X
Comprehensive mapping of natural risks	National		X		X		X				X
	Regional		X		X	X		X			X
	Local		X		X	X		X			X
Comprehensive mapping of protection forest ecosystem service	National	X		X		X			X	X	
	Regional	X		X		x			X	X	
	Local	X		X		x			X	X	
Financing of this ecosystem service	EU	X			X	x		X		X	
	National	X			X	x			x	X	
	Regional	X			X	x			x		x
Natural risk prevention document integrating this ecosystem service	Local	X		X			x		x		x
	National	X			X		x		x	X	
	Regional	X			X		X		X	X	
Existence of a standardized methodology for risks zoning	Local	X			X		X		X	X	
	National	X		X		X			x	X	
	Regional	X		X		X		X		X	
Existence of protection forest management guidelines	Local	X		X		X			X	X	
	National	X		X		X				X	
	Regional	X		X		X		X		X	
Societal demand for valuing forest-based solutions		X		X		X		X		X	

Fig. 1 SWOT Analysis of protective forest policy in the Alpine Space

This matrix has to be improved for integrating the Climate Change dimension. Climate and societal changes are projected to have lasting, adverse effects on forest ecosystems in the coming decades. These impacts will manifest as increased natural disturbances (such as forest fires, droughts, and storms) and as changes in the structure and composition of forest stands. Understanding and anticipating these impacts is essential to prevent negative outcomes that may affect the protection of people and human assets from natural hazards, making this a significant challenge for the foreseeable future.

There may also be potential conflicts between the development of FbS and ecosystem preservation. For example, effective FbS might sometimes lead to reduced biodiversity or increase susceptibility to disturbances like wildfires. To address these complexities, the Integrated Risk Management (IRM) approach should be reinforced to account for multiple risks and ensure protection strategies, all socio-economic factors

in vulnerable areas should be considered (Teich et al., 2022). This includes safeguarding transportation infrastructure, economic activities, and all elements essential to regional development. IRM should emphasize the involvement of local authorities and citizens, recognizing that communities—especially in urban areas—often lack sufficient risk information. Alternative development strategies that enhance territorial resilience against natural hazards should also be explored, considering interdependence across regions and scales.

Effective integration of FbS into protection strategies requires a comprehensive understanding of their services and impacts within IRM frameworks and governance (Nesshover et al., 2017). This involves weighing the benefits and limitations of FbS based on scenarios that reflect each region's unique characteristics, including hazard types, socio-economic factors, development trajectories, and climate (e.g., altitude, drought). A key question is how to position FbS within an overarching protection strategy that must also consider technical protections and all phases of the risk management cycle, from preparedness to recovery. To support this analysis, we could develop multi-criteria decision-making tools and ensure access to robust data and models on how various FbS types impact specific benefits and risks in different landscapes. Mountain areas, in particular, are often exposed to multiple risks in the same territory, making it crucial to optimize FbS under potentially conflicting protection goals. Building on extensive experience from Alpine regions, we could develop indicators to evaluate the capacities and limitations of FbS in reducing natural risks while also preserving, restoring, or managing ecosystems and biodiversity (Shah et al., 2020).

For years, many research teams have been active in advancing FbS initiatives, and further studies are needed to deepen knowledge and expertise in this area. Future investigations, which will draw on both disciplinary and interdisciplinary research, will merge insights from forest science, ecology, geoscience, and social science. Cross-disciplinary and multi-stakeholder approaches are essential to realizing the multi-faceted benefits of FbS, which can be applied across aquatic, terrestrial, and transitional environments. This research contributes and will contribute to developing guidelines and recommendations for assessing existing FbS, identifying suitable FbS for various contexts, understanding the benefits and limitations of FbS, and effectively incorporating FbS into global protection strategies tailored to specific regional characteristics and potential environmental changes, including climate. One of the challenges is the raising awareness strategy to be implemented for educational and training purposes of all the concerned stakeholders.

The main inputs from the workshop are summarized in the following “NbS in a nutshell”.

The 2 basic principles of NbS are:

1. To rely on biological, geological, or hydrological processes to provide ecosystem services beneficial to humans.
2. To work with nature rather than control it, promoting the restoration, protection, and sustainable management of ecosystems.

The 4 Main Benefits of NbS are:

1. Sustainability: NbS provide long-term sustainable solutions by preserving ecosystems and avoiding costly and unsustainable artificial infrastructure.
2. Resilience: By enhancing ecosystems' ability to adapt to environmental and climate changes, NbS help strengthen community resilience.

3. Co-benefits: Nature-based interventions often deliver multiple co-benefits, such as biodiversity protection, improved human health, and the economic well-being of local communities.
4. Cost-effectiveness: In many cases, NbS can be more cost-effective than conventional solutions by avoiding the construction and maintenance costs associated with artificial infrastructure.

NbS face challenges and limitations. Here are the 4 main ones identified during the workshop:

1. Knowledge and Awareness: Currently there is a lack of a real “risk and NbS culture”. For example, the great public generally considers that the forest grows by itself and so there is no need for forest rangers. There is also a strong need for more participative management/decision making. How to harmonize and share knowledge/data/models/success and non-success stories? In this framework a greater awareness of the benefits of NbS is needed, along with a better understanding of natural processes and expressing of the uncertainty of the efficiency of some NbS according to the consequences of Climate Change. A communication strategy tailored to the relevant stakeholders, including policymakers, decision makers, managers, and the general public, must be implemented. This strategy should be based on synthesized data and illustrated with both success and failure stories. The creation of a network of experts (scientific, technical, and political) with recognized experience in NbS is necessary at regional, national, and Alpine scales. At the Alpine level, this network should build on existing structures (Alpine Convention, EUSALP) by either establishing a cross-cutting task force across existing working/action groups or creating a dedicated working/action group. The creation of an online, multilingual resource database for the Alpine region, which will gather documentation on NbS (including examples of concrete projects with a critical analysis of whether or not their objectives were achieved), is necessary. The operation of this resource center and the promotion of NbS will also require the implementation of a "NbS flying circus" in the Alpine regions by the regional correspondents of this resource center.
2. Policy Integration: To maximize their effectiveness, NbS must be integrated into policies and planning practices at all levels, from local governments to international bodies. One of the weaknesses of current policies is the financing plan (scheduling, amounts) for NbS implementation and maintenance. Policies should be developed with the goal of supporting the development of real Integrated Risk Management approach and Science-Decision-Action strategies. A solution could be provided by the EU via an European ecosystems services based policy for risk prevention.
3. Impact Measurement: Developing tools and methods to accurately assess the effectiveness and impact of nature-based interventions is essential. Short/medium/long term monitoring of implemented NbS have to be set up in order to improve adaptive management of ecosystems services.
4. An adapted time scale: While the 8 criteria defined by the IUCN are currently the most developed reference for defining NbS, the associated timescale is too restrictive. It is very rarely possible, if not impossible, to meet all 8 criteria simultaneously. Therefore, it is necessary to define an analysis timescale that takes into account both the dynamics of ecosystems and the work agenda of policymakers and decision-makers.

### 3.1 HOW CAN MUNICIPALITIES USE THIS INFORMATION TO INCREASE/IMPROVE/DEPLOY THE SHOWCASE ACTIONS/TOOLS/METHODOLOGIES IDENTIFIED WITHIN THE WORKSHOP?

The main stumbling block to the deployment of NbS lies in the implementation of a truly integrated management of natural risks on the scale of the entire territory concerned (notion of risk basin). Such management requires an interdisciplinary, multi-sectoral and participative approach. It is only from the moment a municipality commits to this Integrated Natural Risk Management that it will be able to make use of the examples and contributions from this workshop on NbS. To do so, it is necessary to enlist the services of an organization capable of acting as a scientific, technical, and political mediator, leading the discussions to achieve the project's implementation and the mobilization of adequate funding sources. For achieving this, the following main steps have to be address:

1. Capacity Building and Knowledge Sharing
2. Permanent state of the art on NbS with identification of success and non-success stories
3. Organize site visits to compile a catalog of examples.
4. Develop a policy for training, information, and education on NbS for all stakeholders.
5. Integration of NbS in risk prevention/protection mapping, planning and policies
6. Be aware of the scale effects
7. Be aware of the potential consequences of CC on NbS efficiency in short, medium and long term
8. Be trained on the use of online tools (modeling platforms, webgis/webatlas, database) dedicated to natural risks, CC, ecosystems for improving the territorial knowledge
9. Developing of online tools for information sharing and communication with friendly graphical user interfaces and adapted to the target groups concerned

Last but not least: developing a realistic funding and payment scheme for NbS with a proactive policy for using current and proposing new financial incentives.

### 4.1 WHAT FORMAT SHOULD BE USED TO PRESENT CONCLUSIONS TO MUNICIPALITIES (AT REGIONAL EVENTS)?

The most suitable format is to create a booklet presenting the key concepts of NbS along with a showcase catalog. As mentioned earlier, it is also necessary to consider the creation of an online, multilingual resource database for the Alpine region, which will gather documentation on NbS (including examples of concrete projects with a critical analysis of whether or not their objectives were achieved), is necessary. The operation of this resource center and the promotion of NbS will also require the implementation of a "NbS flying circus" in the Alpine regions by the regional correspondents of this resource center. This resource center can and should be linked to similar centers, such as the [CAPA platform](#) of Action Group 8 of the EUSALP.

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